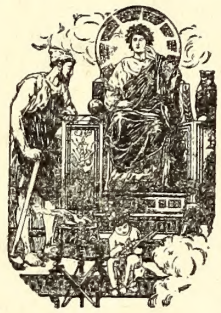
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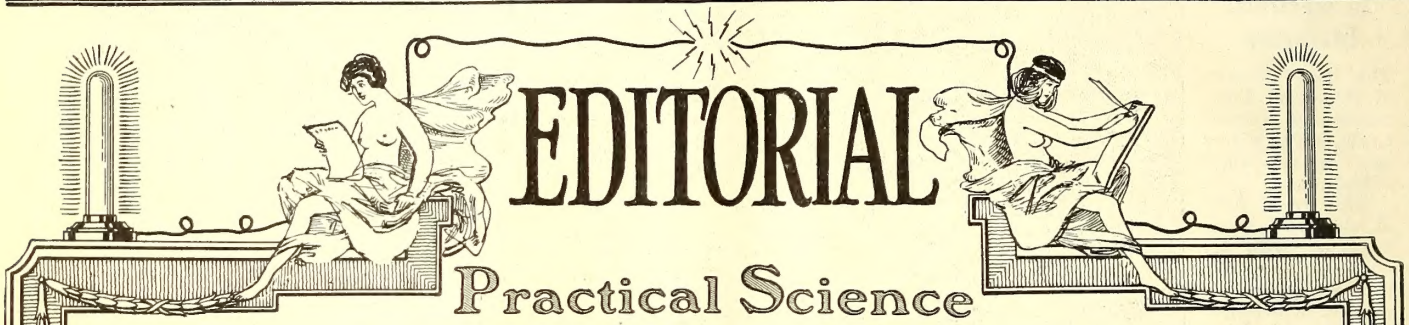
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Practical Science

THE wonderful age in which we are living has never been paralleled in history. We have more comforts, more conveniences, more of everything than human beings ever had, since the creation of the world. Nevertheless, our lives become more and more complex, as time rolls on, while the average human being becomes more perplexed at the strange surroundings in which he finds himself.

Our electro-mechanical age brings forth new surprises constantly, and he who does not know the rudimentaries of mechanics, electricity and general physics is like a blind man in a circus. He hears what is going on, but all is meaningless to him—he cannot get the full benefit of the performance.

Where humanity now finds itself surrounded by machines, and by electrical wires at every hand, it behooves every man to know something about them. Thousands of lives are lost every year because laymen refuse to learn a little about science in general. They get killed because they fight short-circuits with water, when ten minutes of study would have told them that water is a conductor, and that a few handfuls of dry sand—which is a non-conductor—would have saved the life, *and* the house which burnt down due to the short-circuit. If the father had told his boy that a wet rope is a good conductor for electricity that boy would be alive today. Instead, the boy threw the wet rope over the high tension line, while holding it in his hand, and was killed.

If the six hundred auto owners who were asphyxiated last year—the casualties become larger each year—had known a bit of chemistry, they, too, would be living today. But they insisted upon running their engines in a garage with closed doors, and unfortunately, you can't smell carbon monoxid, even if it is deadly.

Then, too, hundreds of people perish in snow storms every year quite unnecessarily. Usually they freeze to death. The white man runs about in a frenzy when he knows himself lost. He becomes overheated, and the perspiration soaks his clothing. Finally he sinks down into the snow, exhausted, and if it is cold enough he is soon frozen stiff. Now Eskimos, who have learned a bit of science by hard experience, prefer to live pleasantly thru the worst snowstorm, with the temperature below zero. If the Eskimo becomes lost in the wilderness he knows better than to run about aimlessly. He promptly digs a cave into the snow, with the entrance away from the wind, using only his hands for tools. Inside of ten minutes he is safely ensconced in a comparatively warm shelter. He then closes up the entrance almost entirely, sits down, drops his head on his knees, and has a refreshing sleep. The next morning he digs himself out, and is on his way.

If the writer had not known something about electricity, he, too, might not be here to write these lines. As a boy he went down into an unoccupied cellar. The wind blew the wooden door shut, locking him in, as the iron latch was outside. The only other exit was an open window hole barricaded with stout iron rods, thru which the wind roared. The temperature was below zero. The cellar was empty, save for a few wooden crates, the object of the visit. The cellar being distant from the house and other habitations, the parents away, and the caretaker off for the night, there was every possibility of his freezing to death. No tools to break down the door, no matches to make a fire. But there was a portable light, with two large electric dry cells in a wooden box, which the writer had brought along to light his way.

He unraveled the stranded electric cord and extracted a single thin copper strand an inch long. With this he short-circuited the dry cells. The wire became white hot. A piece of paper was touched to it, which burst into flame; a broken piece of crate wood was ignited by the flame, and a fire soon roared. A burning crate set the cellar door on fire, and in ten minutes the adventure had come to a close.

H. GERNSBACK.

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The Secret of Being a Convincing Talker

How I Learned It in One Evening

By GEORGE RAYMOND

"HAVE you heard the news about Frank Jordan?"

This question quickly brought me to the little group which had gathered in the center of the office. Jordan and I had started with the Great Eastern Machinery Co., within a month of each other, four years ago. A year ago Jordan was taken into the accounting division and I was sent out as salesman. Neither of us was blessed with an unusual amount of brilliancy, but we got by in our new jobs well enough to hold them.

Imagine my amazement, then, when I heard:

"Jordan's just been made Treasurer of the Company!"

I could hardly believe my ears. But there was the "Notice to Employees" on the bulletin board, telling about Jordan's good fortune.

Now I knew that Jordan was a capable fellow, quiet, and unassuming, but I never would have picked him for any such sudden rise. I knew, too, that the Treasurer of the Great Eastern had to be a big man, and I wondered how in the world Jordan landed the place.

The first chance I got, I walked into Jordan's new office and after congratulating him warmly, I asked him to let me "in" on the details of how he jumped ahead so quickly. His story is so intensely interesting that I am going to repeat it as closely as I remember.

"I'll tell you just how it happened, George, because you may pick up a pointer or two that will help *you*.

"You remember how scared I used to be whenever I had to talk to the chief? You remember how you used to tell me that every time I opened my mouth I put my foot into it, meaning of course that every time I spoke I got into trouble? You remember when Ralph Sinton left to take charge of the Western office and I was asked to present him with the loving cup the boys gave him, how flustered I was and how I couldn't say a word because there were people around? You remember how confused I used to be every time I met new people? I couldn't say what I wanted to say when I wanted to say it; and I determined that if there was any possible chance to learn how to talk I was going to do it.

"The first thing I did was to buy a number of books on public speaking, but they seemed to be meant for those who wanted to become orators, whereas what I wanted to learn was not only how to speak in public but how to speak to individuals under various conditions in business and social life.

"A few weeks later, just as I was about to give up hope of ever learning how to talk interestingly, I read an announcement stating that Dr. Frederick Houk Law of New York University had just completed a new course in business talking and public speaking entitled 'Mastery of Speech.' The course was offered on approval without money in advance, so since I had nothing whatever to lose by examining the lessons, I sent for them and in a few days they arrived. I glanced through the entire eight lessons, reading the headings and a few paragraphs here and there, and in about an hour the whole secret of effective speaking was opened to me.

"For example, I learned why I had always lacked confidence, why talking had always seemed something to be dreaded whereas it is really the simplest thing in the world to 'get up and talk.' I learned how to secure complete attention to what I was saying and how to make everything I said interesting, forceful and convincing. I learned the art of listening, the value of silence, and the power of brevity. Instead of being funny at the wrong time, I learned how and when to use humor with telling effect.

"But perhaps the most wonderful thing about the lessons were the actual examples of what things to say and when to say them to meet every condition. I found that there was a knack in making oral reports to my superiors. I found that there was a right way and a wrong way to present complaints, to give estimates, and to issue orders.

"I picked up some wonderful pointers about how to give my opinions, about how to answer complaints, about how to ask the bank for a loan, about how to ask for extensions. Another thing that struck me forcibly was that, instead of antagonizing people when I didn't agree with them, I learned how to bring them around to my way of thinking in the most pleasant sort of way. Then, of course, along with those lessons there were chapters on speaking before large audiences, how to find material for talking and speaking, how to talk to friends, how to talk to servants, and how to talk to children.

"Why, I got the secret the very first evening and it was only a short time before I was able to apply all of the principles and found that my words were beginning to have an almost magical effect upon everybody to whom I spoke. It seemed that I got things done instantly, where formerly, as you know, what I said 'went in one ear and out the other.' I began to acquire an executive ability that surprised me. I smoothed out difficulties like a true diplomat. In my talks with the chief I spoke clearly, simply, convincingly. Then came my first promotion since I entered the accounting department. I was given the job of answering complaints, and I made good. From that I was given the job of making collections. When Mr. Buckley joined the Officers' Training Camp, I was made Treasurer. Between you and me, George, my salary is now $7,500 a year, and I expect it will be more from the first of the year.

"And I want to tell you sincerely, that I attribute my success solely to the fact that I learned how to talk to people."

****

When Jordan finished, I asked him for the address of the publishers of Dr. Law's Course and he gave it to me. I sent for it and found it to be exactly as he had stated. After studying the eight simple lessons I began to sell to people who had previously refused to listen to me at all. After four months of record breaking sales during the dullest season of the year, I received a wire from the chief asking me to return to the home office. We had quite a long talk in which I explained how I was able to break sales records—and I was appointed Sales Manager at almost twice my former salary. I know that there was nothing in me that had changed except that I had acquired the ability to talk where formerly I simply used "words without reason." I can never thank Jordan enough for telling me about Dr. Law's Course in Business Talking and Public Speaking. Jordan and I are both spending all our spare time making public speeches on war subjects, and Jordan is being talked about now as Mayor of our little town.

So confident is the Independent Corporation, publishers of "Mastery of Speech," Dr. Law's Course in Business Talking and Public Speaking, that once you have an opportunity to see in your own home how you can, in one hour, learn the secret of speaking and how you can apply the principles of effective speech under all conditions, that they are willing to send you the Course on free examination.

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FREDERICK HOUK LAW

As educator, lecturer, executive, traveler and author few men are so well equipped by experience and training as Dr. Law to teach the art of effective speaking. His "Mastery of Speech" is the fruit of 20 years' active lecturing and instruction in Eastern schools and colleges preceded by an education at Oxford Academy, Amherst College, Columbia University, The Teachers College, Brown University, and New York University. He holds the degrees of A.B., A.M., and Ph.D.

Dr. Law is the author of two novels, two books of poetry, and editor of six school text-books. At present he is lecturer in English in New York University. Lecturer in Pedagogy in the Extension Work of the College of the City of New York, Head of the Dept. of English in the Stuyvesant H. S. and writer of the Weekly Lesson Plans for The Independent.

The Burgess BLUE BOOK

for all Practical Men and Electrical Students

(See review of this book by Editor in December issue of your Electrical Experimenter page 568)

I have prepared a pocket-size note book especially for the practical man and those who are taking up the study of electricity. It contains drawings and diagrams of electrical machinery and connections, over two hundred formulas for calculations, and problems worked out showing how the formulas are used. This data is taken from my personal note book, which was made while on different kinds of work, and I am sure it will be found of value to anyone engaged in the electrical business.

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Also Alternating Current Calculations in finding Impedance, Reactance, Inductance, Frequency, Alternations, Speed of Alternators and Motors, Number of Poles in Alternators or Motors, Conductance, Susceptance, Admittance, Angle of Lag and Power Factor, and formulas for use with Line Transformers.

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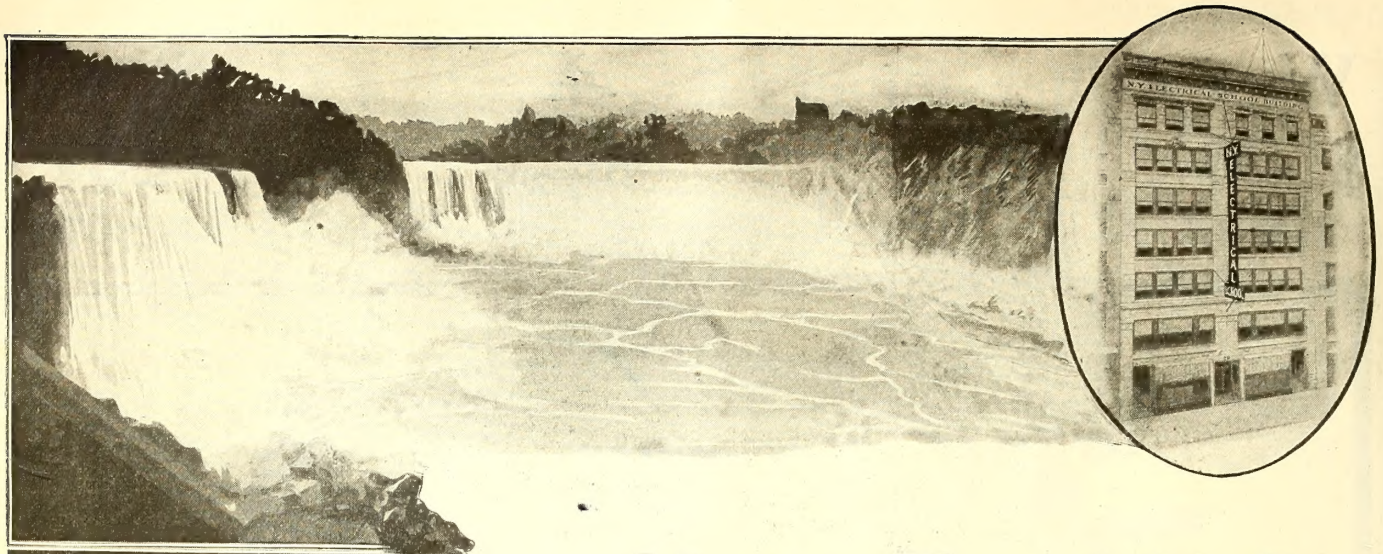
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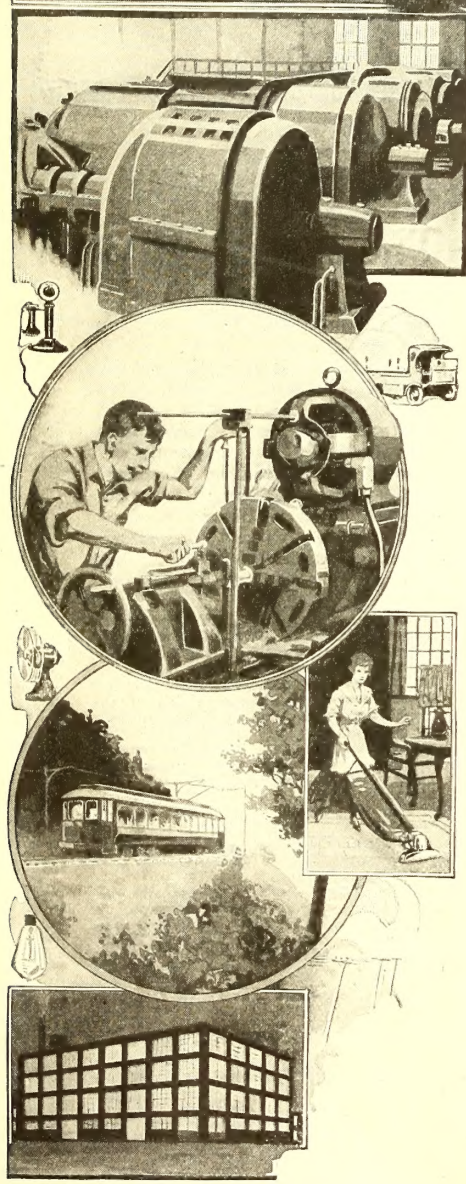
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H. GERNSBACK – EDITOR
H. W. SECOR – ASSOCIATE EDITOR

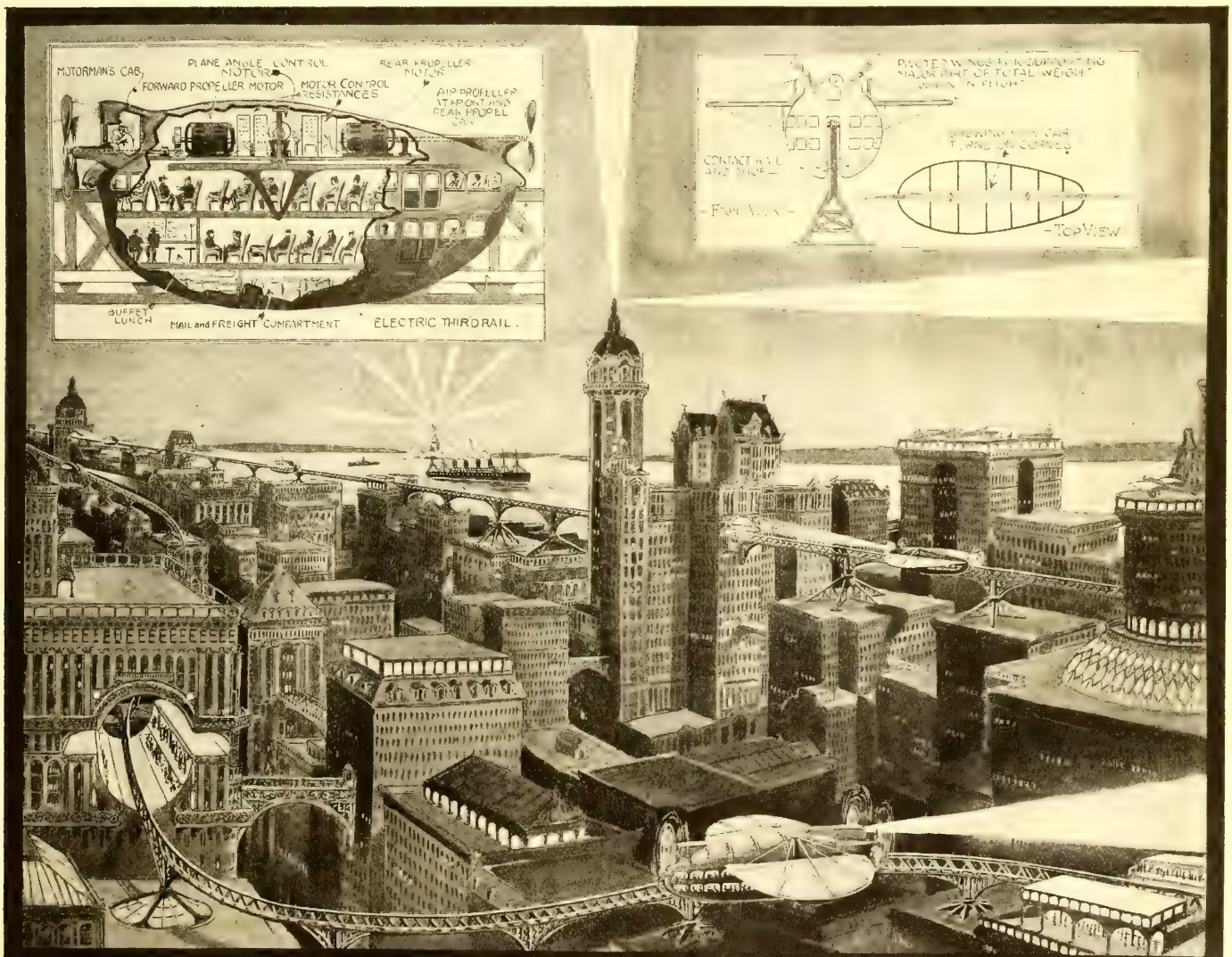
Vol. VII. Whole No. 73 MAY, 1919 No. 1

APR 18 1919 U.S. PATENT OFFICE

Future Rapid Transit

PEOPLE who have traveled abroad will remember having seen the remarkable suspended aërial railway of Elberfeld (Germany), the cars having wheels on the roof instead of underneath, and but one rail being used. This form of construction gives, among other considerations, much greater flexibility to the speeding cars or trains, as for example when they wish to turn sharp curves at comparatively high speed. Possibly many will remember having seen this interesting suspended railway in the motion picture travelogues given by Burton Holmes. It has always seemed to us, however, that these cars have a little too much freedom of movement to make the ride as comfortable as it might be to the passengers, owing to the constant swinging or sidewise rolling motion produced by this cradle suspension arrangement. Apparently there are other people who have entertained similar ideas, for in the accompanying illustration there is shown a new development of a monorail car, which might be termed an "Aërial Monoflier," and which has been recently invented and patented by the celebrated French engineer, M. Francis Laur of Paris. As M. Laur points out in his description of the invention, his scheme relates to an improvement in a vehicle for use in high speed locomotion in connection with a monorail or single track. A very novel idea of the project is a passenger-carrying vehicle somewhat in the form of

(*Continued on page* 66)



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The Aërial Monoflier of Tomorrow—Equipt with Wings, Like an Airplane, It Will Skim Along Thru the Air, Guided by the Monorail. The Cars Are Propelled by Motor-Driven Propellers, Which Derive Their Power from Third Rails, as the Car Glides Along at Speeds of 200 to 300 Miles Per Hour. When in Motion the Entire Weight Is Practically Carried by the Wings, the Same as in an Airplane.

Will Man Freeze the Earth to Death?

By E. T. BRONDSDON

"TO RENT: Ten-room suburban home. Three baths. Sun, sleeping and breakfast porches. Radium heating system (20 pounds) . . ." To find this advertisement, look in the classified columns of any metropolitan newspaper five or six centuries hence. Our great-great-grandchildren fifteen times removed will be worrying about paying the rent on some such dwelling. Have you paid your "Radium Rent" will be a common slogan then.

Radium power, light and heat for apartment and home will seem as much of a commonplace to them as soft coal furnaces seem to us. In tomes of ancient history they will read stories of how their ancestors struggled thru the smoky winter of 1918, and they will marvel at our lack of understanding. Soft coal then will have a place only in museums.

Twenty pounds of radium gives off an amount of heat in six months equivalent to that secured by burning four and one-half tons of the best Pocahontas or anthracite coal. The ten-room house mentioned above would be adequately heated, however, on twenty pounds, because a radium heating plant would be *one hundred per cent efficient*. Even with hot water and hard coal from eighty to ninety per cent of the heat our plants generate goes up the chimney. A radium system would have no chimney. Every single heat unit would be conserved for the interior of the house and distributed by any ordinary medium, such as register, radiator or the like.

In addition to this, the radium system would have the splendid recommendation that there would be no flues, traps or pipes to be cleaned, and no ashes would accumulate to make the householder angry on Saturday afternoon. Then there would be the greatest point of all. Once installed, this radium system *never would have to be replaced!* When one house began to disintegrate from old age, the mysterious metal could be taken out and installed in the system of a new house, and so on forever, unless some careless janitor took it out to clean and left it in the subway Coal men and ash carters would pass into that same merciful oblivion which shelters stage-coach bandits and Indians on the warpath.

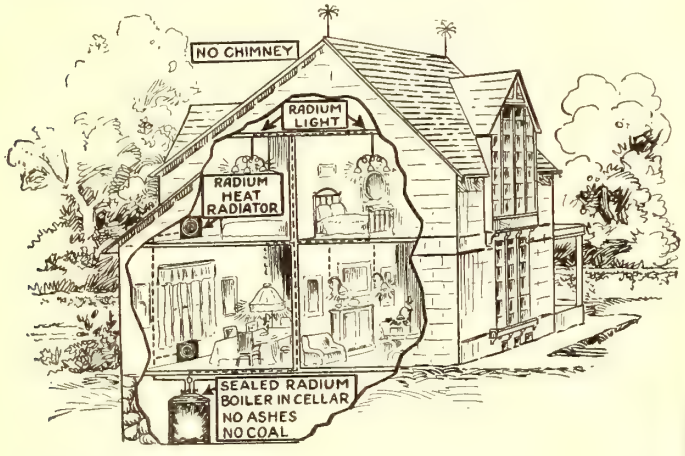
The reason why such a radium system would never have to be replaced is that radium is the one and only close approach to perpetual motion to be found on our globe. Look at a piece of radium one-thousandth the size of a pin point thru a *spinthariscope*. This is an instrument consisting of a high-magnifying lens and an aluminum disc covered with zinc sulfid. When viewed in this manner millions of tiny arrows of fire are seen to be flying from the radium and impinging on the zinc sulfid with an explosion like that of a fire ball from a Roman candle.

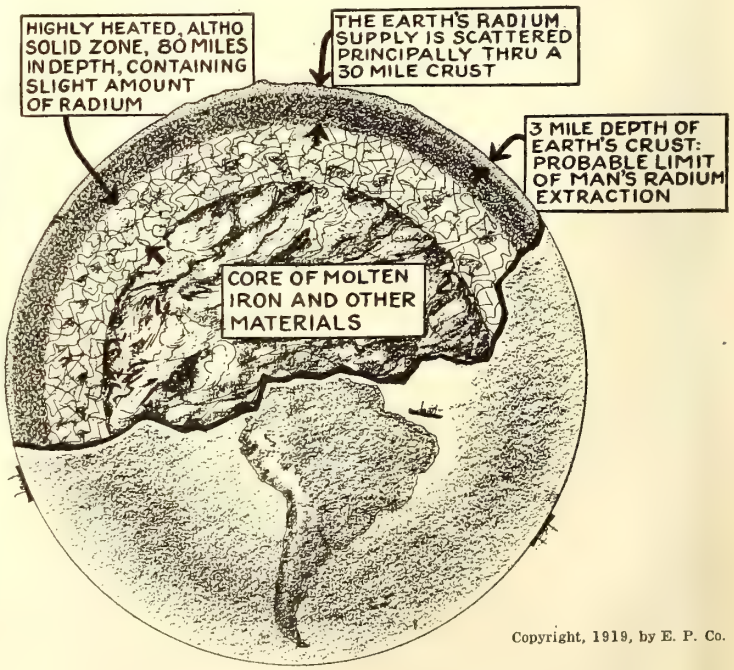
Tho each of the exploding projectiles of helium—radium somehow transforms itself into active atoms of this other element—looks nearly as large as the original divot of radium, you may glue your eye to the spinthariscope for hours—centuries, if you live that long—and you never will see any diminution in the discharge or in the size of the radium piece.* Scientists who have given the matter intensive study over long months and years say that they suspect radium of losing an infinitesimal part of its actual weight in the course of a few eons, but that human beings are going to have trouble gathering accurate data on the subject unless a dynasty of scientific Methuselahs is established.

The one big obvious objection at present to the use of radium for heating plants lies in the scarcity and tremendous cost of the metal. One ounce only would cost, at the present market price, approximately $40,000. The twenty pounds necessary for heating the ten-room house mentioned would retail at $12,800,000, were such a quantity procurable. Figuring interest at six per cent, the cost of that radium heating system for a year—excluding the original investment, which would not appreciably deteriorate—would be in the neighborhood of $768,000, or about 4,000 times the cost of coal heating today.

The only logical reason in the world for even allowing imagination to roam on this subject lies in the terrible and undisputed fact that *somewhere we are going to have to get heat if we are to live!*

So much space has been given in the last decade to learned dissertations on our rapidly decreasing supplies of coal and petroleum that it is useless to dwell on this. Suffice it to say that the last reports of competent authorities state baldly that we will surely be out of both *forever* at the conclusion of the present century, provided our present rate of consumption is neither raised or lowered. Since we have no assurance that the rate of increase of consumption will not keep on, we may bet safely that the year 1975 will see coal and oil so scarce that only millionaires can afford them. Coal then may be $500 a ton, and crude oil $25 a gallon. Alas for the "flivvers"! Imagine Mr. Autoist of that day going into the garage and asking for a new "can" of Radium for his "Radiobile." It can happen. (*Continued on page* 59)





Radium Power, Light and Heat for Apartment and Dwelling Will Seem as Much of a Commonplace to Those of Future Generations as Soft Coal Furnaces Seem to Us. In Tomes of Ancient History They Will Read Stories of How Their Ancestors Struggled Thru the Smoky Winter of 1918, and They Will Marvel at Our Lack of Understanding. All Because of the Wonderful Power of "Radium" to Give Off Energy—Convertible Into Heat, Light, and Power, for a Practically Indefinite Period. At Any Rate for Thousands of Years. So the Principal Problem We Have to Solve Is—How to Find a Far Cheaper Way to Remove the Radium Than We Have at Present. And Why Should We Do This? Because, as Mr. Brondsdon Points Out, the Coal Supply of the World Is Fast Giving Out. On the Other Hand, Man Must Not Remove Too Much Radium from the Earth or the Earth May Freeze to Death.

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*This is not strictly the case, for the zinc sulfid spinthariscope we have to-day, for while the radium will last for thousands of years, the zinc sulfid will give out in a relatively short time. However, there are undoubtedly other substances which would last much longer than zinc sulfid. Another variable factor, variable in the sense that we have not lived long enough with radium yet to tell exactly how long it will last before losing its power, is the total life of this marvelous substance. Scientists tell us that in 1,800 years radium loses one-half of its activity. In another 1,800 years one-half of the remainder will have disintegrated, etc., etc. So that on this assumption the radium will have totally disintegrated in 22,000 years.—Editor.

How the French Located Submarines

ONE by one the multitudinous scientific secrets of the great World War are finding their way to the public press, so that the student of science may at last have his appetite appeased in his quest of descriptive matter on some of the master problems which have been worked out and solved by engineers and scientific workers connected with army and navy developments. Probably no one problem in the whole war drew more attention from laymen and scientists alike than did the one of accurately discovering and locating the whereabouts of the Kaiser's U-Boats. The United States Naval Advisory Board received thousands upon thousands of suggestions, all telling how very simple it was to ferret out and locate the position of an enemy submarine, just by placing a microphone or set of microphones in the hull of a vessel and connecting these up with a set of telephone receivers, so that the sound produced by the submarine propeller and motor would be picked up by the microphones and thus heard in the receivers. Various methods were described for taking certain definite and very precise measurements along these lines, so as to work out mathematically or otherwise the position of the lurking sub-sea fighter. Considerable success was obtained with similar arrangements by the navies of the different countries participating in the World War, but the Walser gear—a special type of hydrophone used particularly for listening to submarines under water was developed and successfully used by the French Navy and other allied vessels for accurately locating enemy submarines at distances of one mile to three miles or more, depending upon the operating conditions and the size of the submarine.

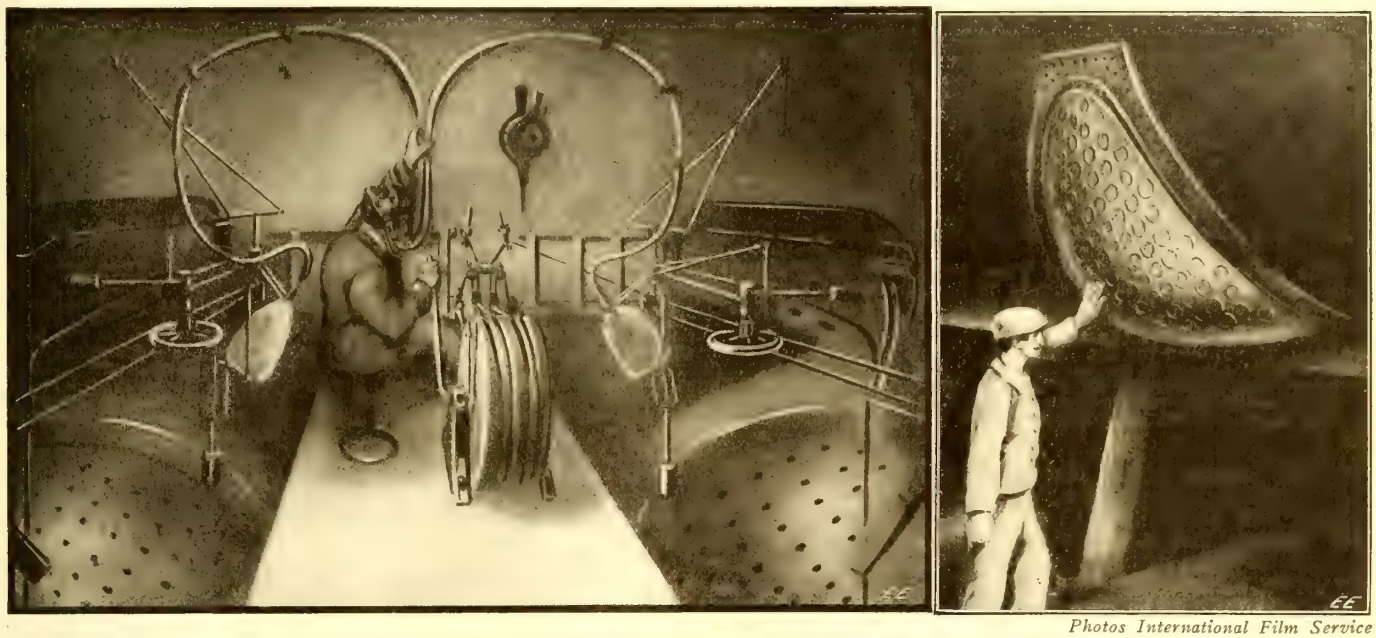
The Walser Gear, whose construction has been kept secret during the war, is a directional apparatus for detecting and recording sounds heard thru water and thus locating the presence or approach of enemy ships. Many different devices for "listening" for enemy ships have been disclosed, but this apparatus, the invention of Lieut. Georges Walser, of the French Navy, is recognized as the most improved type and most practicable.

The sounds are received thru a number of vibrating diaframs fitted into holes pierced in a boss, or "blister" of sheet steel, which replaces a corresponding section of a ship's hull. The observer works in a sound-proof cabin stretching across the whole width of the ship, and wears a listening helmet attached to two trumpets. Into these trumpets the sounds are focust by the vibrating diaframs attached to the the "blister."

Some of the disadvantages of the ordinary listening microphone arrangement for the detection of submarines are the following: Invariably the vessel on which they are mounted has to be stopt momentarily while a listening test is being made, in order that the ship's engines shall not drown out the sounds which the listening operator is endeavoring to pick up from the sea. It is interesting to mention in this connection, that some of the American listening devices of this type were so remarkably sensitive that even a small dynamotor used on the regular wireless apparatus on the vessel had to be mounted on springs, so that the extremely slight mechanical vibration set up by it would not interfere with the sounds picked up from the water on the submerged microphones fastened to the hull of the boat. Another fault found with the ordinary "hydrophone" is that the different sounds received simultaneously could not be distinguished very readily from one another, and even if but one sound was picked up, the direction from which the sound emanated was not very perfectly indicated.

Practically speaking then, one of the

(Continued on page 82)



Photos International Film Service

The Walser Gear—a Type of Hydrophone Used for Submarine Listening. The Walser Gear, Whose Construction Had Been Kept Secret During the War, is a Directional Apparatus for Detecting and Recording Sounds Thru Water and Thus Locating the Presence or Approach of Enemy Ships. This Apparatus is the Invention of Lieut. Georges Walser, of the French Navy, and is Recognized as the Most Improved Type and Most Practicable. The Sounds are Received Thru a Number of Vibrating Plates Fitted Into Holes Pierced in a Boss, or "Blister" of Sheet Iron, Which Replaces a Corresponding Section of a Ship's Hull. The Observer Works in a Sound Proof Cabin Stretching Across the Whole Width of the Ship, and Wears a Listening-helmet, Attached to Two Trumpets. Into These Trumpets the Sounds are Focused By the Vibrating Plates Attached to the "Blister." Left:—Detecting the Presence of Enemy Ships On or Under the Surface of the Sea. An Observer Using the Walser Gear in a Special Cabin Fitted Up as a Listening Post. Right:—On the Hull of the "Henriette II", a French Warship Which is Using the Apparatus, Showing the Exterior of the Sound—Collecting Boss or "Blister".

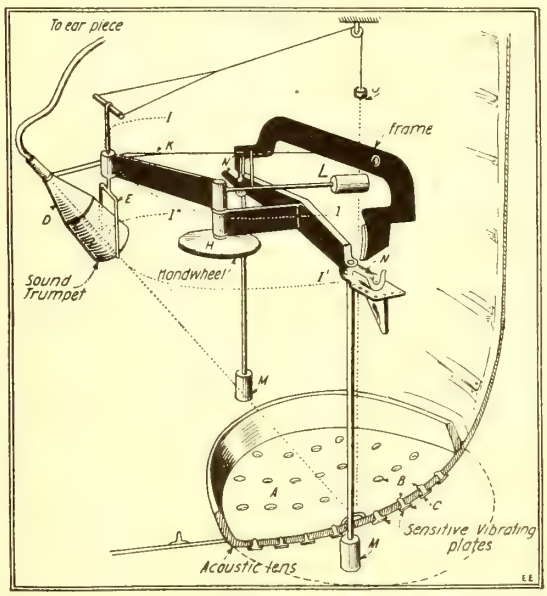
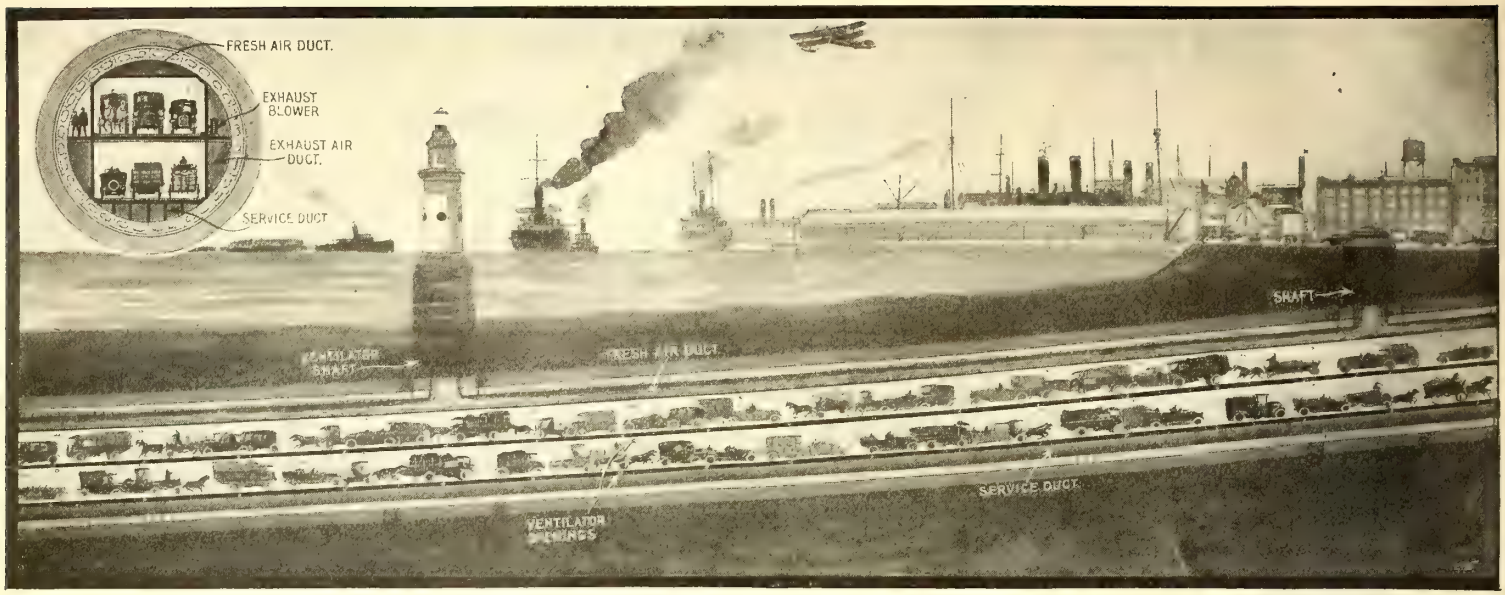


Diagram of One "Lens" of the Walser Submarine Detector and Locater, Showing the Carefully Worked Out Balancing Scheme for Supporting the Movable Sound Trumpet Over the Various Sound Focal Points.



The Accompanying Sectional View Shows Vividly How the New Vehicular Tunnel Under the Hudson River at New York City Will Look When Finished. There Seems to be No Question at Present as to the Possibility of Building This Tunnel, and the Only Remaining Details Are Engineering Considerations Such as Ventilation, Etc., Which Are Being Rapidly Solved by Some of the Crack Engineers of America, Including No Less a Personage Than General George W. Goethals, Builder of the Panama Canal, and Now Holding the Position of Consulting Engineer to the Interstate Bridge and Tunnel Commissions of New York and of New Jersey. Several Other Proposals Have Been Brought Forward for the Building of This Tunnel Under the Hudson River, But the Goethals Plan Seems to be the Most Feasible, and the One Most Likely to be Adopted. The Length of This Vehicular Tunnel Will be About 9,400 Feet from Portal to Portal, with a Distance of 5,500 Feet, or More Than a Mile Separating the Bulkhead Lines, if These Are Placed Back of the Shore Line. In View of the Fact that the Ventilation Problem is at Present One of the Most Important, and the One Responsible for the Most Discussion Among Tunnel Experts, We Have Several Suggestions in the Present Article and Illustrations Which Might, if Adopted, Help to Bring About the Early Adoption

Hudson River

By H. WINFIELD
Associate Member American

THE bridging of the Hudson River, commonly known as the North River in New York City, is an engineering problem that has been before the people of the states of New York and New Jersey for probably more than thirty years. A bridge across this great water highway would no doubt have been constructed many years ago, if it had been found possible to raise sufficient funds to render this dream a living reality. Engineering experts have recently bestirred themselves with the thought of crossing the Hudson either by bridge or else by means of a tunnel, particularly a vehicular tunnel suitable for horse-drawn, electric and gasoline propelled vehicles. The bridge question seems to have been discarded practically altogether now, owing to its tremendous initial cost, which would be about $72,000,000 at least, compared to the initial cost of $12,000,000 for constructing a large tunnel under the Hudson on the newly revised plan proposed by General George W. Goethals, the well-known American engineer and builder of the Panama Canal. General Goethals has been appointed consulting engineer to the Interstate Bridge and Tunnel Commissions of New York and of New Jersey. There are many reasons why New York should have means of communication such as this, as its sister state supplies, either directly or indirectly, a very large portion of the food and other commodities for greater New York's population of 7,000,000, which is brought to the piers on the west side of the Hudson by numerous railroads. Right here there is a constant and prohibitive wastage of perishable food products, owing to the highly congested and inadequate terminal facilities afforded for their movement.

At the present time there is more or less agitation in the legislatures of both states between those friendly and unfriendly to the Hudson River project. So far the one great problem, according to some of the testimony being given, and which has seemed almost insurmountable, is the proper ventilation of this tube, especially where gasoline driven vehicles are to be permitted to exhaust devitiating gases into the air of the tunnel. But according to a very able engineering report on this project, given in the Journal of the Franklin Institute and prepared by Martin Schreiber, Chief Engineer of the Public Service Railway Company of New Jersey, the ventilating problem of such a tunnel as proposed by General Goethals and other engineers can be readily taken care of, as actual laboratory tests have proven, and which have provided a satisfactory basis for calculating the results of such a long tunnel as that under the Hudson. Also to back up the argument for building the tunnel, there is precedence afforded by the fact that London, England, has built two vehicular tunnels under the Thames River, one 6,200 feet long, and the other 6,883 feet long.

The editors make several new tunnel suggestions, which are shown in the illustration accompanying this article, whereby the gigantic ventilating problem could be overcome to a large extent by controlling the kinds of traffic that should be allowed to pass thru the tube. First, the writer would suggest that the engineers contemplating the building of this tunnel consider a cable-way, one of which would be provided on each roadway, east and west, for the purpose of hauling *gasoline operated* vehicles thru the tunnel, *without their engines being operated,* thus doing away with the production of the objectionable carbon monoxid and other poisonous gases emanating from their exhaust. It would not be an impossible, or even impracticable matter, if such an electric motor-operated cable-way, similar to the old cable-car systems, were used to haul the gasoline vehicles thru the tunnel to Jersey or to New York. It could be arranged to have the owners purchase a standard cable grip, which could be fitted on to any gasoline vehicle at nominal cost.

Another proposal, made by Mr. H. Gernsback, is one employing a *moving roadway* of sufficient width to accommodate gasoline auto trucks, the roadway being operated by electric motors spaced at suitable intervals along its length.

Another proposal suggested by the writer would be to utilize a trolley wire over the one line of traffic apportioned to gasoline vehicles on each roadway, and having the owners of these vehicles equip them with a trolley pole, but by the time the owners had installed an electric motor under the gasoline vehicles for use with it, it would probably be just as well for the tunnel operating engineers to ask the owners of such vehicles to invest in electric trucks for that particular traffic intended to go via the tunnel.

All of the tunnel proposals now under consideration agree on the location, which extends from Twelfth Street, Jersey City, to Canal Street, New York. The termini of the tunnel at both ends are located in the center of the trucking and freight districts. The New Jersey terminus is also happily located adjacent to the great freight yards of the principal railroads, and close to the main ferry lines, thus providing every chance for close co-operation. Besides, the great Lincoln and other much used vehicular highways lead to the location proposed for the Jersey City terminus.

The Hudson tubes as well as the Pennsylvania tunnels under the Hudson River, which are used for railway traffic exclusively, were driven by the well-known shield method. General Goethals, in his proposal for the new Hudson vehicular tunnel, has advocated the shield-driven double-deck single tube, as shown in the accompanying illustration. This tube is to have an internal diameter of 36 feet, with two 18-foot roadways, one super-imposed above the other, and a concrete floor between them. This proposal for the tunnel would permit of four lines of vehicles, two on each roadway, two of the faster moving type such as pleasure automobiles on the upper floor, and two of the slower moving vehicles, such as auto-trucks, on the lower floor.

Most of these under-river tubes have been constructed with cast-iron blocks built of segmental form, which were bolted together after being put in place, and which thus tended to resist any external hydrostatic



of the Tunnel Project. Among These Features Are the Following:—First, That a Ventilator Shaft be Placed a Comparatively Short Ways Out in the River at Either Approach, So as to Simplify the Ventilating Problem by Reducing the Length Between the Bulkheads. Second, That Gasoline Vehicles be "Hauled" Thru the Tunnels So as to Eliminate the Fouling of the Air by Obnoxious Exhaust Gases, Particularly Carbon Monoxid, by Means of a Moving Platform. Third, Haul Gasoline Vehicles Thru the Tunnel by a Cableway Similar to the Well-Known Cable Car System. Fourth, Cause the Gasoline Vehicles to be Fitted with a Trolley Pole and Electric Motor for the Purpose of passing Thru the Tunnel Without Discharging Obnoxious Gases. The Goethals Proposal Calls for a Concrete Block Tunnel, 42 Feet in Outside Diameter, with Two Road Levels, as Here Shown. One Roadway Will be for East-Bound Traffic, and the Other for West-Bound Traffic. Actual Laboratory Tests On a Short Length of Tunnel Have Shown That 750 H.P. Would be Required to Operate the Fresh Air and Exhaust Fans, with a Maximum Capacity of 360,000 Cubic Feet of Fresh Air Per Minute.

Vehicular Tunnel

SECOR

Institute Electrical Engineers

pressure with great power, much in the same way that the stones of an archway tend to support the arch. The outside of these segmental steel tubes is covered over with a fairly thick coating of concrete. Here is where the Goethals proposal differs radically from former practise, and there is considerable discussion now taking place as to the feasibility and practicability of his proposed design, which is as follows:

General Goethals' proposition is that the tunnel be constructed of O'Rourke concrete blocks in segmental form. Outside of this tube a gravel packing is to be placed. Some experts seem to doubt whether such a tube would be thoroly water-proof, and also what would happen in case of an earthquake or other severe concussion, as when a powder boat or supply of explosives might happen to blow up in the harbor, as has occurred several times during the war, when the concrete tube might crack with an appalling loss of life.

Detailed plans have been drawn up by the New York State Bridge and Tunnel Commission, under the direction of Major General George W. Goethals and John F. O'Rourke, which provide for the driving of the tunnel by the use of a shield forty-two feet in diameter—the method most usual when dealing with soft material. The material under the Hudson River is a soft silt and sand overlaid by still softer material of sewage origin, which is almost fluid. These conditions are complicated by the presence of ledge rock which is occasionally encountered. In a shield having a diameter of twenty-five feet, there is a difference in pressure between the top and bottom of ten pounds per square foot. This makes it difficult to guard against blow-outs and other accidents caused by the difference in pressure at the top and bottom of the shield, tunnel experts consulted by the state commissions have pointed out.

The diameter of the shield used in driving the Hudson tunnel was 17 feet; that of the Pennsylvania tunnel shields 23 feet 6 inches. The latter were the largest ever used under either the Hudson or the East rivers. The Rotherhithe tunnel, under the Thames River in England, was driven with a shield 30 feet in diameter thru clay mixt with shells, pebbles, loam, a much firmer material than that under the Hudson.

Of course, the traffic would have to be handled so that approximately half of the vehicles would move *eastward* and the other half *westward*. Once the tunnel is built, however, this becomes a problem for the traffic engineers of that year to solve. According to the Goethals plan, the fresh air duct is at the top of the tunnel, and fresh air is constantly pumped along this duct by means of powerful electrically-driven blowers and fans, while the foul air, including exhaust from the gasoline vehicles, is drawn out thru ducts at the bottom of the roadway. Besides, there are additional ventilating and foul air ducts at either side of the tunnel, walled off from the roadways.

To find out exactly what would happen in a section of such a tunnel with a number of gasoline vehicles operating their engines therein, a test building, corresponding in cross-section to the proposed tunnels and measuring 125 feet in length, was constructed at Newark, N. J. Eight automobiles were operated in this building, which could be shut off air-tight and fresh air pumped in at the top and the exhaust pumped out at the bottom, or vice versa. A number of elaborate tests of various kinds were carefully made by experts, including Professor Gellert Alleman, of Swarthmore, Pa., and Dr. H. Jermain Creighton, of Swarthmore College. From a very elaborate and convincing analysis on the various gases present in the tube after the automobiles had been operated for a period of forty minutes, Prof. Alleman reported that when all doors were closed and the ventilators opened, after the engines of eight cars had been *running light* for forty minutes, the condition of the atmosphere was almost normal, so far as physiological action was concerned, and the amount of carbon monoxide content not dangerous This calculation was further supported by the fact that eighteen persons who remained in the tunnel during the test for a continuous period of forty minutes experienced no unpleasant sensations from breathing the air. The contaminated air in this particular test showed .075 per cent. carbon monoxid, and 6 per cent. carbon dioxid, which proved that the per cent. of carbon monoxid was so small as to be negligible. With the data thus obtained, it was calculated that air supply fans with a maximum capacity of 360,000 cubic feet of fresh air per minute, and exhaust fans having 20 per cent. more capacity, would be required to ventilate the tunnel. The total amount of horse-power computed for operating these fans was 750 H.P. The length of the proposed tunnel under the Hudson, from portal to portal, would be approximately 9,400 feet, with a distance of about one mile, or somewhat over 5,000 feet between the bulkhead lines.

As aforementioned, London has built two vehicular tunnels under the Thames, one 6,200 feet long, the other 6,883 feet. Public interest in tunnels for New York was aroused about thirty years ago by Austin Corbin, who proposed tubes under both the Hudson and East Rivers. Scientists charted the bottoms of the two rivers and reported that tunnel construction was feasible. Perhaps it might have been undertaken at that time but for Mr. Corbin's death. Twenty years later William G. McAdoo undertook this work. President Cassatt, of the Pennsylvania, persuaded his directors to authorize the construction of tubes under the Hudson, also under Manhattan Island, extending under the East River to Long Island.

The total underwater section of the tube will be about 1 3/5 miles, and it is conservatively estimated that it will have a daily capacity of approximately 100,000 vehicles. Statistics compiled from data of 1917 show that during that year 4,800 vehicles crost over the five ferry lines between New York and New Jersey in the vicinity of the proposed tunnel every day. The material thru which the trench must be dug is soft silt and mud.



The Accompanying Sectional View Shows Vividly How the New Vehicular Tunnel Under the Hudson River at New York City Will Look When Finished. There Seems to be No Question at Present as to the Possibility of Building This Tunnel, and the Only Remaining Details Are Engineering Considerations Such as Ventilation, Etc., Which Are Being Rapidly Solved by Some of the Crack Engineers of America, Including No Less a Personage Than General George W. Goethals, Builder of the Panama Canal, and Now Holding the Position of Consulting Engineer to the Interstate Bridge and Tunnel Commissions of New York and of New Jersey. Several Other Proposals Have Been Brought Forward for the Building of This Tunnel Under the Hudson River, But the Goethals Plan Seems to be the Most Feasible, and the One Most Likely to be Adopted. The Length of This Vehicular Tunnel Will be About 9,400 Feet from Portal to Portal, with a Distance of 5,500 Feet, or More Than a Mile Separating the Bulkhead Lines, If These Are Placed Back of the Shore Line. In View of the Fact that the Ventilation Problem is at Present One of the Most Important, and the One Responsible for the Most Discussion Among Tunnel Experts, We Have Several Suggestions in the Present Article and Illustrations Which Might, If Adopted, Help to Bring About the Early Adoption of the Tunnel Project. Among These Features Are the Following:—First, That a Ventilator Shaft be Placed a Comparatively Short Ways Out in the River at Either Approach, So as to Simplify the Ventilating Problem by Reducing the Length Between the Bulkheads. Second, That Gasoline Vehicles be "Hauled" Thru the Tunnels So as to Eliminate the Fouling of the Air by Obnoxious Exhaust Gases, Particularly Carbon Monoxid, by Means of a Moving Platform. Third, Haul Gasoline Vehicles Thru the Tunnel by a Cableway Similar to the Well-Known Cable Car System. Fourth, Cause the Gasoline Vehicles to be Fitted with a Trolley Pole and Electric Motor for the Purpose of passing Thru the Tunnel Without Discharging Obnoxious Gases. The Goethals Proposal Calls for a Concrete Block Tunnel, 42 Feet in Outside Diameter, with Two Road Levels, as Here Shown. One Roadway Will be for East-Bound Traffic, and the Other for West-Bound Traffic. Actual Laboratory Tests On a Short Length of Tunnel Have Shown That 750 H.P. Would be Required to Operate the Fresh Air and Exhaust Fans, with a Maximum Capacity of 360,000 Cubic Feet of Fresh Air Per Minute.



Hudson River Vehicular Tunnel

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Associate Member American Institute Electrical Engineers

THE bridging of the Hudson River, commonly known as the North River in New York City, is an engineering problem that has been before the people of the states of New York and New Jersey for probably more than thirty years. A bridge across this great water highway would no doubt have been constructed many years ago, if it had been found possible to raise sufficient funds to render this dream a living reality. Engineering experts have recently bestirred themselves with the thought of crossing the Hudson either by bridge or else by means of a tunnel, particularly a vehicular tunnel suitable for horse-drawn, electric and gasoline propelled vehicles. The bridge question seems to have been discarded practically altogether now, owing to its tremendous initial cost, which would be about $72,000,000 at least, compared to the initial cost of $12,000,000 for constructing a large tunnel under the Hudson on the newly revised plan proposed by General George W. Goethals, the well-known American engineer and builder of the Panama Canal. General Goethals has been appointed consulting engineer to the Interstate Bridge and Tunnel Commissions of New York and of New Jersey. There are many reasons why New York should have means of communication such as this, as its sister state supplies, either directly or indirectly, a very large portion of the food and other commodities for greater New York's population of 7,000,000, which is brought to the piers on the west side of the Hudson by numerous railroads. Right here there is a constant and prohibitive wastage of perishable food products, owing to the highly congested and inadequate terminal facilities afforded for their movement.

At the present time there is more or less agitation in the legislatures of both states between those friendly and unfriendly to the Hudson River project. So far the one great problem, according to some of the testimony being given, and which has seemed almost insurmountable, is the proper ventilation of this tube, especially where gasoline driven vehicles are to be permitted to exhaust devitiating gases into the air of the tunnel. But according to a very able engineering report on this project, given in the Journal of the Franklin Institute and prepared by Martin Schreiber, Chief Engineer of the Public Service Railway Company of New Jersey, the ventilating problem of such a tunnel as proposed by General Goethals and other engineers can be readily taken care of, as actual laboratory tests have proven, and which have provided a satisfactory basis for calculating the results of such a long tunnel as that under the Hudson. Also to back up the argument for building the tunnel, there is precedence afforded by the fact that London, England, has built two vehicular tunnels under the Thames River, one 6,200 feet long, and the other 6,883 feet long.

The editors make several new tunnel suggestions, which are shown in the illustration accompanying this article, whereby the gigantic ventilating problem could be overcome to a large extent by controlling the kinds of traffic that should be allowed to pass thru the tube. First, the writer would suggest that the engineers contemplating the building of this tunnel consider a cable-way, one of which would be provided on each roadway, east and west, for the purpose of hauling *gasoline operated* vehicles thru the tunnel, *without their engines being operated*, thus doing away with the production of the objectionable carbon monoxid and other poisonous gases emanating from their exhaust. It would not be an impossible, or even impracticable matter, if such an electric motor-operated cable-way, similar to the old cable-car systems, were used to haul the gasoline vehicles thru the tunnel to Jersey or to New York. It could be arranged to have the owners purchase a standard cable grip, which could be fitted on to any gasoline vehicle at nominal cost.

Another proposal, made by Mr. H. Gernsback, is one employing a *moving roadway* of sufficient width to accommodate gasoline auto trucks, the roadway being operated by electric motors spaced at suitable intervals along its length.

Another proposal suggested by the writer would be to utilize a trolley wire over the one line of traffic apportioned to gasoline vehicles on each roadway, and having the owners of these vehicles equip them with a trolley pole, but by the time the owners had installed an electric motor under the gasoline vehicles for use with it, it would probably be just as well for the tunnel operating engineers to ask the owners of such vehicles to invest in electric trucks for that particular traffic intended to go via the tunnel.

All of the tunnel proposals now under consideration agree on the location, which extends from Twelfth Street, Jersey City, to Canal Street, New York. The termini of the tunnel at both ends are located in the center of the trucking and freight districts. The New Jersey terminus is also happily located adjacent to the great freight yards of the principal railroads, and close to the main ferry lines, thus providing every chance for close co-operation. Besides, the great Lincoln and other much used vehicular highways lead to the location proposed for the Jersey City terminus.

The Hudson tubes as well as the Pennsylvania tunnels under the Hudson River, which are used for railway traffic exclusively, were driven by the well-known shield method. General Goethals, in his proposal for the new Hudson vehicular tunnel, has advocated the shield-driven double-deck single tube, as shown in the accompanying illustration. This tube is to have an internal diameter of 36 feet, with two 18-foot roadways, one super-imposed above the other, and a concrete floor between them. This proposal for the tunnel would permit of four lines of vehicles, two on each roadway, two of the faster moving type such as pleasure automobiles on the upper floor, and two of the slower moving vehicles, such as auto-trucks, on the lower floor.

Most of these under-river tubes have been constructed with cast-iron blocks built of segmental form, which were bolted together after being put in place, and which thus tended to resist any external hydrostatic pressure with great power, much in the same way that the stones of an archway tend to support the arch. The outside of these segmental steel tubes is covered over with a fairly thick coating of concrete. Here is where the Goethals proposal differs radically from former practise, and there is considerable discussion now taking place as to the feasibility and practicability of his proposed design, which is as follows:

General Goethals' proposition is that the tunnel be constructed of O'Rourke concrete blocks in segmental form. Outside of this tube a gravel packing is to be placed. Some experts seem to doubt whether such a tube would be thoroly water-proof, and also what would happen in case of an earthquake or other severe concussion, as when a powder boat or supply of explosives might happen to blow up in the harbor, as has occurred several times during the war, when the concrete tube might crack with an appalling loss of life.

Detailed plans have been drawn up by the New York State Bridge and Tunnel Commission, under the direction of Major General George W. Goethals and John F. O'Rourke, which provide for the driving of the tunnel by the use of a shield forty-two feet in diameter—the method most usual when dealing with soft material. The material under the Hudson River is a soft silt and sand overlaid by still softer material of sewage origin, which is almost fluid. These conditions are complicated by the presence of ledge rock which is occasionally encountered. In a shield having a diameter of twenty-five feet, there is a difference in pressure between the top and bottom of ten pounds per square foot. This makes it difficult to guard against blow-outs and other accidents caused by the difference in pressure at the top and bottom of the shield, tunnel experts consulted by the state commissions have pointed out.

The diameter of the shield used in driving the Hudson tunnel was 17 feet; that of the Pennsylvania tunnel shields 23 feet 6 inches. The latter were the largest ever used under either the Hudson or the East rivers. The Rotherhithe tunnel, under the Thames River in England, was driven with a shield 30 feet in diameter thru clay mixt with shells, pebbles, loam, a much firmer material than that under the Hudson.

Of course, the traffic would have to be handled so that approximately half of the vehicles would move *eastward* and the other half *westward*. Once the tunnel is built, however, this becomes a problem for the traffic engineers of that year to solve. According to the Goethals plan, the fresh air duct is at the top of the tunnel, and fresh air is constantly pumped along this duct by means of powerful electrically-driven blowers and fans, while the foul air, including exhaust from the gasoline vehicles, is drawn out thru ducts at the bottom of the roadway. Besides, there are additional ventilating and foul air ducts at either side of the tunnel, walled off from the roadways.

To find out exactly what would happen in a section of such a tunnel with a number of gasoline vehicles operating their engines therein, a test building, corresponding in cross-section to the proposed tunnels and measuring 125 feet in length, was constructed at Newark, N. J. Eight automobiles were operated in this building, which could be shut off air-tight and fresh air pumped in at the top and the exhaust pumped out at the bottom, or vice versa. A number of elaborate tests of various kinds were carefully made by experts, including Professor Gellert Alleman, of Swarthmore, Pa., and Dr. H. Jermain Creighton, of Swarthmore College. From a very elaborate and convincing analysis on the various gases present in the tube after the automobiles had been operated for a period of forty minutes, Prof. Alleman reported that when all doors were closed and the ventilators opened, after the engines of eight cars had been *running light* for forty minutes, the condition of the atmosphere was almost normal, so far as physiological action was concerned, and the amount of carbon monoxide content not dangerous. This calculation was further supported by the fact that eighteen persons who remained in the tunnel during the test for a continuous period of forty minutes experienced no unpleasant sensations from breathing the air. The contaminated air in this particular test showed .075 per cent. carbon monoxid, and 6 per cent. carbon dioxid, which proved that the per cent. of carbon monoxid was so small as to be negligible. With the data thus obtained, it was calculated that air supply fans with a maximum capacity of 360,000 cubic feet of fresh air per minute, and exhaust fans having 20 per cent. more capacity, would be required to ventilate the tunnel. The total amount of horse-power computed for operating these fans was 750 H.P. The length of the proposed tunnel under the Hudson, from portal to portal, would be approximately 9,400 feet, with a distance of about one mile, or somewhat over 5,000 feet between the bulkhead lines.

As aforementioned, London has built two vehicular tunnels under the Thames, one 6,200 feet long, the other 6,883 feet. Public interest in tunnels for New York was aroused about thirty years ago by Austin Corbin, who proposed tubes under both the Hudson and East Rivers. Scientists charted the bottoms of the two rivers and reported that tunnel construction was feasible. Perhaps it might have been undertaken at that time but for Mr. Corbin's death. Twenty years later William G. McAdoo undertook this work. President Cassatt, of the Pennsylvania, persuaded his directors to authorize the construction of tubes under the Hudson, also under Manhattan Island, extending under the East River to Long Island.

The total underwater section of the tube will be about 1 3/5 miles, and it is conservatively estimated that it will have a daily capacity of approximately 100,000 vehicles. Statistics compiled from data of 1917 show that during that year 4,800 vehicles crost over the five ferry lines between New York and New Jersey in the vicinity of the proposed tunnel every day. The material thru which the trench must be dug is soft silt and mud.

COMING INVENTIONS 2

THE THOUGHT RECORDER

By H. GERNSBACK

When the writer first conceived the idea of the thought recorder, he asked three prominent scientists regarding their views on recording thoughts electrically. The letters are reproduced herewith excerpted. It will be noted that Nikola Tesla disagrees with the writer as to thought transmission at all, but his letter nevertheless will give considerable food for thought to many readers.

Dr. Lee de Forest, inventor of the audion, is not too sure about thought transmission.

Dr. Greenleaf Whittier Pickard, the inventor of the silicon and pericon detector, as well as many other wireless specialties, has several interesting ideas, and his letter will certainly prove a revelation, particularly to those interested in radio.

IN studying the evolution of the human specie we must go back to the time when man proper, as we know him, had not as yet arrived on this planet. Our great biologists have irrefutable evidence that everything in Nature works on a slow, laborious plan, one specie being developed slowly into another from the smallest animalculae up to present man. When man was still in the what we may call animal stage, i.e., when he was not "thinking," as that term is understood, he was wholly guided by instinct. His "thoughts," if so they may be called, were probably on a much lower plane than thoughts of the average dog. The chances are that the present day dog probably "thinks" much better than prehistoric man. We also find that thought and language go hand in hand. Crudely speaking, prehistoric man had no better language than any highly developed animal, such as a dog, cat or a horse.

Thru thousands of years of evolution, however, instinct developed into crude thought, and finally there came a time when prehistoric man really began to think, as we know the term. That was the time when he began to utter his thoughts by means of his voice. At first only a few crude words were formulated, and probably consisted of not much more than the gibberish of a chimpanzee. Little by little organized thought arrived, and words, translated into speech kept pace with the advancing thought of man. As the human race kept advancing at a slow pace, its thinking qualities increased little by little, and the senses correspondingly became more sharpened.

This is especially true of the human thinking machinery which perhaps has advanced more rapidly than the senses. Thus we find that certain senses have even been retarded, such as, for instance, sight, smell and hearing. When man lived his wild life it was very necessary for these senses to be much sharper than they are at present; hence our poor hearing, bad sight and very much poorer smell. On the other hand, as the battle for existence becomes more and more acute, and as moreover the battle is not as much physical as mental, it follows that the mind and its thinking machinery should naturally become more and more developed, which, in fact, it does. We may safely say that within the next hundred thousand years—which is only a small span of time in man's evolution—the human mind will be an entirely different sort of apparatus than it is today. Man's mental power will be infinitely greater than what it is at present. Already we have indications that man's thoughts, or the effects therefrom, do not necessarily have to remain *within* his skull, but that they actually radiate from the latter in a very imperfect manner. As the human race advances, there is no doubt that thought transference proper will become an accomplished fact. It has already been shown experimentally by Di Brazza, as well as Charpentier, that concentrated thinking will produce certain external effects, as for instance, a slight fluorescence on a zinc sulfid screen, or a suitably excited X-ray screen. This would tend to prove that thoughts are of an electrical nature, having probably a very short wave length. As most electrical effects in space are depend-

(*Continued on page* 84)

THREE FAMOUS SCIENTISTS' VIEWS ON THOUGHT TRANSMISSION

Altho I am clinging to ideals, my conception of the universe is, I fear, grossly materialistic. As stated in some of my published articles, I have satisfied myself thoroly thru careful observation carried on for many years that we are simply automata acting in obedience to external influences, without power or initiative. The brain is not an accumulator as commonly held in philosophy, and contains no records whatever of a phonographic or photographic kind. In other words, there is no stored knowledge or memory as usually conceived, our minds are blanks. The brain has merely the quality to respond, becoming more and more susceptible as the impressions are often repeated, this resulting in memory.

There is a possibility, however, which I have indicated years ago, that we may finally succeed in not only reading thoughts accurately, but reproducing faithfully every mental image. It can be done thru the analysis of the retina, which is instrumental in conveying impressions to the nerve centers and, in my opinion, is also capable of serving as an indicator of the mental processes taking place within. Evidently, when an object is seen, consciousness of the external form can only be due to the fact that those cones and rods of the retina which are covered by the image are affected differently from the rest, and it is a speculation not too hazardous to assume that visualization is accompanied by a reflex action on the retina which might be detected by suitable instruments. In this way it might also be possible to project the reflex image on a screen, and with further refinement, resorting to the principle involved in moving pictures, the continuous play of thoughts might be rendered visible, recorded and at will reproduced.

Nikola Tesla.

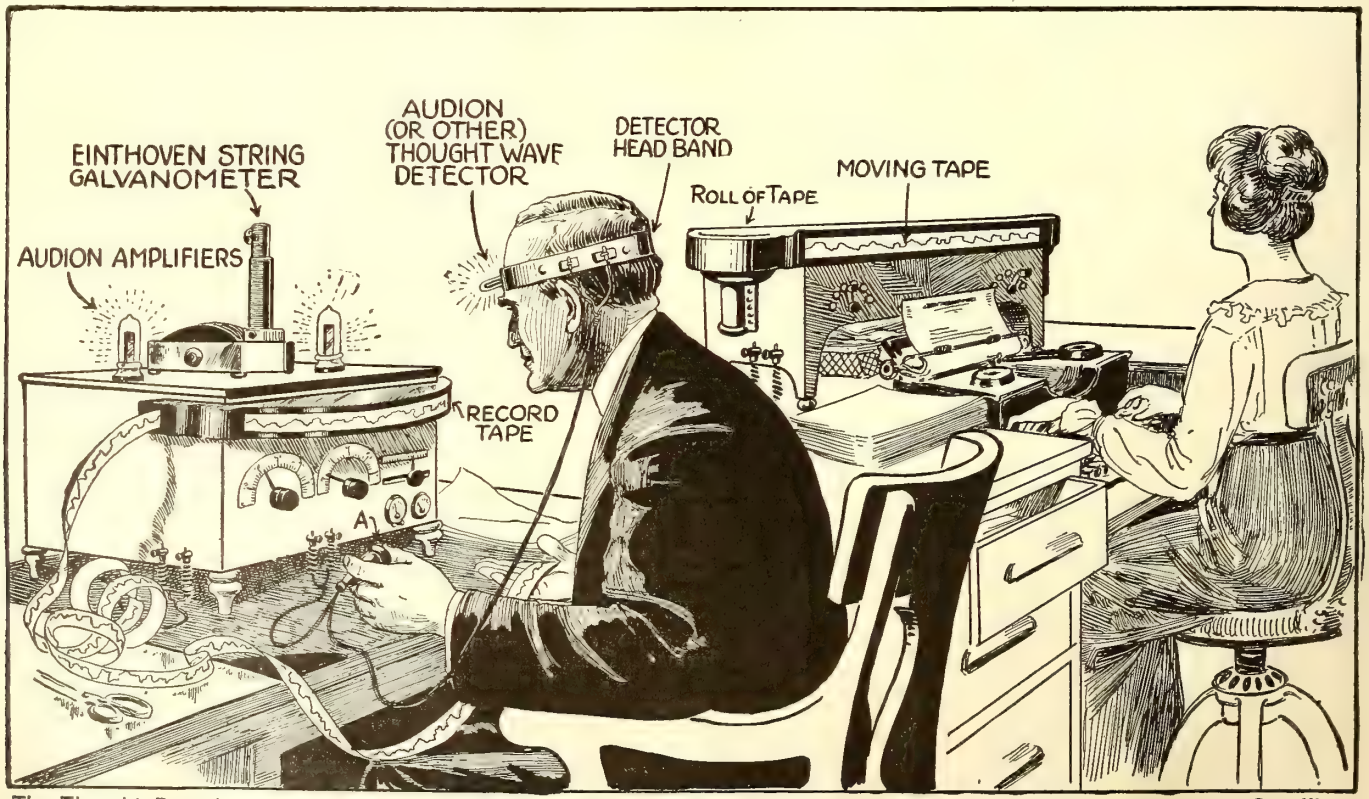
Your article should be an interesting one, particularly as to the audion suggestion. The audion, however, seems to have a certain wavelength limitation, so that unless the waves to be recorded lie between about 3×10^{10} cm. and 3×10^{2} cm., they are not apt to be "picked up."

A more likely range to search would be from 3×10^{2} cm. down to 3×10^{10} cm., that is, down to the harder Gamma rays, or to even shorter wavelengths, starting with the shorter Hertzian waves. Here the audion would be useless, save as a second stage in the detection, i.e., as an amplifier for some other form of detector.

Greenleaf W. Pickard.

While I have little doubt that there is such a thing in nature as transference of thought from one brain to another, I am not aware that sufficient data has ever been gathered on such a highly abstruse subject to permit forming any definite opinion.

Lee De Forest.



The Thought Recorder is an Instrument Recording Thoughts Directly by Electrical Means, On a Moving Paper Tape. Our Illustration Shows What a Future Business Office Will Look Like When the Invention, Which as Yet Only Exists in the Imagination, Has Been Perfected. By Pushing the Button A, the Tape is Started and Stopt Automatically So That Only Thoughts That Are Wanted Are Recorded.

Paris Letter

By JACQUES BOYER

Paris Correspondent of the ELECTRICAL EXPERIMENTER

Airplane-Radio.

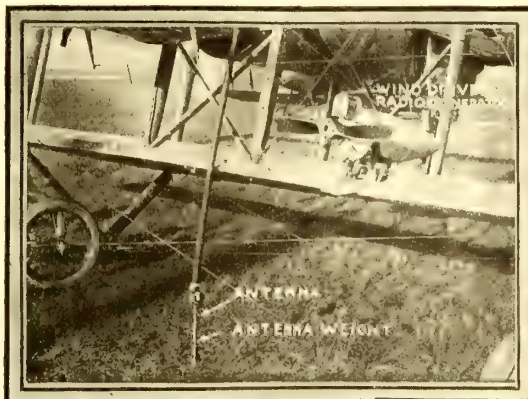
Paris, February, 1919.

THE war having ended thru the conclusion of the armistice, the military censor now allows the publication of information concerning various technical matters of the French Army. In this and in the following monthly letters, we will unfold thru the ELECTRICAL EXPERIMENTER the latest European technical developments as they come to our attention.

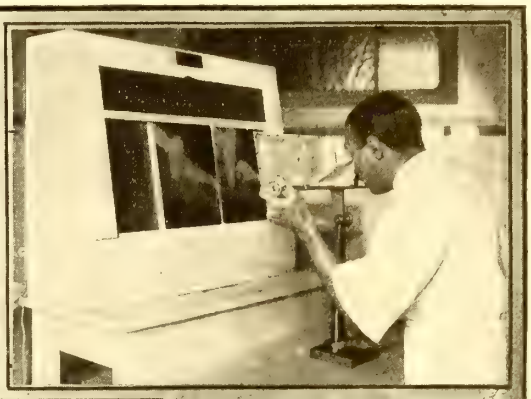
Particularly during the war, the censorship has been so rigid that many important inventions have never been even mentioned in the technical press. We shall be glad to describe these monthly for the benefit of EXPERIMENTER readers.

The accompanying photographs show the latest system of radio-telegraphy installed on French Airplanes during the war. Fig. 1 shows what is called the "radio-telegraph dynamo" on a Farman airplane.

All the French combat machines were equipt with this or similar apparatus. Between 25 and 150 kilometers could be covered by means of this apparatus weighing some thirty odd kilograms. For receiving the wireless waves the aviators of course used the audion, and by use of sound-proof helmets, it was possible to receive the orders clearly, notwithstanding the terrific noise of the airplane motor. The small dynamo shown in Fig. 1 is operated by means of a small air propeller, and this motor works entirely independent from the power plant of the airplane. As long as the airplane is in motion the propeller will turn due to the rush of the air, and thus even if the engine becomes stalled, the aviator can still use his wireless, for the 'plane while volplaning down furnishes enough energy to drive the small auxiliary dynamo. The wireless antenna trails behind the airplane thru the steel tube as seen in Fig. 1, at the end of which there is a small pulley. At the free end of the antenna wire there is a weight of two or three kilograms (4 to 6 pounds) which tends to keep the antenna more or less taut. The wire stays of the airplane themselves form the "ground" for the wireless system. All aviators in the air were constantly in touch with each other, and in order that one airplane should not be mistaken for another one, different wave lengths were used for each. Not only this, but other tricks as for instance, sending at a different intensity, was often resorted to by certain aviators in order that the ground station would know from which 'plane the signals emanated.



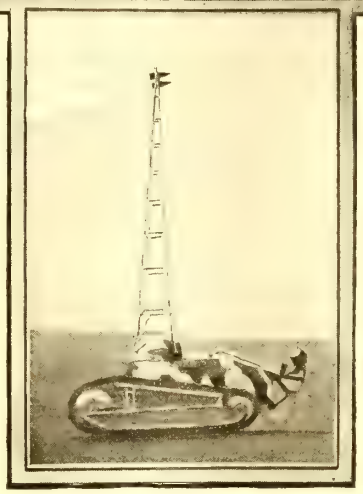
French airplane radio generator of the wind driven type and antenna employed. The dynamo is fitted with a small air blade which spins it rapidly. The antenna and weight are lowered from a reel on the cockpit. Similar schemes are in use on American Airplanes. Fig. 1.



The "Radio-stereoscope" is the latest in French X-ray apparatus. By its means it now becomes possible to rapidly locate bullets or fractures — owing to the perspective of vision thus afforded. The X-ray plates are illuminated from behind, while the physician views them thru the special coödinating instrument shown. Fig. 3.

Signaling Tanks.

The "baby" Renault tanks now well known in the United States, played an important rôle in pushing back the Huns. They had not a little to do with the Allied victory and were constructed by the French engineer, Louis Renault. This well-known French technician created many different models, some of which carried cannon and machine guns, while others merely carried ammunition. One of the strangest ones constructed by him is the *"tank projecteur"* (signaling tank). It is shown in the accompanying photograph, Fig. 2. This tank is built along the lines of the "baby" tank, but in the back we find on an inclined steel truss a little dynamo driven by the machinery of the tank. Two "signaling projectors" are mounted at the top of a light metallic mast, the four lower legs of which are mounted on a revolving cupola which makes it possible for the mast to be immediately revolved in any direction. The top of the mast is 7½ meters from the ground. The two searchlights are arranged in such a manner that they can send out two independent light shafts, or the two shafts can be converted into a single shaft of light. In the inside of the tank we find our usual Morse telegraphers, operating a key which controls the light shafts. By means of this arrangement, the ordinary Morse or Continental Code can be sent out by breaking up the light shaft into "dots and dashes" the same as is done in the usual method of signaling with lights. Mr. Renault has incorporated several refinements into the search lights, one of which is an iris obturator whereby the volume of the light can be increased or decreased at will.



The "Baby" Renault Tanks Played an Important Rôle in Pushing Back the Huns. Some of These Tanks Carried Cannon and Machine Guns. The "Tank Projecteur" Here Shown Was Effectively Used for Signaling Purposes. Fig. 2.

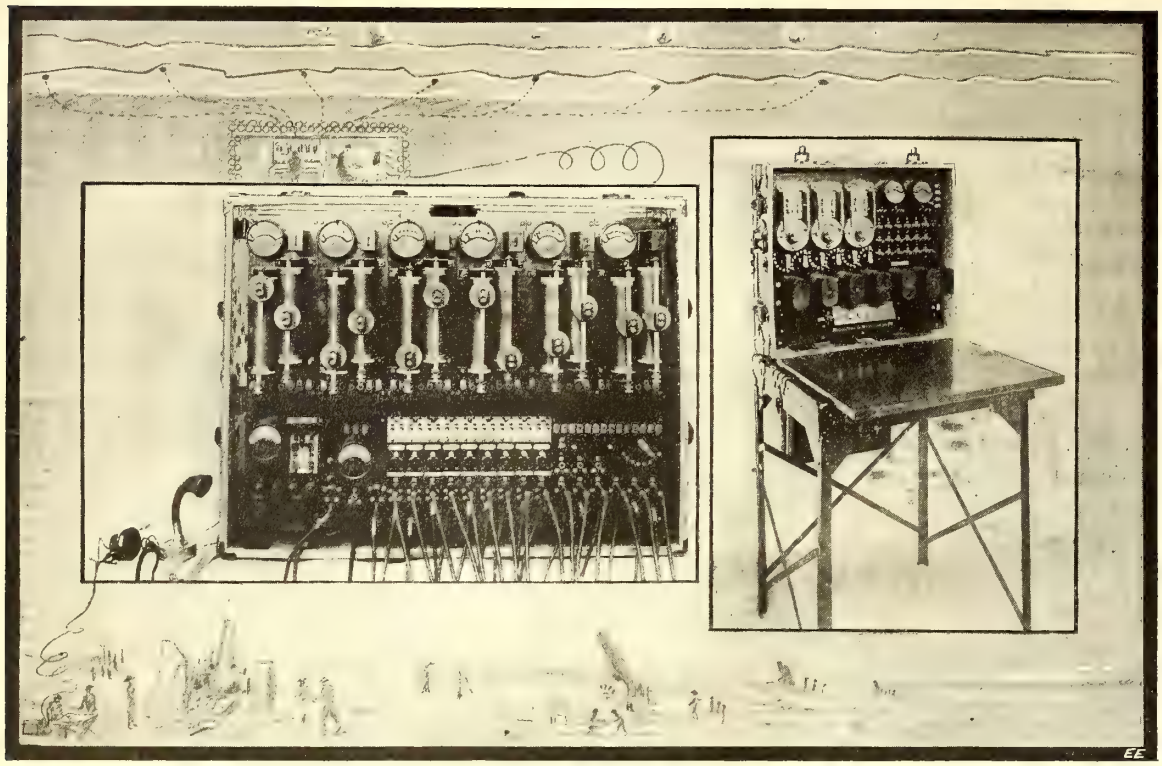
The war has brought forth a great many surprises, many of which for military reasons having remained secret, and many will continue a secret for some time to come. Our readers no doubt are very much interested in many of the war devices brought out during the war by our European Allies. We have therefore made arrangements with our Paris correspondent, Mr. Jacques Boyer to send us an article each month on hitherto unpublished information. The first article of the series appears on this page.—*Editor.*

Radio-stereoscope.

This apparatus has been developed by the French engineer, M. Nemirovsky, the X-ray specialist of Paris. It has given wonderful results to the French military physicians, and it now becomes possible to locate metallic or other foreign pieces in the human body in a manner not possible before. The ordinary X-ray photograph shows only the foreign body, but it is impossible to tell how deep the penetration is, and often the physician cannot tell if a bullet is in front or in back of a certain organ. In other words, he does not know just how deep the bullet is embodied. Everyone who has looked thru the ordinary stereoscope will readily understand how objects "stand out" and how they reveal their exact location to the human eye.

It is this principle which is made use of by M. Nemirovsky, who has also greatly simplified the radio-stereoscope technique. Our illustration, Fig. 3, shows the method. Two X-ray pictures taken at one time by super-imposing two plates and afterward developing them are placed side by side in an arrangement termed a *"negatoscope."* The plates are illuminated from behind by means of an electric lamp. The physician then regulates the radio-stereoscope by means of a thumb screw as shown, until he sees the bones, and all other parts as well. The foreign body then stands out in plain relief. The physician now examines the plates carefully and he obtains a clear mental picture which subsequently gives him an exact idea as to just how deep the foreign body is emplaced. If necessary during the operation, he can frequently inspect the negatives stereoscopically in order to guide himself should this be necessary.

Locating Enemy Guns by Flash and Sound



Switchboards Used for Flash or Sound Spotting of Enemy Artillery. Photo at Left Shows a Type B-T Sound Ranging Set Such as Used By the United States Army Signal Corps During the War. Many of These Switchboards Were Successfully Used At the Front. It is Slightly Larger Than the Smaller Model and Requires a Little More Time to Set Up, But On the Other Hand It Combines Many More Telephone Circuits. A Single Section Has Located as High as 117 Guns of Enemy Batteries In 24 Hours. The Right Hand Photo Shows a Small Portable Switchboard, Known as a Flash Ranging Set. This Signal Board is Used in Conjunction With an Observation Telescope for Locating the Flash of Enemy Guns and General Activities At the Extreme Front, and is Suitable for Night or Day Service.

THE accompanying photographs show respectively two of the war's newer developments, which even the veterans of the Spanish-American War were not familiar with. For one thing, of course, "flash ranging" and "sound ranging," as they are called, are really two military developments which were brought about by the fact that vastly greater numbers of guns were used in the great world war than were ever even dreamed of before.

Let us first consider the "flash spotter." The flash spotter usually takes up his location in the vicinity of front line trenches, or in a shell hole from which he can effectively use an observation telescope for minutely observing and locating in what direction the flash of an enemy gun occurs. The electrical switchboard shown herewith forms a part of the communication link with the artillery and general intelligence headquarters, so that the position of the enemy guns can be quickly made known, and either shelled at once by counter-battery fire by the artillerists, or else the location is accurately plotted on large maps for future consideration, depending upon the activity of the enemy gun or guns at the moment.

The flash spotter, if he happens to be located in a listening post or shell hole, or in fact in any other forward location, invariably has with him his trusty portable telephone connected by wire to the nearest communicating depot, where we find one of the small portable switchboards here shown. These switchboards are fitted with the proper regulating instruments for creating the best working conditions on the various circuits, and make provision for connecting and disconnecting a large number of circuits, in some cases, about 30 or 40 lines running out to various flash ranging observation stations, or in other cases as many as 100 or more lines. The work of the flash spotter is finished for any particular case when his observations, as to the angle in which the flash was observed, and a similar or different angle measured by a co-observer somewhere down the line, have reached the engineers. These experts, by means of special slide rules and tables, quickly solve the distance of the enemy gun and its definite location geographically by the information afforded thru the observation data submitted by two or more flash ranging observers. In other words, it is *triangulation*, which mathematical quantity has been raised to the n'th power by Uncle Sam's artillery experts.

The work of the "sound ranging" experts in locating enemy guns, both large and small, is somewhat different from that of the flash ranging corps. One of the switchboards used in connection with the sound ranging of enemy guns is illustrated herewith. Hundreds of these switchboards were successfully used at the front during the progress of the war. A single section of sound-ranging equipment located as high as 117 guns of enemy batteries in 24 hours.

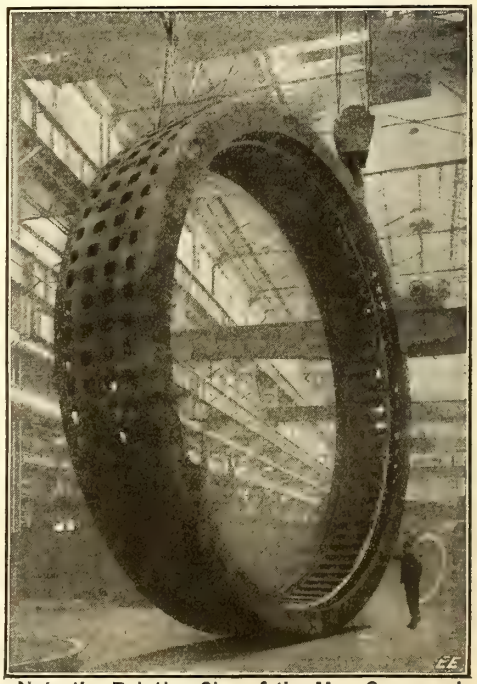
(*Continued on page* 68)

World's Largest Generator

The accompanying illustration shows one of the largest water-wheel type generators ever built, and its gigantic dimensions may be judged by comparison with the figure of the man standing beside it. This is one of several water-wheel generators built for the Keokuk electric generating station of the Mississippi River Power Company. This mastodonic generator has 52 poles and delivers a current at 11,000 volts potential. This is a high voltage for a generator to produce, owing to the strains on the revolving windings, etc. Much higher voltages are frequently used for the transmission line, and voltages of 50,000 to 75,000 are common for such transmission, these extra high potentials being obtained by means of stationary transformers in the power station where the generators are located.

The large field or stator frame here shown forms the stationary part of the generator, and the rotating member which is also of gigantic size and mounted on a steel shaft several feet in diameter, is put in place and lined up with high accuracy when the stator frame of the generator is put in place and bolted to its foundation. These large machines are invariably built in sections which can be bolted together after they have reached the site of their installation.

The transformer comprises a laminated sheet iron core on which there are two windings or series of windings, one of which forms a low voltage primary which is connected with the generator, driven by a water-wheel or other source of primary power; while the second set of windings form a high voltage or secondary circuit, in which any desired potential current is induced by induction, the primary and secondary windings being linked magnetically by means of the iron core. Transmission lines are in use at the present day with potentials of 150,000 volts and higher.—*Photo Courtesy G. E. Co.*

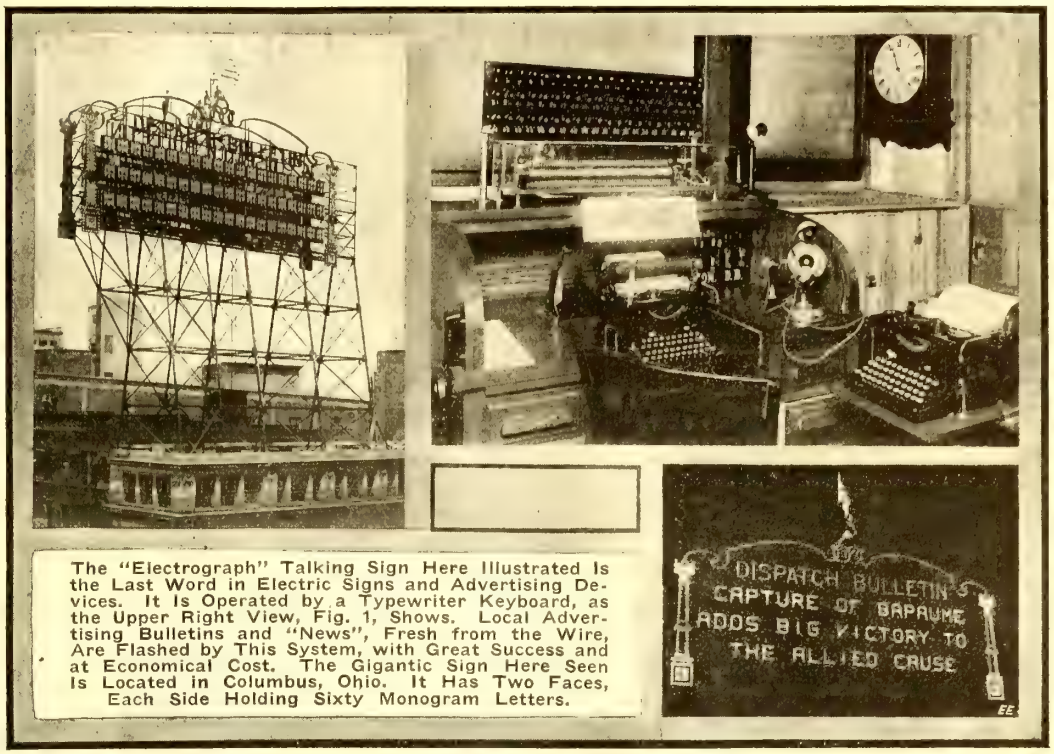


Note the Relative Size of the Man Compared to the Huge Stator of the Largest Water-Wheel Type Generator Ever Built. It Develops a Current of 11,000 Volts.

Novel Electric Talking Sign

THE accompanying illustrations, Figs. 1, 2 and 3, show the design, construction and method of operation of an electric bulletin board, operated by a typewriter, which is said to be the latest achievement in the electric sign industry. This new illuminated sign called the *Electrograph* has been erected on the Dispatch Building in Columbus, Ohio, and flashes the latest news, fresh from the press wires, and advertising bulletins for local and national concerns.

It may be stated that this Illuminated Sign has two sides, each side holding sixty monograms, arranged in three rows. Each monogram contains a clever arrangement of twenty-one lights, combinations of which form any letter or numeral and a few other characters, each one measuring two by three feet.



The "Electrograph" Talking Sign Here Illustrated Is the Last Word in Electric Signs and Advertising Devices. It Is Operated by a Typewriter Keyboard, as the Upper Right View, Fig. 1, Shows. Local Advertising Bulletins and "News", Fresh from the Wire, Are Flashed by This System, with Great Success and at Economical Cost. The Gigantic Sign Here Seen Is Located in Columbus, Ohio. It Has Two Faces, Each Side Holding Sixty Monogram Letters.

The photograph Fig. 1 shows the operating room. The typewriter method of operation distinguishes this device from others of similar character. A standard machine is used and contacts are made by striking the keys just as they would be struck in ordinary typing. An extra platen, bearing silver plugs, over which a stylus rides, selects the monograms automatically as the writing proceeds, thus throwing the letters in their proper places on the sign. The letters remain in place until the bulletin is completed and may be held any length of time; it is then released by pressing a single key.

It is of interest to note that a unit releasing device enables the operator to strike any one letter out and replace it with another without interfering with the other letters. Thus, if an error is made, it may be promptly corrected. The operator cannot see the sign as he works and so a pilot board has been provided directly in front of him, consisting of sixty green light bulbs, corresponding to the sixty monograms on either face of the board. When a letter is struck, with the platen set at any given position, the letter appears in the corresponding monogram and automatically lights the corresponding green light.

For illustration, it will be seen that if the platen is set with the stylus on No. 3 plug and the letter "K" is struck, "K" will appear in the monogram and green light No. 3 will burn. If it does not burn, the operator knows that the "K" failed to appear in the monogram and he strikes it again. When the operator writes a bulletin, the typewriter keys write on paper in the usual manner. This gives a complete record of everything that appears on the board. The record is used in checking advertising.

It is claimed that an ordinary bulletin may be written in ten seconds. It usually is left burning ten or more seconds after being completed. This indicates the amount of advertising and news that may be flashed in an evening.

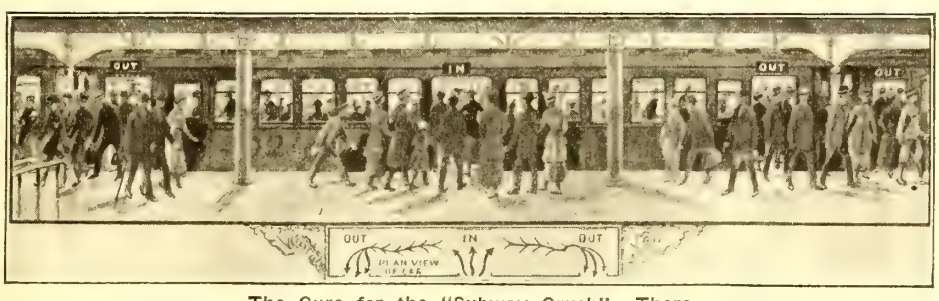
Mr. Alton D. Spencer, of the *Evening Dispatch*, points out that the news feature gives the electrograph an advertising pull not possible with ordinary electric signs. Latest news from the peace table fronts is bound to attract attention, and while the crowds watch for news, they read the advertisements. On election night the electrograph is the center of attraction, as the returns are flashed more promptly than is possible by any other means. This service, of course, increases the value of the sign to the advertisers and gets more results from them than they could get from a sign hanging in front of their places of business and at less cost.—*By Frank C. Perkins.*

Relieving the Car Crush

By Sidney Gernsback

HAVE you ever seen a Subway crowd being herded into a car? Of course you have, if you are living in "little old New York." If not, thank the Lord and turn to the next page. You are not interested! Not at all! And then again you may get a notion to visit that "Burgh" one day; well, read on, it may interest you after all!

Let us go back to that Subway crowd on a rainy Monday morning between 8 and 9 A. M. and let us try to board a car at Times Square. There our train stops, packed brimful with its rain-smelling, sneezing and coughing cargo. You think there is not room for as much as another umbrella in the car you have selected. But behold the convulsory jerking and pushing going on in the middle of the car. Our well trained eye reads these signs, like an Indian would read footprints on the warpath: These spasmodic movements, this pushing, twitching and thrusting can mean only one thing: somebody wants to get off that train! And if somebody wants to get off, a half dozen other bodies want to get on, and usually do, too.



The Cure for the "Subway Crush".—There Are Three Doors on Each Subway Car: Two on Each End and One, About the Same Size as the Front and End Door Combined, in the Center. Let the Outgoing Passengers Use the End Doors Only, and the Incoming Travelers the Center Doors Only, as the Diagram Indicates.

Acting on this well established principle we push and get pushed toward the open car door. A melodious voice from the end of the car sings out: "Let 'em get off! Let 'em get off!" And behind you a gentleman wearing the snug uniform of a Subway gladiator pushes on: "Step lively!"

And right here it is where Kipling is wrong about that east and west business "who never shall meet!" Take it from an old Subway traveler: *they do meet!* They not only meet! They clash and they col-

(*Continued on page* 56)

My Inventions

By Nikola Tesla

IV. The Discovery of the Tesla Coil and Transformer

FOR a while I gave myself up entirely to the intense enjoyment of picturing machines and devising new forms. It was a mental state of happiness about as complete as I have ever known in life. Ideas came in an uninterrupted stream and the only difficulty I had was to hold them fast. The pieces of apparatus I conceived were to me absolutely real and tangible in every detail, even to the minutest marks and signs of wear. I delighted in imagining the motors constantly running, for in this way they presented to the mind's eye a more fascinating sight. When natural inclination develops into a passionate desire, one advances towards his goal in seven-league boots. In less than two months I evolved virtually all the types of motors and modifications of the system which are now identified with my name. It was, perhaps, providential that the necessities of existence commanded a temporary halt to this consuming activity of the mind. I came to Budapest prompted by a premature report concerning the telephone enterprise and, as irony of fate willed it, I had to accept a position as draftsman in the Central Telegraph Office of the Hungarian Government at a salary which I deem it my privilege not to disclose! Fortunately, I soon won the interest of the Inspector-in-Chief and was thereafter employed on calculations, designs and estimates in connection with new installations, until the Telephone Exchange was started, when I took charge of the same. The knowledge and practical experience I gained in the course of this work was most valuable and the employment gave me ample opportunities for the exercise of my inventive faculties. I made several improvements in the Central Station apparatus and perfected a telephone repeater or amplifier which was never patented or publicly described but would be creditable to me even today. In recognition of my efficient assistance the organizer of the undertaking, Mr. Puskas, upon disposing of his business in Budapest, offered me a position in Paris which I gladly accepted.

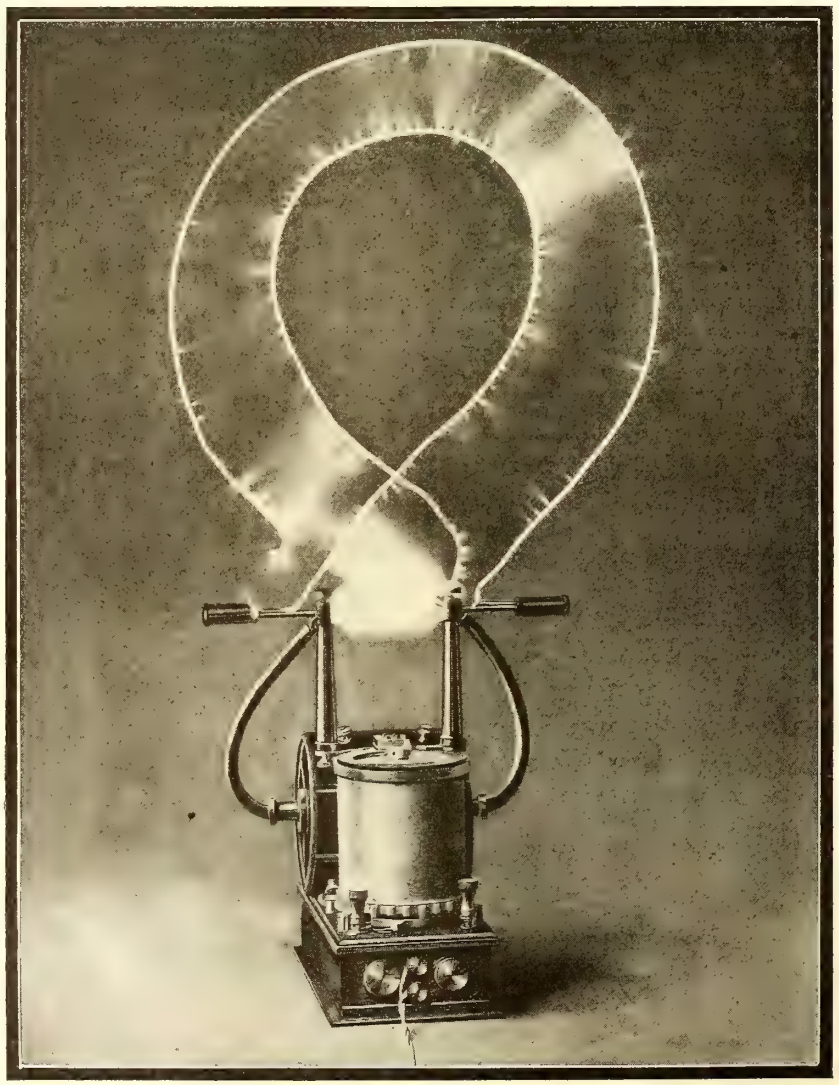


Fig. 1—Tesla Oscillation Transformer (Tesla Coil) Presented by Lord Kelvin Before the British Association in August, 1897. This Small and Compact Instrument, Only 8 Inches High, Developed Two Square Feet of Streamers With Twenty-Five Watts From the 110 Volt D. C. Supply Circuit. The Instrument Contains a Tesla Primary and Secondary, Condenser, and a Circuit Controller.

I never can forget the deep impression that magic city produced on my mind. For several days after my arrival I roamed thru the streets in utter bewilderment of the new spectacle. The attractions were many and irresistible, but, alas, the income was spent as soon as received. When Mr. Puskas asked me how I was getting along in the new sphere, I described the situation accurately in the statement that "the last twenty-nine days of the month are the toughest!" I led a rather strenuous life in what would now be termed "Rooseveltian fashion." Every morning, regardless of weather, I would go from the Boulevard St. Marcel, where I resided, to a bathing house on the Seine, plunge into the water, loop the circuit twenty-seven times and then walk an hour to reach Ivry, where the Company's factory was located. There I would have a woodchopper's breakfast at half-past seven o'clock and then eagerly await the lunch hour, in the meanwhile cracking hard nuts for the Manager of the Works, Mr. Charles Batchellor, who was an intimate friend and assistant of Edison. Here I was thrown in contact with a few Americans who fairly fell in love with me because of my proficiency in—billiards. To these men I explained my invention and one of them, Mr. D. Cunningham, Foreman of the Mechanical Department, offered to form a stock company. The proposal seemed to me comical in the extreme. I did not have the faintest conception of what that meant except that it was an American way of doing things. Nothing came of it, however, and during the next few months I had to travel from one to another place in France and Germany to cure the ills of the power plants. On my return to Paris I submitted to one of the administrators of the Company, Mr. Rau, a plan for improving their dynamos and was given an opportunity. My success was complete and the delighted directors accorded me the privilege of developing automatic regulators which were much desired. Shortly after there was some trouble with the lighting plant which has been installed at the new rail-

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Mr. Tesla's articles started in our February issue

road station in Strassburg, Alsace. The wiring was defective and on the occasion of the opening ceremonies a large part of a wall was blown out thru a short-circuit right in the presence of old Emperor William I. The German Government refused to take the plant and the French Company was facing a serious loss. On account of my knowledge of the German language and past experience, I was entrusted with the difficult task of straightening out matters and early in 1883 I went to Strassburg on that mission.

The First Induction Motor Is Built.

Some of the incidents in that city have left an indelible record on my memory. By a curious coincidence, a number of men who subsequently achieved fame, lived there about that time. In later life I used to say, "There were bacteria of greatness in that old town. Others caught the disease but I escaped!" The practical work, correspondence, and conferences with officials kept me preoccupied day and night, but as soon as I was able to manage I undertook the construction of a simple motor in a mechanical shop opposite the railroad station, having brought with me from Paris some material for that purpose. The consummation of the experiment was, however, delayed until the summer of that year when I finally had the satisfaction of *seeing rotation effected by alternating currents of different phase, and without sliding contacts or commutator*, as I had conceived a year before. It was an exquisite pleasure but not to compare with the delirium of joy following the first revelation.

Among my new friends was the former Mayor of the city, Mr. Bauzin, whom I had already in a measure acquainted with this and other inventions of mine and whose support I endeavored to enlist. He was sincerely devoted to me and put my project before several wealthy persons but, to my mortification, found no response. He wanted to help me in every possible way and the approach of the first of July, 1919, happens to remind me of a form of "assistance" I received from that charming man, which was not financial but none the less appreciated. In 1870, when the Germans invaded the country, Mr. Bauzin had buried a good sized allotment of St. Estèphe of 1801 and he came to the conclusion that he knew no worthier person than myself to consume that precious beverage. This, I may say, is one of the unforgettable incidents to which I have referred. My friend urged me to return to Paris as soon as possible and seek support there. This I was anxious to do but my work and negotiations were protracted owing to all sorts of petty obstacles I encountered so that at times the situation seemed hopeless.



Fig. 2—This Illustrates Tests With Spark Discharges From a Ball of Forty Centimeters Radius in Tesla's Wireless Plant Erected at Colorado Springs in 1899. The Ball Is Connected to the Free End of a Grounded Resonant Circuit Seventeen Meters in Diameter. The Disruptive Potential of a Ball, Is, According to Tesla, in Volts Approximatelly V = 75,400 r (r Being in Centimeters), That Is, in This Case 75,400 x 40 = 3,016,000 Volts. The Gigantic Tesla Coil Which Produced These Bolts of Thor Was Capable of Furnishing a Current of 1,100 Amperes in the High Tension Secondary. The Primary Coil Had a Diameter of 51 Feet! This Tesla Coil Produced Discharges Which Were the Nearest Approach to Lightning Ever Made by Man.

***THE** proverbial trials and tribulations known to every inventor were not spared Tesla, the world's greatest inventor of all times. In this article we see him, arrived at young manhood, struggling along in a cold world. Already his fame has spread far and wide and his genius is recognized. But converting genius and fame into dollars and cents is quite a different matter, and the world is full of unappreciative and unscrupulous men. Tesla, the idealist, cared little for money and thus was promptly taken advantage of. But let Tesla himself tell you in his own inimitable style. It is a wonderful story.*

In this month's installment Tesla also tells us how he made one of his most important as well as sensational discoveries—the Tesla Coil. Few inventions have caused such a sensation as this one which culminated in the only man-made lightning ever produced. The Tesla coil has so many uses and has been built in so many styles that it would take a catalog to list them all. From the spectacular high frequency stunts on the stage down to the "violet" ray machine in your home; all are Tesla coils in one form or another.

Wireless without the Tesla Coil would not be possible today. Without an oscillation transformer, spark gap and condenser—which is a Tesla Coil—the sending station would be crippled.

But it is for industrial purposes where the Tesla Coil will shine brightest in the future. The production of Ozone, the extraction of Nitrogen from the air in huge quantities—all are children of Tesla's fertile brain. His coil is the key to them all.

EDITOR.

German "Efficiency".

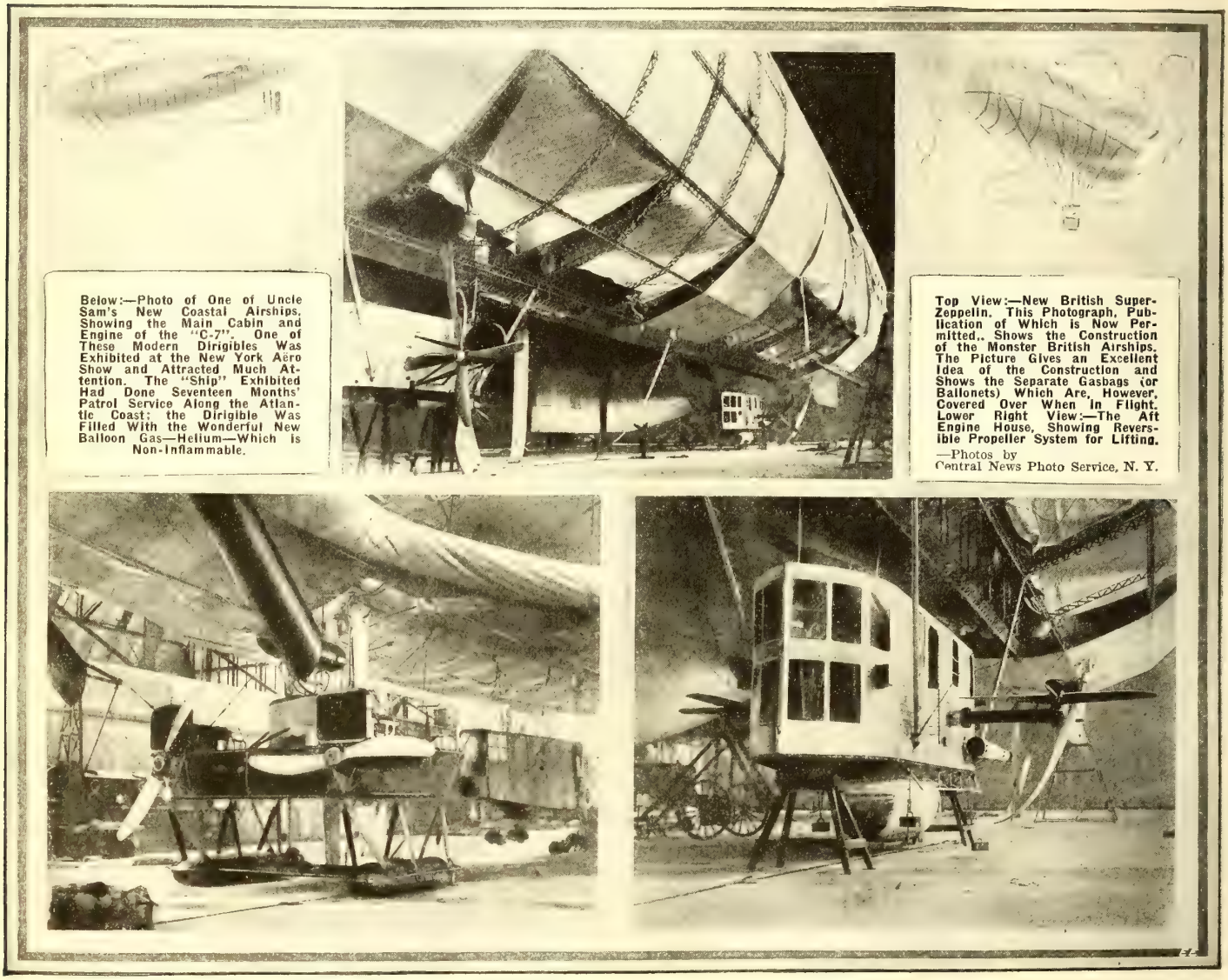
Just to give an idea of German thoroness and "efficiency," I may mention here a rather funny experience. An incandescent lamp of 16 c.p. was to be placed in a hallway and upon selecting the proper location I ordered the *monteur* to run the wires. After working for a while he concluded that the engineer had to be consulted and this was done. The latter made several objections but ultimately agreed that the lamp should be placed two inches from the spot I had assigned, whereupon the work proceeded. Then the engineer became worried and told me that Inspector Averdeck should be notified. That important person called, investigated, debated, and decided that the lamp should be shifted back two inches, which was the place I had marked. It was not long, however, before Averdeck got cold feet himself and advised me that he had informed *Ober-Inspector* Hieronimus of the matter and that I should await his decision. It was several days before the *Ober-Inspector* was able to free himself of other pressing duties but at last he arrived and a two-hour debate followed, when he decided to move the lamp two inches farther. My hopes that this was the final act were shattered when the *Ober-Inspector* returned and said to me: *"Regierungsrath* Funke is so particular that I would not dare to give an order for placing this lamp without his explicit approval." Accordingly arrangements for a visit from that great man were made. We started cleaning up and polishing early in the morning. Everybody brushed up, I put on my gloves and when Funke came with his retinue he was ceremoniously received. After two hours' deliberation he suddenly exclaimed: "I must be going," and pointing to a place on the ceiling, he ordered me to put the

(Continued on page 64)

The New York Aëro Show

THE aëronautical exposition which was held jointly in Madison Square Garden and the 69th Regiment Armory, New York City, March 1st to 15th, was the most successful aëro show and exposition ever held in the United States. Many remarkable exhibits were shown, including large bombing 'planes, small high-speed pleasure and scouting 'planes, besides a gigantic naval sea plane, of the stations at the Madison Square Garden or 69th Regiment Armory could be establisht with the flying 'planes or dirigibles, and in turn wireless telephonic speech was transmitted from the aircraft to the respective land stations. The effect on the public was startling, as while most of them had undoubtedly read of the wireless telephone, they did not have the slightest idea as to what the apparatus used for the purpose wonderful indeed, to stand in the crowd before the radio exhibit, and hear this conversation flitting back and forth between the operator in front of you and a second operator flying thru the air at a speed of 80 to 100 miles an hour.

One day a captive propaganda balloon broke from its moorings over the Sixty-ninth Regiment Armory and shot into the clouds, spilling leaflets, its anchorage dang-



Below:—Photo of One of Uncle Sam's New Coastal Airships, Showing the Main Cabin and Engine of the "C-7". One of These Modern Dirigibles Was Exhibited at the New York Aëro Show and Attracted Much Attention. The "Ship" Exhibited Had Done Seventeen Months' Patrol Service Along the Atlantic Coast; the Dirigible Was Filled With the Wonderful New Balloon Gas—Helium—Which is Non-Inflammable.

Top View:—New British Super-Zeppelin. This Photograph, Publication of Which is Now Permitted,. Shows the Construction of the Monster British Airships. The Picture Gives an Excellent Idea of the Construction and Shows the Separate Gasbags (or Ballonets) Which Are, However, Covered Over When in Flight. Lower Right View:—The Aft Engine House, Showing Reversible Propeller System for Lifting.

—Photos by Central News Photo Service, N. Y.

and a powerful Caproni tri-plane. A captured German 'plane of the Albatross type was also exhibited. There were also shown a number of gas type, or lighter-than-air aircraft, such as solo balloons, blimps, a naval dirigible which had seen seventeen months' service on coast patrol work, etc. The "gas bags" were filled with the new balloon gas—Helium. The individual exhibits included many interesting auxiliary appurtenances in the flying world, such as rapid-fire photographic cameras, aircraft machine guns, measuring instruments for indicating the velocity of the 'plane thru the air, et cetera, and a host of other new and highly novel devices.

Radio-telephony was demonstrated by the Army Radio Corps of the Air Division in a very popular and interesting way. During the course of the exposition, various types of aircraft flew over the city, equipt with wireless telephone and telegraph installations, so that communication from either looked like, or how it worked, and many of them had a twisted notion that it had something to do with *telegraphy* somehow or other. However, Uncle Sam's radio experts, as soon as they got the sets up and working, soon showed the visitors how the wireless telephone worked. The roof operator, who is stationed at that point so that he could readily observe the approach of aircraft, would start calling the airplane or dirigible as soon as it came to view, somewhat in this fashion: "Hello airplane! Hello airplane! Hello airplane!" After a few moments' pause, and when the operator had manipulated the tuning of the apparatus to the right point and gotten his Audion detector and amplifiers adjusted to the proper strength, the voice of the pilot on the airplane, hovering in the air several hundred feet above the aëro show, could be heard calling, thru a large Audion amplifier—"Hello land station! I get you all right now, land station!" It was really very ling. Up to approximately 3,000 feet it sailed, where it exploded in a burst of brown smoke, falling upon a roof in the neighborhood of Fifth Avenue. Came the wireless comment from an airplane aloft:

"Did you see that? It burst about a thousand feet under us—ought to make good stuff for the reporters. By the way, are any down there?"

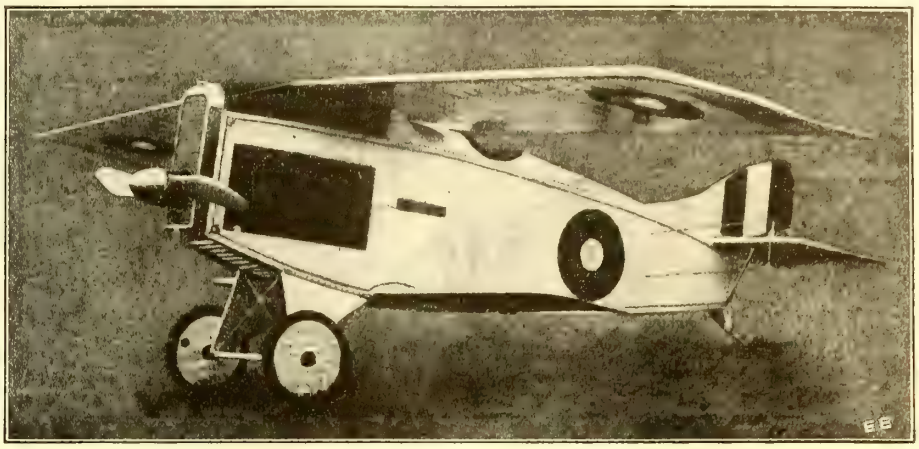
'Yes," broke in a newspaper man standing near the land wireless set, "and will you spell your observer's name for the reporters?"

"Yes—it's Sergeant S-a-u-v-e-g-e-a-u. He had a date to come to New York this afternoon, and altho he's come he can't fill his date very well, unless he comes down and lands on the crankshaft. Anything else?"

"No, thanks," said the reporter as he hung up on the first *interview* by wireless telephony yet recorded.

The radio apparatus exhibited, including that in the exhibit of the United States

Navy, was that of the vacuum bulb or Audion type. The range of the wireless telephone airplane apparatus for transmitting and receiving speech signals varies, of course, with the size of the transmitting set, the length of the aërials used on the airplane and several other factors. It is interesting to note at this point that only recently Secretary of the Navy Daniels carried on a wireless telephone conversation on March 11th with an airplane flying over the Potomac River at a distance of 150 miles. In this two-way wireless telephone conversation with the Secretary of the Navy, who was located at Washington, he used his ordinary desk telephone, which was connected up to the wireless transmitting set in another building. A recent report states that radio-telegraphic communication from earth to 'plane has been carried on over a distance of 200 miles.



The Fastest Airplane Exhibited At the Aëro Show In New York—The "Christmas Bullet" —Rated Speed 200 Miles Per Hour. Test Showed 185 M.P.H. To Be Used as "Taxiplane" to Deliver Dispatches to Vessels One Day Out At Sea.

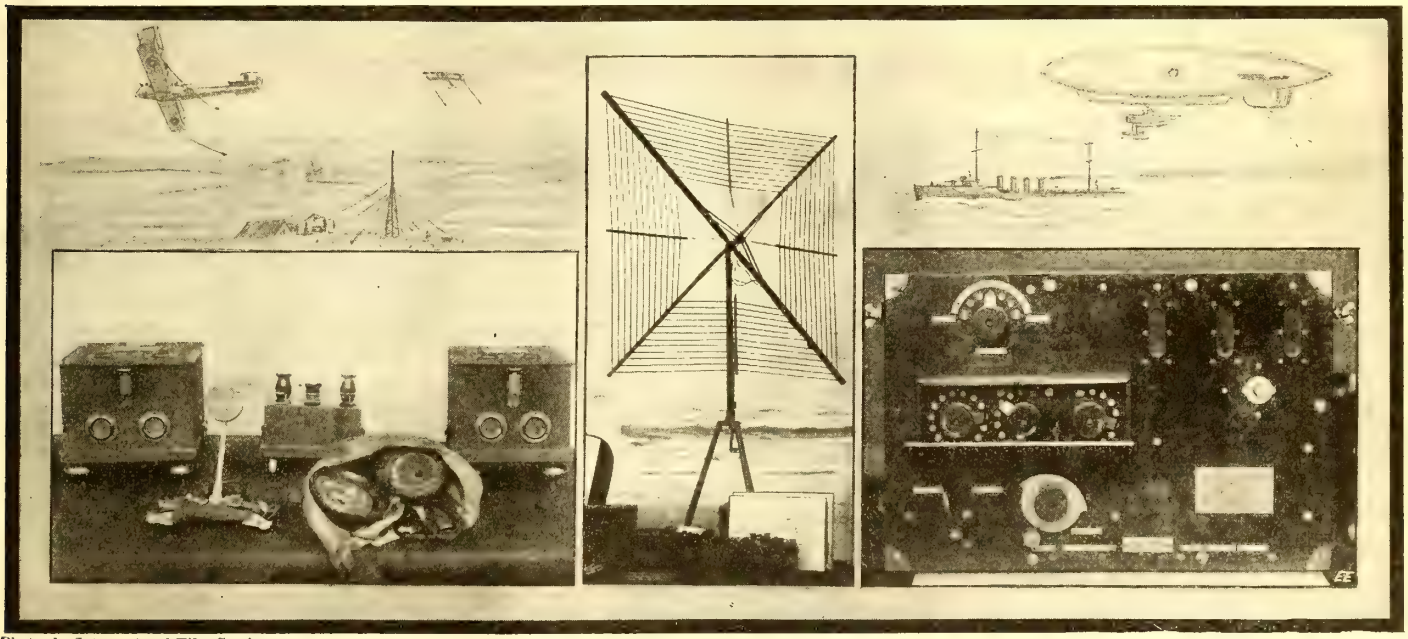
The form of antenna used on aircraft during the war has been invariably that employing a quick-acting reel, on which the phosfor bronze stranded antenna cable was wound upon or released from, according to the desires of the pilot. However, in the newer aërial systems as applied to the airplane, not one, but two aërials are utilized, and no reels are employed. Each wire is about 100 feet long, with a two-pound lead weight at the end, and flies out from either extreme of the wings. These wires, contrary to popular conception, are said not to interfere with the maneuvering of the plane at all. One of the officers at the radio exhibit explained that the 'planes can rise and land with these wires outstretched without any trouble. One of the wires forms the aërial, while the other forms a counterpoise ground capacity. The tuning and detecting apparatus are connected between them in the cockpit.

In looking over the wireless equipment on the various 'planes, one was struck by the wide-spread adoption of the wind-driven wireless dynamo, and even the gigantic foreign bombing planes, including the Handley-Page, were fitted with a wind-driven radio generator. This small dynamo is usually mounted just to one side of the fuselage or cockpit, and is rigidly secured to the wing. As the airplane speeds thru the air, the propeller on the small dynamo is rapidly spun, and the necessary current thus produced for operating the radio telephone or telegraph instruments. Whenever an airplane or dirigible was in radio telephonic communication with the station at the show, the most frequent question heard among the audience was: "Why is it that the terrific noise of the airplane engine is not heard above the comparatively weak voice of the pilot?" The explanation is simple when you know how it is done. The explanation for the non-transmission of the airplane engine exhaust noises is as follows: Many weary weeks were spent in special research on this particular problem by experts of the concerns who developed the radio telephone during the war, under great pressure, but thanks to their keen perception of the principles involved in successfully telephoning by radio from a moving vehicle in the air, in proximity to a terrific noise such as produced by the airplane, these engineers had the forethought to finally devise a special sound detecting instrument or microphone, which is strapt to the aviator's breast, and in the front of which there is a metal plate containing three small holes about the size of a needle. The voice waves of the airplane operator impinge directly against this plate, and readily pass thru the small openings in it, thus vibrating the diafram of the microphone, while the violent swirling noises set up by the airplane engine pass by it without affecting the diafram thus protected.

Here are some of the outstanding electrical and other features which appealed to the visitor of the aëro show, in looking over the airplanes of all designs, both large and small. On one of the 'planes one found *red* and *green* signal lights, which were placed respectively on the extreme outer ends of the lower wing. Another novelty was the electric searchlight of small size, mounted over the cockpit so as to be rapidly manipulated by the pilot or his assistant, for the purpose of making landings at night or helping to locate the enemy in a night attack. Many interesting exhibits were on hand of the various magneto ignition systems. A beautiful model was shown of a spark phase-angle indicator, which roused great interest among the spectators, as the sparks staggered around the edge of a rapidly revolving two-foot black disc, which was covered over with sheet glass. Of course, there were electric lights in the aviators' quarters, or cockpit, besides many other electrical and allied features of great interest, such as signaling systems between the pilot and the observer, provision for supplying current to the electrically-heated aviator's clothes, which the aviators always wear on long distance trips, or in night flying when it is particularly cold.

Other exhibits included luminous radium dial measuring instruments and gages, electro-pneumatic and other forms of aërial photographic apparatus, some of which operated at very high speed, as can be read-

(*Continued on page 60*)

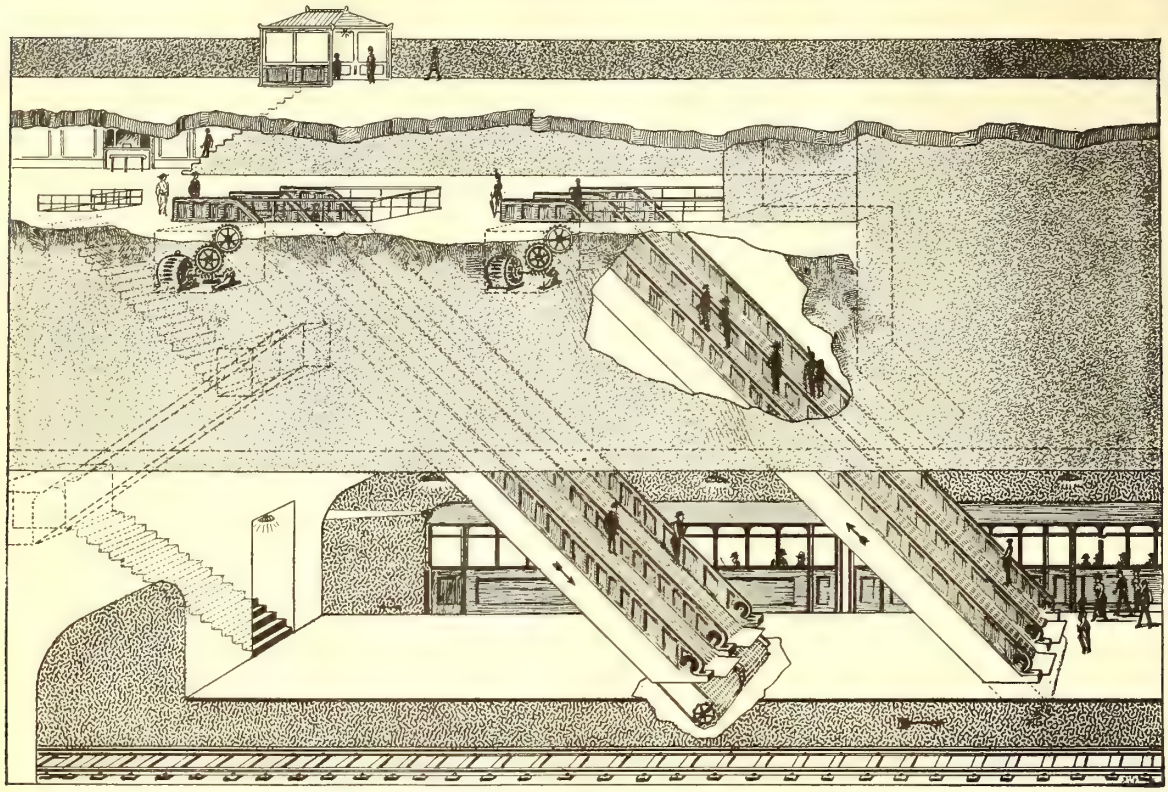


Photos by International Film Service

Airplane Radio at the "Aëro Show." Left:—A Short Range Wireless Telephone Set, Transmitting and Receiving, Used on Airplanes. Center:—A Radio Direction Finder, Used for Locating Direction of Transmitting Stations. Right:—The Airplane "Land Station" Wireless Telephone Set, Transmitting and Receiving, One of the Many Exhibitions of the Special Feature at the Aëro Show Held In New York City. The Management of the Show Arranged for Demonstrations and Exhibitions of the Many Developments of Aërial Communication Recently Adopted by the U. S. Government.

Monster Escalator for New York Subway

THE New York subway system has incorporated in its various ramifications some of the most novel engineering features possest by any similar transportation system in the world. Moving platforms have been suggested and tried in various New York transportation systems, and moving stairways or escalators are not unknown to the metropolis' subway and elevated railroad traveling public by any means. But one of the most interesting and highest lift escalators is now being built at the Park Place and Broadway station of the 7th Avenue Subway, New York City. The accompanying illustration shows a sectional view of this subway innovation, which promises to make this station one of the highest speed stations of its kind in the world.



An Innovation in Escalators is to be Tried Out at the Park Place Station of the Seventh Avenue Subway In New York City. Four Escalators Will be Available, Any Or All of Which May be Operated Either Up Or Down, Depending Upon the Direction of Traffic, Which Is Mostly Eastward in the Morning and Westward at Night.

The four escalators to be finally installed will be *reversible*, and several ways of operating these electric motor-driven moving stairways will be available. In the morning when this downtown station of the great metropolis is flooded with office-bound passengers, then if necessary all four of the escalators may run *upward* to carry the traffic to the street. After about 10 o'clock in the morning when the traffic thins down, until it is about half uptown and half downtown, then two parallel escalators can be upward and the other two downward. If the traffic is quite light, it will be up to the station master to cut out two of the escalators and block them off, running one of the remaining pair upward and the other downward. As the crowd slowly changes and becomes a strong uptown-bound traffic, toward the latter part of the afternoon, then all of the escalators will be run *downward*.

The reason for installing the escalators at this station was because of the fact that the 7th Avenue Subway, which dives under the Interboro Subway, running under Broadway at this point, has to pass under the latter Subway, and as it is located about three levels underground, this renders present climbing to the street up existing stairways a very tedious and laborious exertion, which is almost as bad as climbing the steps of the Washington Monument. Of course, the present staircases will remain in place, as under the condition where north-bound traffic might necessitate operating all of the escalators downward, then passengers arriving on southbound trains would have to gain access up these stairways to the street. It would probably be more expedient to operate three of the escalators downward and one upwards, a problem which the traffic engineers will have to determine by careful check over a considerable period of time, after the escalators have been in operation for a while.

Lightning of All Kinds

Lightning photos are more or less common, and a great number of them have been publisht in the various issues of this Journal from time to time, but one of the most astonishing lightning pictures ever recorded by the camera, is that shown in the accompanying view, which incorporates every form of lightning, such as bead, forked, chain and ribbon, so-called heat or *flash*, and ball lightning. This picture is extremely interesting to all photographers, who have attempted to obtain good photos of lightning discharges. It is quite a trick to photograph lightning in just the way you would like to have it appear on a finished picture.

In some cases, and as is the usual practise, excellent lightning pictures are obtained by waiting for a dark period just after a flash, and then opening the camera shutter, which has previously been set for a time exposure. As soon as the next flash of lightning occurs, the shutter is at once closed, and the plate then developed. This sounds simple, but as Shakespeare said, "There is many a slip twixt the cup and the lip," and one humorous instance comes to mind of an ambitious lightning photographer, who sud-

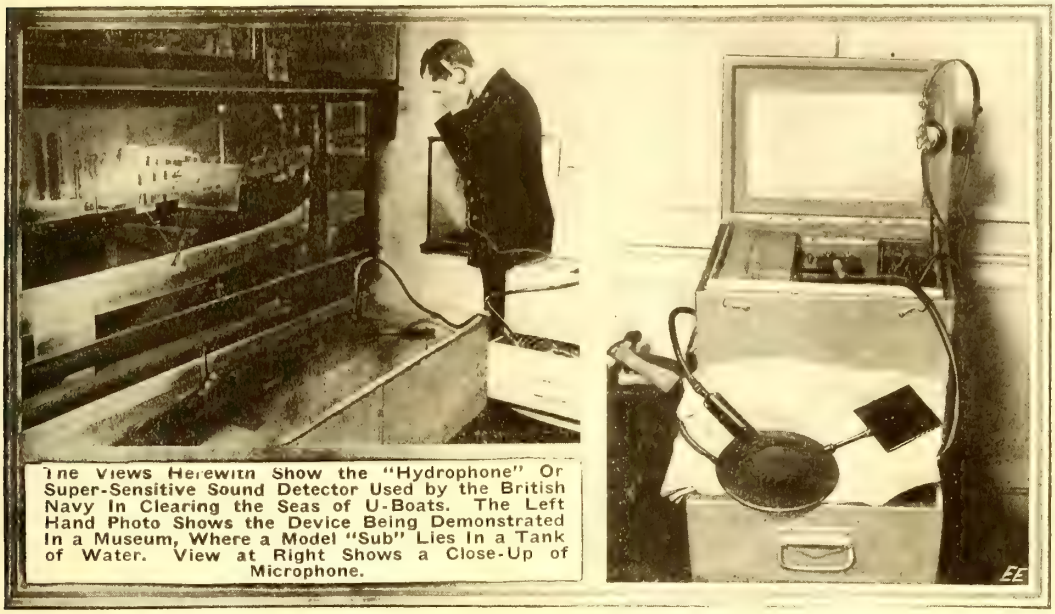
(*Continued on page* 56)



In this Remarkable Photo Lightning of Many Kinds—Chain, Bead, Forked and Ribbon Varieties—Are Shown. A Photo Hard to Beat.

U. S. PATENT OFFICE

British Submarine Detector



The Views Herewith Show the "Hydrophone" Or Super-Sensitive Sound Detector Used by the British Navy In Clearing the Seas of U-Boats. The Left Hand Photo Shows the Device Being Demonstrated In a Museum, Where a Model "Sub" Lies In a Tank of Water. View at Right Shows a Close-Up of Microphone.

This invention was used extensively and successfully by the British Navy during the war. Wires lead to various stations on the ship, at which listeners are posted. By this means a steady watch is kept and the approach of every undersea craft is heralded. One of the photos shows a model submarine in an experimental tank, showing the hydrophone in the tank, while the man with the receivers listens to the sounds from the propeller which warn of the approaching submarine.

Practically all of the British ships were equipt with the device, and it is acknowledged that many ships were saved by means of the instrument, which is somewhat like a dictagraph, i.e., a super-sensitive telephone transmitter connected with a low resistance telephone receiver. The sound detecting microphone is placed in a submerged part of the hull.

Electric Violin-Virtuoso a Marvel

One of the most wonderful musical instruments ever perfected is the electrically played violin-virtuoso shown herewith. Musicians said it could never be done—but it has been accomplisht at last, with a range of action almost, if not, indeed, actually, miraculous.

The control of both speed and pressure of the bows of the self playing violin is said to be perfect. Regardless of how fast or slow the tempo the proper ratio of pressure is consistently maintained. This is accomplished by means of a small electric motor possessing a speed of from 200 to 6,000 (and any intermediate rate) revolutions per minute, and so constructed that the amount of pressure applied to the bows is automatically and accurately regulated by the speed. Thus even the softest notes are clear and sweet, while the loud are rich and sonorous. Furthermore, one by one, there has been added to the Violano-Virtuoso various devices for producing not only the staccato, but the arpeggio, portamento, pizzicato, shake, trill and all other musical variants peculiar to violin playing.



The Electrically Played Violin is Truly a Wonder of Modern Science—It Was Long Predicted That Such a Device Could Not Be Built. But It Has—and Sixty Magnetically Operated Fingers Do the Work—and Play Better Than Most Human Violinists. Four magnets Operate the Bows.

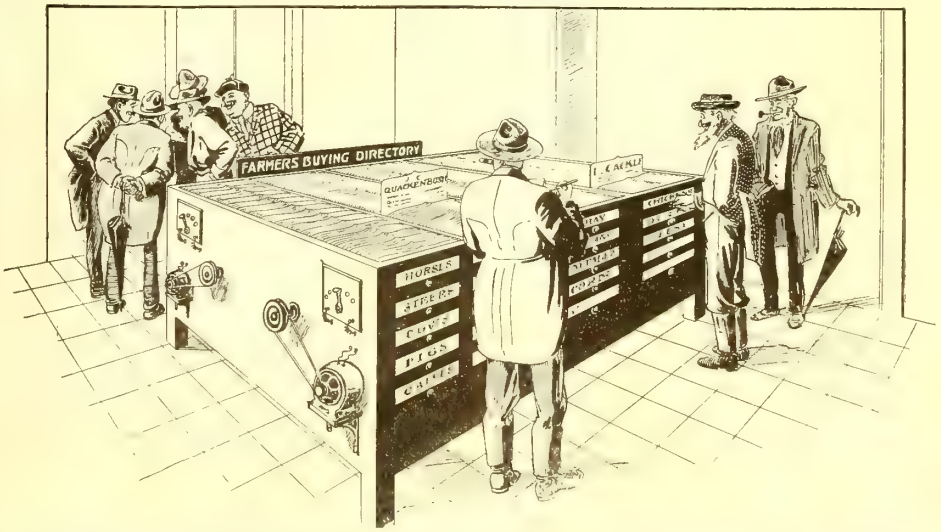
Sixty "fingers" perform the action. As the contact cylinder carrying the paper (fed by a secondary cylinder) revolves, and the perforations in the music roll pass given points, contact is made with one or more of the brushes and an electric current flows to finger magnets resting over the finger board. Each of these magnets attracts an armature connected with a finger operating rod acting upon the violin strings. The same current also acts simultaneously on the bow action magnets. Another magnet produces the "staccato" while the tremolo

(*Continued on page* 56)

Push a Button--Get a Pig

The Federal Agricultural Agent up in Litchfield, Conn., being frequently called upon to help farmers find things they needed and having no definite means of knowing where they were to be had except for gossip heard on his rounds, conceived the idea of an agricultural survey. Now, if you want to locate a supply of seed corn or oats, a grain binder, a pure-bred bull, or some young pigs, in any community in five counties in that State, all you have to do is to walk into the office of the State Librarian at Hartford, run a series of cards thru an electric sorting machine, and, Presto! you have the information.

It may sound a little like the story of Aladdin's lamp, but it is only big business applied to farm affairs under war stress. The Council of Defense took up this plan and offered to back the farm bureaus to the limit in every county in the State. Five of the eight counties began surveys early in March, 1918. Forty questions, under the headings of area, crops harvested in 1917, crops planted to be harvested in 1918, live stock on hand, machinery on hand, and employes, were included in the survey, and a corps of volunteer farmer census enumerators got busy. When the survey was completed the farm bureaus had a stack of cards containing minute information as to the resources and needs of every farm. An electric sorting machine was installed in the State Library, and any fact disclosed by the survey can be made available by throwing on an electric switch. The survey has been invaluable by helping. Connecticut to mobilize her agricultural forces for peace needs.



Push a Button—Get a Pig! Sounds Incredulous, Does It Not? Yet Up in Connecticut They Have Such an Electric System in Operation. You Don't Exactly Get the Pig Or Cow by Pushing the Button, But You Do Obtain Data as to Where You Can Buy Them.

Putting It Over on Fritz

By K. K. SAMMERIN

Tricks and Odd Slants of Warfare that Puzzled the Hun

THE immediate ancestor of the "Mills" hand grenade was the "jam tin." This was an awkward and unreliable species of bomb, shaped like a canned soup receptable, with a six- or eight-inch projecting fuse intended to burn four seconds. Sometimes it fulfilled expectations exactly, but more often the fuse was temperamental. It went off before the time was up, or sputtered long enough, after dropping in the German trench, to allow one of the enemy to pick it up and toss it back. Because, early in the fall of 1915 when this crude weapon flourished, bombs of any kind were so scarce that the soldiers often made their own, few opportunities for dosing the enemy with his own pills were overlooked.

The last day upon which Fritz monkeyed with "fizzers" from the Allied trenches with any degree of self-confidence was November 12th, 1915. That occasion taught him that even a "dud" jam tin has its lively moments.

For several weeks preceding the date mentioned a French ordnance engineer had been experimenting with what he termed "instantaneous fuse." This was made up, wound in waxed thread, just like the ordinary fuse used in jam tins. The essential and important difference between the two varieties lay in the fact that while straight fuse fizzed off at the rate of *one and one-half inches a second*, the instantaneous variety burned *twenty-six feet a second!*

Without giving the fact much publicity, several thousand jam tins identical in appearance with the stock variety were made up. In every way but one these were the same; the six-inch fuse was instantaneous, and was made with the end charred a trifle, to look as if the bomb had been lighted and had gone "dud" after being thrown.

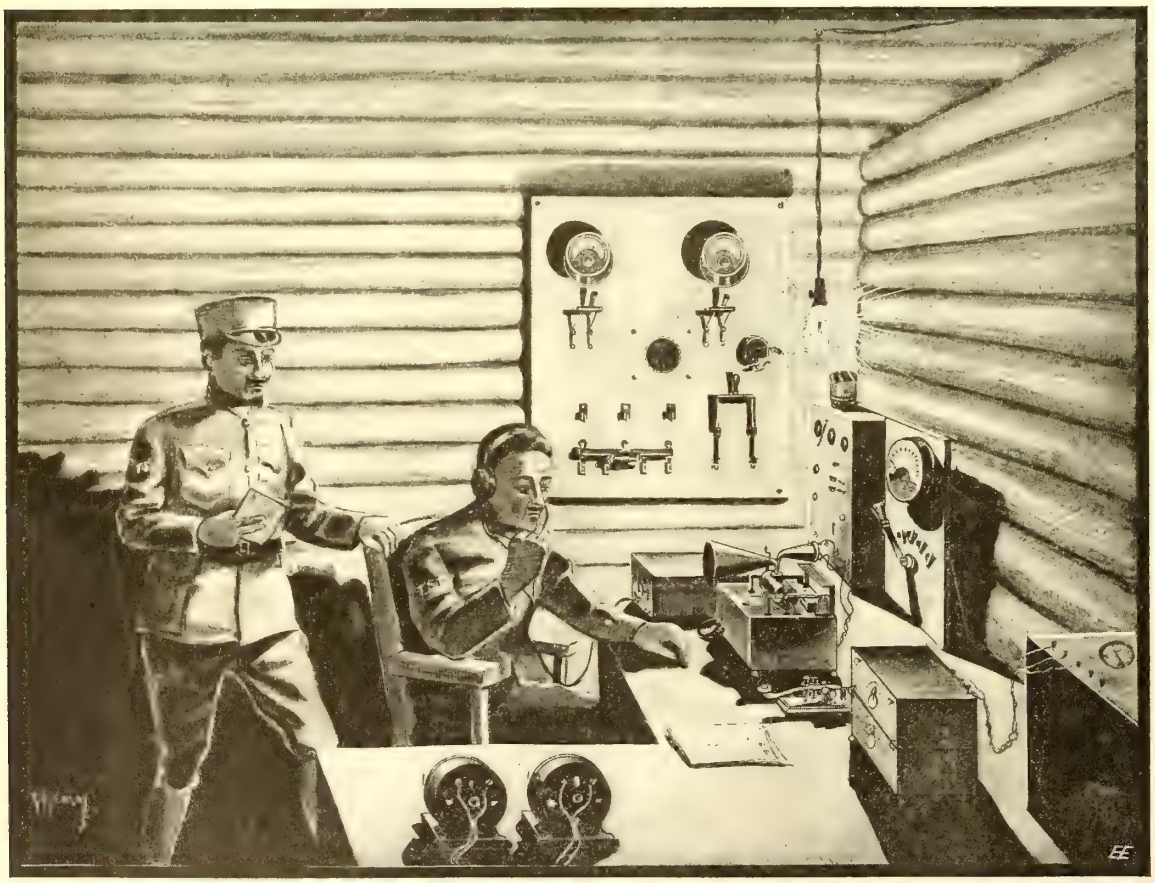
Over a sixty-kilometer front in the Verdun sector the bombers were assembled and coached in the use of this new weapon. Simultaneously at seven in the evening "parties" started out for the German wire. Stopping here, each of the four hundred bombers participating delivered himself of four regular "jam tin" grenades and four of the "imitations" before scurrying back.

Fritz noted one striking feature of the engagement. Many of the Allied missiles landed "dud"; this probably was due to the extraordinary *inefficiency* of the French ordnance department, concerning which the German privates had been told so much. All along the line German defenders picked up the imitation duds and lighted their fuses, intending to bomb the bombers with French ammunition.

The havoc that resulted was appalling! Each grenade, of course, exploded the instant it was lighted. Because a raid was in progress, anyway, each individual accident received no attention at the moment. If Fritz saw Heiney go up in smoke while handling a French bomb, he thought simply that Heiney had been too careless—tough luck for Heiney, but *he* would never get caught that way. A second later another trick bomb would send him to join his Hun Comrade.

For several minutes after the bombers reached their sheltered trench the explosions continued across No Man's Land. It was estimated at the time that a full thousand of the grenades exploded in the hands of German soldiers before anyone found out the secret. Since the average bomb exploding in the confined lane of a trench will kill three and wound six soldiers, it is fairly safe to assume that this simple trick cost the Germans at least *five thousand men in killed and wounded!* From that day forward it was official practise in the German lines to let French bombs severely alone.

Another point at which Allied wits bested German scheming was at forecasting retreats by the enemy. To civilians, well-posted with data on the occasional exploits of airplane observers, this does not sound sensational in the least, but doubtless to the Huns themselves the manner in which the Allied forces knew of the last retreat in the Soissons-Reims sector in time to take full advantage of it seemed little less than miraculous. No matter what airmen may say about the photographs they took, or the observations made by telescope from a 'plane, this latter scheme could only tell of a retreat actually under way—too late for much action by the Allies. On the other hand, the method described here not only would tell for certain, two weeks in advance of the first troop or supply train movement, *but would mark off the exact line to be abandoned, and tell the depth to which the Germans intended to relinquish their hold!*



He Thought He Detected Something That Sounded Just a Little Like a Message! He Wound the Phonograph and Turned Its Speed Indicator Down So That the Record Revolved Only a Few Times a Minute. Then He Applied the Needle Again. Aha! There Was Something There!

This was done simply by listening in on the unintelligible gibberish of German trench wireless with Allied instruments. Ordinarily, of course, three-fourths of the signaling done in the front trenches is done by means of telephone, orders being sent thru one central station by wire to all parts of the sector.

Towards the end of the war, however, the Germans began to run out of wire and telephone instruments. They could not replace them because of a lack of the materials. Therefore they began to plan on saving every instrument and foot of wire when a retreat was to be made. They took out the stations gradually, and as they removed them they set up trench wireless instead. The Allies, after finding out this plan, simply watched the appearance of wireless sets where 'phone stations had been; when the wireless began to predominate it was certain that ten days or two weeks would

(*Continued on page 77*)

Cold Light

By ROGERS D. RUSK, M. A.

COLD light is one of the wonders of the modern age. Light without heat seems like a contradiction, nevertheless it is a scientific fact. Since the discovery of the electrical

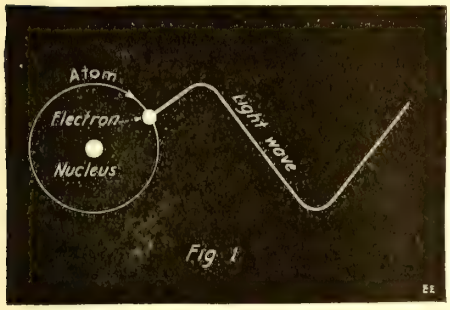


Diagram Illustrating the Old Theory of Light Produced by Electricity. In This Explanation the Electron is Considered as Continuously Producing Light Waves by Its Rotation. The Newer Theory of Light and Heat Waves is Shown at Fig. 2.

nature of light, the possibility of transforming electricity directly into light, without the production of heat, has been a tempting goal. For centuries, scientists dreamed of solving the mystery of the *firefly* and the *Aurora Borealis,* but dreamed in vain. They saw light without heat produced in Nature, but could not produce it themselves.

Today the discovery that light may be produced without heat, by means of electrical ionization, seems to be the key to the situation, and we can only wonder where it may lead us. At the present time over 96 per cent of all the energy used in the fifty million incandescent lamps in the United States, instead of being turned into light, *is wasted in the form of heat!* Moreover the astonishing production of light without heat by ionization has given us a new view of the relation between light and electricity and the great problem of the origin of light.

It used to be thought that light could only be produced by incandescence, that is, thru heating of a solid body to white heat. Strange as it may seem, the candle and the kerosene lamp are really incandescent lights. The light they give off is due to white-hot particles of carbon liberated in the combustion process. Even the light from an arc lamp is mainly due to the crater in the positive carbon being heated to incandescence.

The fact that heat is not the only factor which effects the production of light can be easily seen in two ways. First, salts of sodium, potassium and lithium may be thrown in the same flame at exactly the same temperature, but the first gives off a bright yellow light, the second a violet, and the third a deep red. Second, light is produced by an electric spark in a partial vacuum, such as a Geissler tube, *with little or no heat at all.* In both of these cases the light *must* be produced by the breaking up of the molecules, of the solid or gas, into electrically charged particles, or ions, in a manner to be explained later.

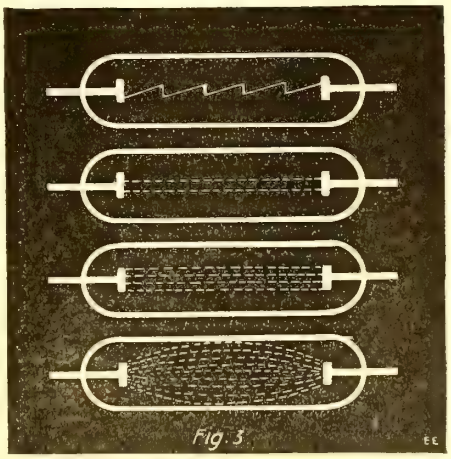
The idea of using cold light for illuminating purposes seems to have first occurred to Nikola Tesla. Very early in his career he suggested that the effects produced in Geissler tubes might be utilized in that way. Not until recent years, however, did his suggestion bear fruit in the shape of the now famous Moore *vacuum tube* light, invented by McFarland Moore, which produces a fine soft light from a glass tube thirty to forty feet long, filled with carbon dioxid. The heat which this light produces is almost negligible.

Cold light is a term used to indicate luminous radiation *without* heat radiation, and that means maximum efficiency, i.e., a colder and a colder source. The old fashioned kerosene lamp wastes 36.4 calories of heat per second for every candlepower of light produced. The gas mantle wastes 11, and the tungsten lamp but from 1. to 2. calories.

Considering electric lights only, the heat loss in tungsten lamps has been reduced by the introduction of gases such as nitrogen into the bulb, but arc lights have made a greater development. The invention of the enclosed arc reduced the heat loss without reducing the illumination. Then the invention of the flaming arc increased the illumination without increasing the temperature of the arc. The latter is the most interesting development because part of the light from the flaming arc is *cold light,* from the chemicals in the flame which are ionized by the electric current. The cold light from these ions plus the light from the incandescent carbons makes the flaming arc nearly *three hundred per cent* more efficient than the ordinary incandescent lamp.

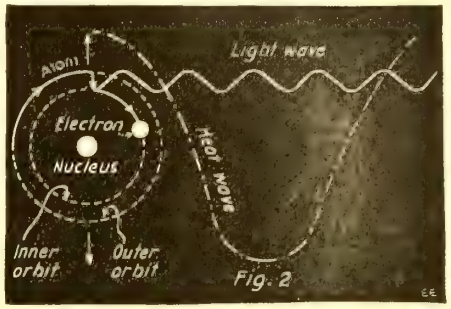
The first flaming arc appeared in 1900, known as the Bremer arc, and using carbons impregnated with several chemical salts. Later Steinmetz and Whitney used the rare metals titanium and chromium in their arcs and produced a still more efficient light. About the same time the *mercury vapor* light was invented, which gave a brilliant bluish white light from the mercury ions in the arc. Later still is the discovery by two scientists, Franck and Hertz, that an electric current of only 4 volts, when past thru *cold iodin vapor,* produces a faint light of definite color. When the voltage is raised to twelve, another color is obtained. This is *true cold light,* produced directly from the molecules as they are ionized by the current. How this is possible, and how light and heat may be produced independently of each other, will now be shown.

What the actual source of a light wave is has been one of the mysteries of science since the beginning of history. The discovery by Maxwell, Hertz and others that light is an electro-magnetic vibration, caused scientists to look for the electric charges which produce these waves. When the electron was discovered it was thought that the solution had been found, but there



How "Cold Light" May be Obtained by Exhausting an Ordinary Glass Tube. When Air is Pumped Out of a Tube in Which There is an Electric Spark Discharge, a Stage is Reached Where the Whole Tube is Filled with a Soft Luminous glow—Cold Light.

was still one great drawback. Scientists said that as the electron revolved about its axis in the molecule it produced light waves just like a paddle wheel in a body of water. But as all molecules of all substances con-



The New Theory of Light and Heat Waves, Which Says that Light is Produced Intermittently. Here Light is Produced by the Electron Jumping from One Orbit to Another, as the Circular Orbital Paths Indicate.

tain electrons which are constantly in motion, then all substances should give off light all the time. This was ridiculous, as everything in the world and the whole universe would be of a dazzling brightness like the sun.

The discoveries of today are changing this idea completely. One of the world's greatest physicists, Planck, says electrons cannot give off light waves continuously, but emit definite quantities at intervals. This theory he calls the *quanta theory,* and another physicist, Bohr, says the time the light is given off is when the motion of the electron is suddenly changed from its normal continuous motion, by its jumping from one atom to another, or from one orbit to another about the same atom. This is a very simple theory, but it is often the simplest theory which best explains the facts. When trillions of trillions of electrons are doing this at the same time, the light is to all purposes continuous. These theories have received added confirmation from work done recently by Prof. Millikan of Chicago University, who gained fame by his original measurements of the electron itself.

The principle of the new theory can be easily explained by an illustration. If a ball is whirled in a circle on the end of a string, the pull on the string is steady and continuous as long as the ball whirls with the same speed. However, if the ball is suddenly stopt or hit by something which makes it change its course, a jerk or a wave will be felt in the string. Now an electron does the same thing, only the jerk or wave is sent out in all directions by the electro-magnetic field about the electron. This jerk or wave is the little quantity which Planck calls a "quanta". The familiar way in which an electron is pictured as continuously producing light waves, by its rotation, is shown in Fig. 1, but this is wrong according to the above theory. What really must happen is shown in Fig. 2, where the two circles represent different orbits and the full line represents the path of the electron jumping from one orbit to another and at the same time emitting a quantity of radiation or *light.* The way in which electricity or some other agency causes this disturbance of the electron is not fully understood.

The most remarkable thing about it all is that heat and light waves may be produced independently. A heat wave is produced by the vibration of the whole molecule or atom as shown by the big arrows and dotted wave line in Fig. 2. And under

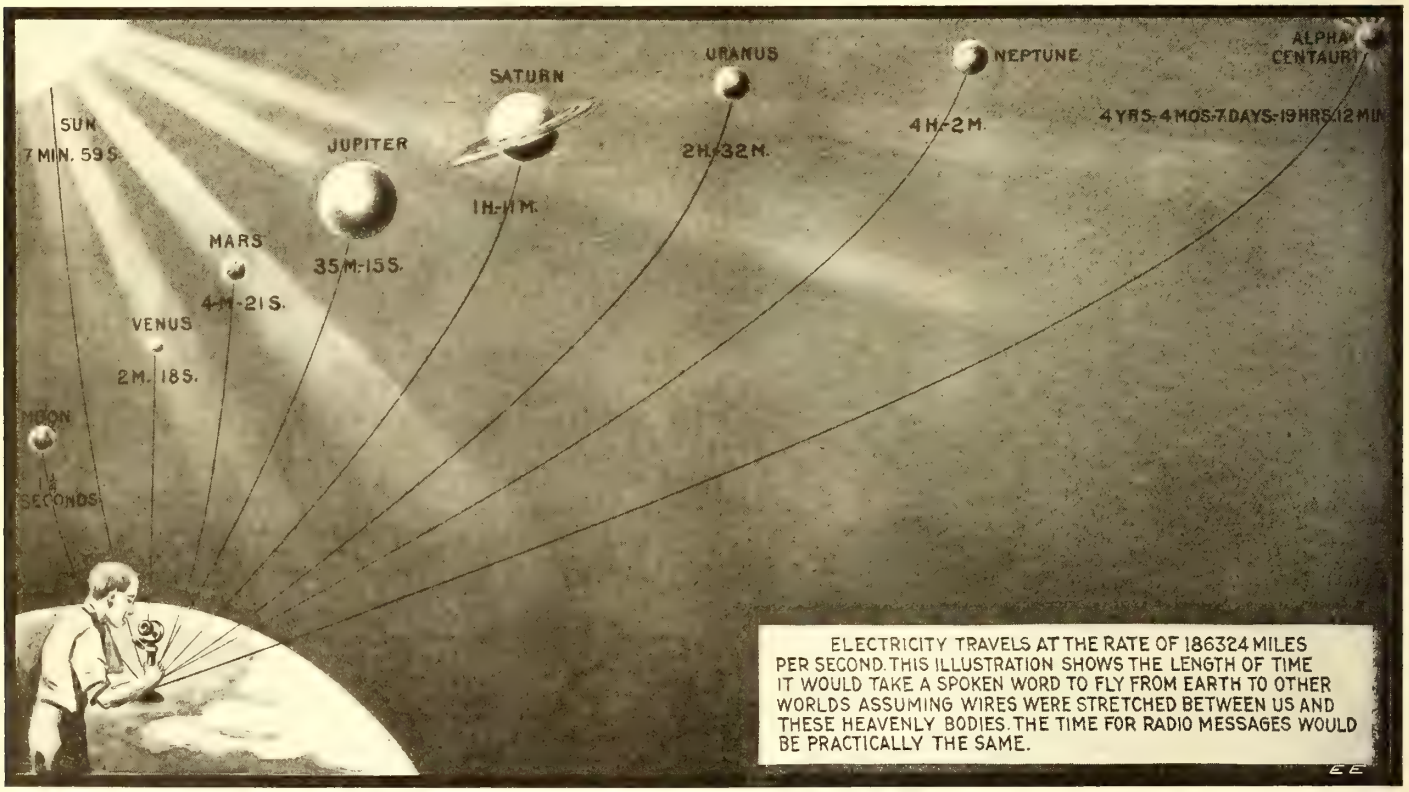
(*Continued on page* 73)

Popular Astronomy

Astronomical Distances

By ISABEL M. LEWIS
of the U. S. Naval Observatory

THE immensity and grandeur of the scale upon which the visible universe is fashioned lies almost beyond human comprehension. To visualize the vast extent of our own solar system which is but a single unit in the system of the stars we may have recourse to earthly standards of measurements, such as the mile. But when we desire to express in terms of units that can be grasped by our imagination, the distances of the stars that lie far, far beyond, we find that all ordinary standards of measurement become utterly inadequate for our purpose. For the measurement of celestial distances *within* the solar system the unit employed is either the familiar mile or kilometer or the "astronomical unit," which is the mean distance from the earth to the sun (ninety-two million nine hundred thousand miles in round numbers).



Next Time When You Are Impatient and Fretting Because "Central" Keeps You Waiting Ten Seconds for a Connection, Imagine That Your Best Girl is on Neptune. You say "Hello" and It Takes Exactly 4 Hours and 2 Minutes for "Hello" to Get Up to Neptune, and Then You Have to Wait 4 Hours More to Give Your Sweetheart a Chance to Say "Hello" in Return. While If She Were on Alpha Centauri, It Would Take Your Voice Over Four Years to Get to Her and an Equal Time for Her Voice to Get Back, Altho You Know That Electricity Travels at the Rate of 186,324 Miles a Second.

The unit of measurement employed for distances *beyond* the solar system is either the *light year* or more recently the *parsec* which appears to be rapidly replacing the light year among astronomers. A "light year" is the distance that light, with its finite but almost unimaginable velocity of one hundred and eighty-six thousand miles *per second, travels in a year.* It is equal in round numbers to sixty-three thousand times the distance from the earth to the sun or approximately six thousand billions of miles. The parsec is equal to three and twenty-six hundredths (3.26) light years, and it is approximately two hundred thousand times the distance from the earth to the sun. It is "the distance of a star with the *parallax* of a second," a fact which its name conveys to us. In other words, at the distance of one parsec the distance from the earth to the sun, "the astronomical unit," would subtend an angle equal to one second of arc. This angle is spoken of as the parallax of the star. The larger the parallax; that is, the larger the angle that the astronomical unit or radius of the earth's orbit subtends, viewed from the star, the nearer the star is to us. The fact that there is no known star within one parsec, or three and twenty-six hundredths light years, of the sun shows the immensity of the scale of the universe of stars.

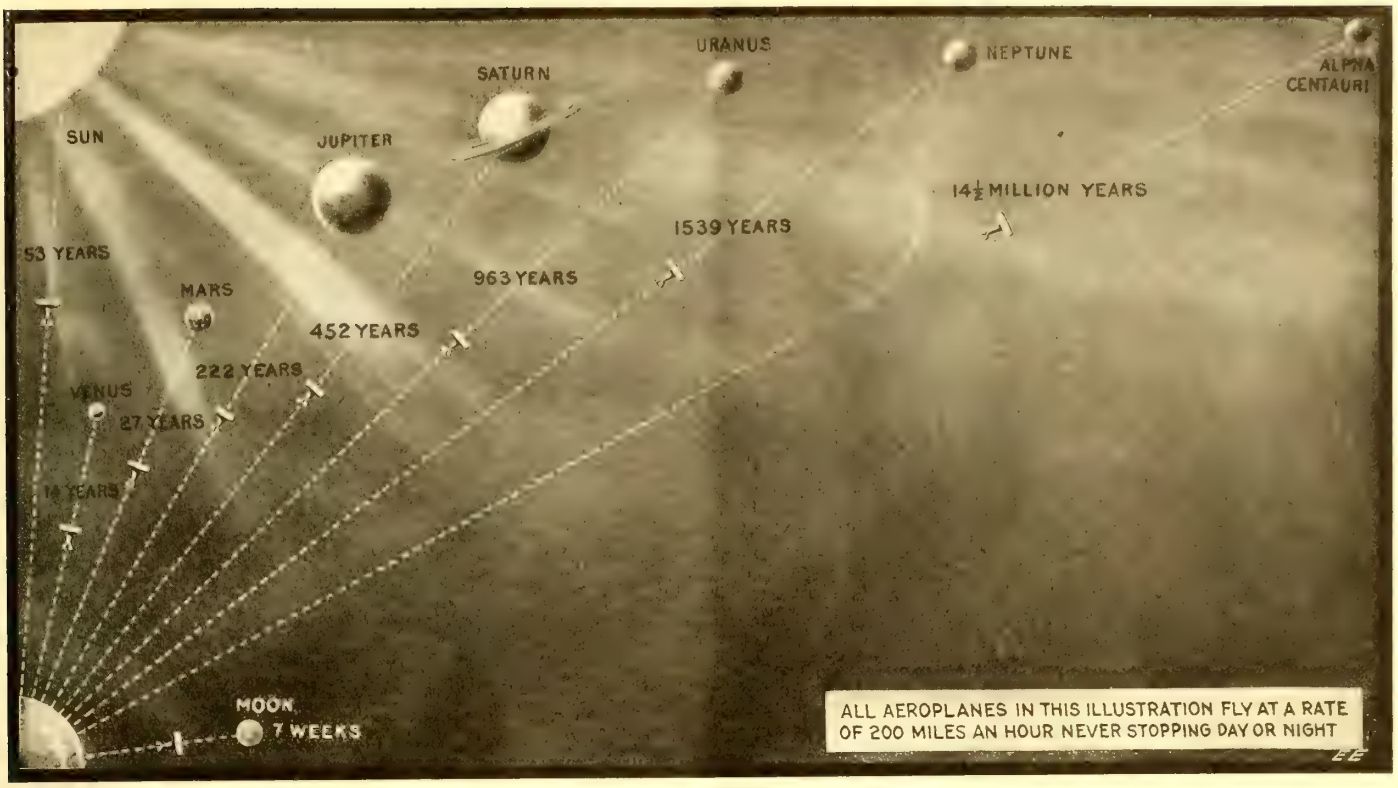
Before considering the distances of the stars and the extent of the sidereal system of which our sun and his satellites form a part, let us undertake to express the distance of the sun, moon and planets from the earth and the extent of the solar system in terms with which we are familiar.

The nearest to the earth of all celestial bodies is its satellite, the moon. So near is the moon that if we should make on some great plain a model of the solar system in which the astronomical unit, the distance from earth to sun, would be four hundred feet, the distance between earth and moon would be only one foot. On the same scale the most distant planet Neptune would be two and one-quarter miles away. In round numbers the moon is distant from us sixty times the distance from the earth's center to its surface or two hundred and forty thousand miles and thru our great telescopes we see it as it would appear at a distance of one hundred miles.

Granted that it were possible to escape the earth's gravitational bonds and to travel by our swiftest means of conveyance, the airplane, thru interplanetary space, let us consider how long it would take us to reach the moon, sun and planets if our speed were unslackened at two hundred miles an hour. An airplane traveling at this rate would circumnavigate the earth in a little over five days and would reach the moon in seven weeks. A trip to the sun, however, would require fifty-three years.

After traveling for fourteen and a fraction years we would pass the orbit of Venus and eighteen years later the orbit of Mercury. If we preferred to travel outward from the earth in the direction of Mars and the outer planets instead of toward the sun, more than twenty-seven years would elapse before the orbit of Mars would be crost. An airplane journey to Jupiter would be a matter of more than two hundred years, to Saturn four hundred and fifty years, to Uranus nearly one thousand years and to Neptune about one thousand five hundred years. To cross the solar system on the diameter of Neptune's orbit would be a journey of more than three thousand years. The sun's attraction reaches far beyond Neptune's orbit, however. There are comets belonging to the solar system compelled by the sun's attraction to accompany him on his travels thru space that return periodically to the immediate vicinity of the sun from regions far beyond the orbit of Neptune and there is also the possibility that one or more undiscovered planets may travel around the sun in orbits exterior to Neptune's orbit.

Measured in terms of familiar units, such as are employed for the measurement of distances on our own planet, the extent of the solar system is tremendously great. Seen from Neptune, the sun presents no appreciable disk. It is in this sense starlike to the Neptunians, but seen from Neptune the stars appear no more brilliant and



The Fastest Vehicle Known to Man is the Airplane. Supposing There Was Air Instead of a Vacuum Between the Earth and the Other Heavenly Bodies, It Would Take an Airplane a Very Considerable Time to Reach These Bodies. Even to the Moon, the Nearest of All Heavenly Bodies, Only 236,000 Miles Distant, Seven Weeks Would Be Consumed in Reaching It By Airplane. To Reach Neptune, It Would Take 1359 Years. Such Are the Immense Distances of the Universe.

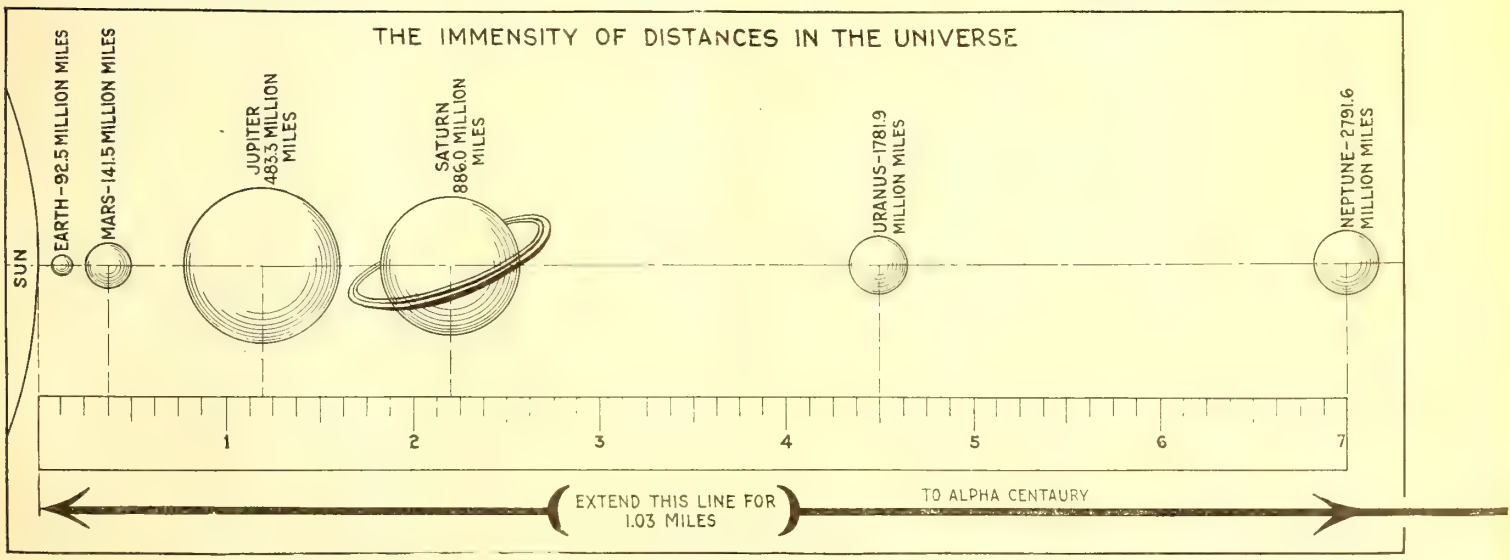
therefore no nearer than they do to us.

To Neptune the sun, tho star-like in form, supplies a very appreciable quantity of light and heat (one nine hundredth of the amount the earth receives) while the amount of light and heat that Neptune receives from the nearest stars is entirely inappreciable. When our airplane reaches Neptune after a journey of one thousand five hundred years, it is, as it were, just clearing the ground for its flight to the stars. To cover the intervening space to the nearest star, traveled by light in four and a third years, an airplane would require *fourteen and a half million years*. In that time the solar system itself would be in some far distant part of the universe, for it is speeding onward thru space at the rate of twelve miles a second or about four astronomical units a year.

Changing now our unit of measurement that we may express interstellar distances in comprehensible numbers, we prepare to travel from the earth to the stars with the velocity of light.

At this speed, one hundred and eighty-six thousand miles per second, we circumnavigate our globe in one-seventh of a second, reach the moon in one and a fourth seconds and the sun in eight minutes. In a little over four hours we pass the orbit of Neptune and are started on our journey to the stars penetrating further and further into interstellar space. For a year we travel and reach not a single star tho we are speeding ever onward with the velocity of light. We have now covered the distance of one light year which means the waves of light from the sun we have left behind must travel for a year before they reach us. We continue our journey and find ourselves next at a distance of one parsec from the sun. We have traveled a distance of approximately three and a quarter light years, and were it possible to see the earth as well as the sun at this distance, the two would appear to be but one second of arc apart, a distance that requires the most careful adjustment and manipulation of the telescope to measure accurately. We are still one light year distant from Alpha Centauri, the nearest of the bright stars. A few of the stars may now appear somewhat brighter than they appear to us on earth, but the majority of the stars appear just as we see them here on earth and the forms of the constellations remain practically unchanged in appearance, for we are only beginning our journey thru the sidereal universe and our position in the universe has only shifted in a slight degree. If we should continue our journey to the immediate vicinity of Alpha Centauri, we would find that it is not like our own sun, a single star, but is a binary star consisting of two suns in revolution around their common center of gravity. The distance of this binary system from the solar system has been meas-

(*Continued on page* 54)



In This Illustration, We Are Trying to Convey to the Reader an Idea of the Enormous, Unthinkable Distances of the Universe. If the Distance from the Sun to Neptune, Which in Reality is 2,791 Million Miles, is Represented By Seven Inches On This Scale, Then the Distance from the Sun to the Nearest Star, Alpha Centauri, Would Be Slightly Over One Mile. Note How Near the Earth is to the Sun, Altho 92 Million Miles Away from It. In Order to Show the Earth Without It Touching the Sun, It Was Necessary In This Drawing to Make the Earth Smaller Than Mars. In Reality Mars is Smaller Than the Earth. The Other Planets Are Shown in Their Correct Proportions.

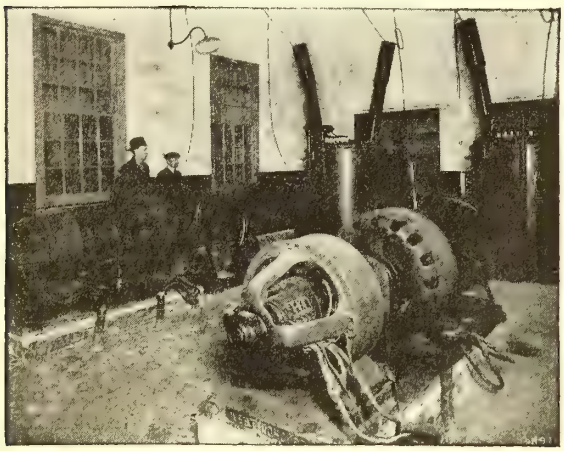
Reclaiming Metal Dust From Flue Gases

IN refineries of different types there is always a possibility of some valuable by-products, waste, etc., being lost by gases ascending the flue. This is particularly true in the metal treating field. Here it has been found possible to save solid and liquid particles from the flue gases by an electrical process. This consists in passing the gases thru tubes in which are suspended insulated chains charged with high voltage direct current. In passing thru the tube the particles carried by the gases become electrified and are projected against the walls to the tubes. These tubes are grounded and thus the particles drop into hoppers below. Mechanical rectifiers convert the low voltage alternating current into direct current.

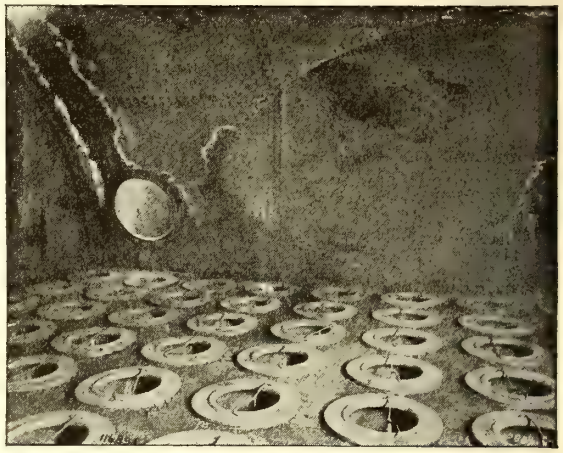
An interesting application of this process was recently made in a copper refinery. In this particular installation there is another noteworthy fact and that is the size of the generating and transforming unit used.

The treater tubes containing the high tension electrodes and thru which the flu gases pass are arranged in six groups. The electrodes are suspended at the top from a rack which provides ample insulation, and are connected with the high tension direct-current line at the bottom. The gases from the furnaces pass thru pipes 13 feet in diameter, a "Y" with valves being provided so that the gases can be made to go either thru the treater or directly to the stack as desired. See figure herewith.

It is stated that over 90 per cent of the flue dust can be removed and that the value of the copper, zinc and other metals recovered will within a short time pay for the treating equipment.



This Power Plant Delivers 100,000 Volts and .5 Ampere, Direct Current, for Precipitating the Solid Particles in Flue Gases, Such as in the Metal Refining Field, Thus Saving as Much as 90 Per Cent of the Flue Dust.

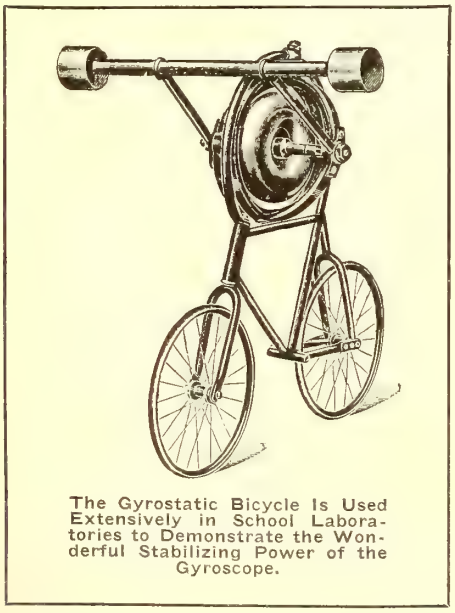


Interior of High Tension, Direct Current, Electrode Chamber Inside of Flue Tube Measuring 13 Feet in Diameter. The Electrodes Are Suspended Chains Which Carry the Charge When in Use.

The transformers are of 40 kva. capacity, 200 volts low tension and 100,000 volts high tension. To the motor-generator shafts are coupled the commutating rectifiers for transforming the high-tension alternating current into direct current.

A Gyrostatic Bicycle

The accompanying illustration shows a novel gyrostatic bicycle model built by a London scientific instrument maker, and this machine will maintain its equilibrium for a considerable period of time. Many of us most probably have seen the street fakir shouting loud and longly about the wonderful possibilities of the toy gyroscope,



The Gyrostatic Bicycle Is Used Extensively in School Laboratories to Demonstrate the Wonderful Stabilizing Power of the Gyroscope.

and the apparatus here shown duplicates the many startling maneuvers that the little twenty-five-cent toy gyro performs. When a gyroscope balance wheel is spun rapidly, and providing the rim of the wheel is sufficiently heavy to give it a good momentum, it will be found very difficult to shift the bicycle, or other device on which the spinning gyro is mounted. To demonstrate the principle of the gyroscope—which is based upon the fact that a spinning or rotating mass tends to preserve its plane of rotation—all one has to do is to jack up the rear wheel of a bicycle, and by turning the pedals, cause this wheel to spin rapidly. Now hold the bicycle off the ground a short distance, and endeavor to turn the complete bicycle sidewise. You will experience a surprisingly strong counter-turning effect, which tends to keep the bicycle in its upright plane as long as the wheel spins at a fair rate of speed. Many of these gyros are electrically driven; also it is well to keep in mind the fact that even an ordinary bicycle exerts some gyrostatic effort, and this has much to do with the success of the rider in maintaing his upright position while spinning along on two wheels mounted in tandem, that is, one behind the other. You have probably noticed, if you have ever ridden a bicycle that the faster you go, the easier it is to maintain your balance. The increasing gyrostatic effect as the rotational speed of the wheels increased was the reason.

A HARD DRINKER OF SOFT DRINKS.

This little girl is a soft drink demonstrator and she sits in show windows all day long pouring drink after drink of some delicious beverage into the glass and raising it to her lips and draining it with the greatest ease.

She seems to like the beverage, for after each drink she nods her head a couple of times with a happy smile which seems to say, "My, that was good"; then she pours down another one.

The figure is made life size of papier maché and mounted on a tabourette, which contains the electric motor and speed reducing mechanism. The cams and levers which operate the arms and head are thoroly concealed inside the body.

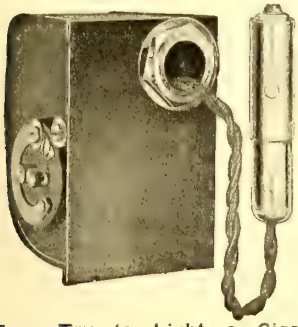


Drink Hearty, Little Girl. It's Only Some of Willie Bryan's Famous Grape Juice. An Electric Motor Solves the Mystery of This Silent and Ever-Drinking Demonstrator.

Try These On Your Auto

ELECTRIC CIGAR LIGHTER FOR THE AUTO.

At last—a perfect electric cigar lighter. It should prove a boon to motorists. It is handy and convenient—always within reach. The burner tip is made of heavy wire and will last indefinitely. Burner tip is protected by a cap not shown in cut. This neat and efficient cigar lighter is equipt with 5½ foot cord, which automatically rewinds. The lighter is easily attached to the battery in the car and costs practically nothing to operate.



Ever Try to Light a Cigar While Driving an Auto? This Electric Cigar Lighter Does the Trick Better Than Matches and Does Not "Blow Out".

NEW MAGNETO IMPULSE STARTER.

One of the many reasons why the magneto is so firmly established as the supreme ignition system is the fact that it does not depend upon any other unit or units for its electrical output and distribution of current.

The magneto transforms mechanical energy into electrical energy. The moment the shaft of a magneto-equipt engine revolves, the magneto begins to generate electrical energy for ignition; and, following requirements, the higher the rate at which it is driven the more intense are the sparks.

To facilitate *starting* when necessary, the magneto here shown can be supplied, with an impulse starter, which automatically "speeds up" the magneto armature at the exact moment of firing the *initial* gas charge or charges, thus providing at even low speeds the full electrical capacity of the magneto.

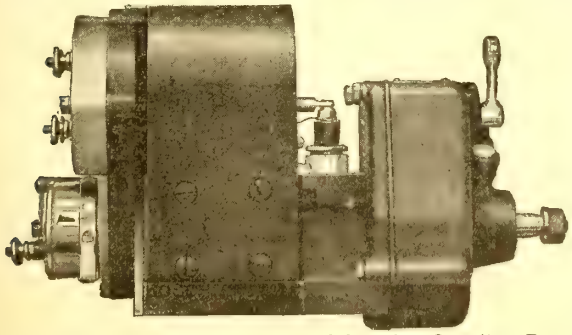
In a word, the impulse starter or coupling is a mechanical device for the purpose of obtaining positive and efficient starting, without the aid of batteries or a battery system of ignition.

The impulse starter is located between the magneto drive and the armature; when the engine is cranked or barred over, the armature is held stationary, while energy is being stored up by the compression of a series of springs. At a predetermined moment the springs are released and the armature is given a partial revolution at high speed. In this way, intense sparks are provided, and the engine given its starting impulse.

As soon as the engine commences its regular operation, or attains a speed of about 120 r.p.m., the impulse starter is automatically disengaged, the "starter" transmitting the driving energy to the magneto as a flexible coupling.

The control of the "starter" is by means of a lever mounted on a shaft projecting from the front of the housing. The lever is so constructed that it can either be operated by hand or thru the medium of a control connection.

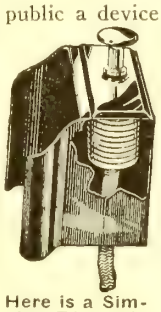
The impulse starter is not an attachment, but is provided only as a part of this new magneto.



By Storing Up Energy in a Special Spring Coupling Device, It Becomes Possible to Spin This Magneto at Starting, and Provide a Hot Spark.

HEADLIGHT DIMMER

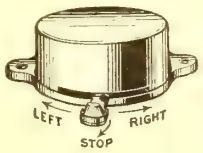
An Ohio electric concern is offering the public a device known as a headlight dimmer for use on Ford cars to dim the headlights when driving at night. This dimmer, it is claimed by the maker, can be attached to any Ford car by simply clamping it over the steering post and connecting the wires to the lighting circuit. The wires are easily connected, and when in use it is said that the dimmer will not affect the ignition or lighting system in a detrimental way. The control is made possible by means of a push and pull switch and a barrel type resistance. It is pointed out that it makes possible the use of a brighter light than can be secured thru the use of dimming lenses, yet at the same times makes it convenient to dim the lights according to requirements of traffic laws.



Here is a Simple Electric Headlight Dimmer, Something Every Car Requires by Law. It Answers to the Call of Fords.

EFFECTIVE AUTO SIGNAL.

In this new electric auto signal there is only one *signal box*, which is placed on the left rear fender (or body or panel in the case of commercial vehicles and trucks). This shows both from the front and rear, and is visible day and night. The left rear fender is the logical place for the signal, as it is seen by all cars following from the rear, or cars approaching from the front, as well as by the traffic policeman, who is always to the left of cars approaching him.

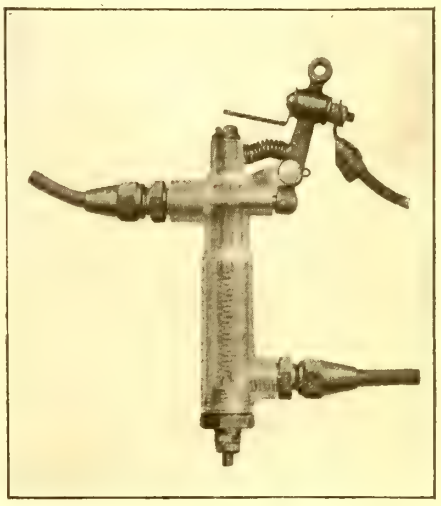




A Logical Design In Electric Auto Signals, Which Can Be Seen from Front or Rear. It is Controlled from the Driver's Seat by Means of a 3-Way Switch.

The signal is controlled for *left, right,* or *stop* by a plainly marked, single handle, three-way switch attached to the steering column immediately below the steering wheel, or in a place most accessible to the person driving. It is easily attached, and there are no moving parts to get out of order. A tell-tale buzzer indicates that the signal is functioning. A very slight amount of current from the lighting system of the car or dry cells is consumed. The signal is easily installed on the car by any mechanic.

ELECTRICALLY HEATED PRIMER FOR QUICK STARTING OF AUTOS.



This Electrically Heated Primer Will Save Much Useless Cussing and Start Your Auto Engine in a Jiffy. The Fuel is Heated, Mixed With Air and Vaporized, Then Sucked Into the Engine. A Simple and Positive Device.

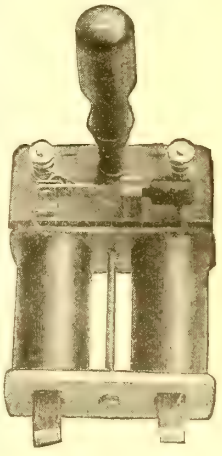
The autoist usually thinks of a primer as a means of pumping fuel into the cylinders quickly. The master primer here shown is not a pump in any sense of the word. The fuel is first heated boiling hot, vaporized by heat and mixed with air. Then drawn into the cylinders by suction of the motor. The suction draws only the quantity needed. Liquid gasoline will not explode. It must be vaporized. It must have air mixed with it to make it explosive.

Liquid fuel in large quantities carbonizes the engine. With the throttle of the carburetor closed, the master primer acts as an auxiliary carburetor—supplies the motor with what it needs in any kind of weather—heated vapor. The heating coil draws 20 amperes, about the same as the horn. Without it you may turn a balky engine over a hundred times.

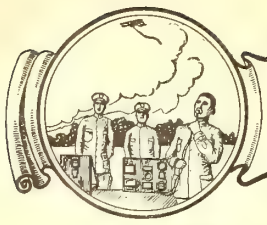
To operate the primer all one need do is just pull a button on the dash. The same operation as choking the carburetor. Pulling the button makes electrical contact and opens the outlet valve of the primer. When car starts let go of button; the contact is broken and valve shuts off automatically.

NEW MAGNETIZER FOR REMAGNETIZING FORD MAGNETOS.

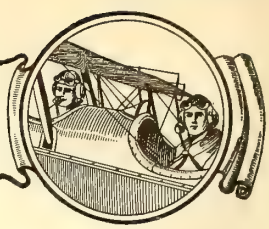
The Ford engine will display a great deal more "pep" if the magnets on the magneto are kept charged. We all know these magnets will lose their magnetism, which naturally reduces the energy displayed by the engine. The magnetizer is constructed in such a way that these magnets can be charged without taking the engine apart. All that is necessary is to take off the transmission cover. The magnets can then be charged, requiring only three or four seconds to each magnet. This is done by connecting the magnetizer to a well charged 6 or 12-volt battery or a sufficient number of dry cells in series.



Ford Owners Will Hail With Delight This New Magneto Magnetizer.



RADIO DEPARTMENT

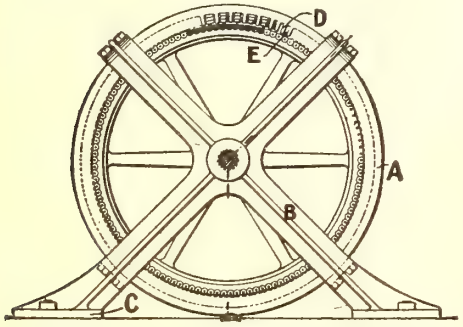


The True Wireless

By NIKOLA TESLA

Written Exclusively for The Electrical Experimenter

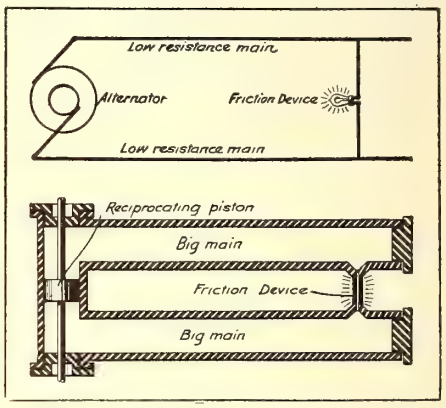
EVER since the announcement of Maxwell's electro-magnetic theory scientific investigators all the world over had been bent on its experimental verification. They were convinced that it would be done and lived in an atmosphere of eager expectancy, unusually favorable to the reception of any evidence to this end. No wonder then that the publication of Dr. Heinrich Hertz's results caused a thrill as had scarcely ever been experienced before. At that time I was in the midst of pressing work in connection with the commercial introduction of my system of power transmission, but, nevertheless, caught the fire of enthusiasm and fairly burned with desire to behold the miracle with my own eyes. Accordingly, as soon as I had freed myself of these imperative duties and resumed research work in my laboratory on Grand Street, New York, I began, parallel with high frequency alternators, the construction of several forms of apparatus with the object of exploring the field opened up by Dr. Hertz. Recognizing the limitations of the devices he had employed, I concentrated my attention on the production of a powerful induction coil but made no notable progress until a happy inspiration led me to the invention of the oscillation transformer. In the latter part of 1891 I was already so far advanced in the development of this new principle that I had at my disposal means vastly superior to those of the German physicist. All my previous efforts with Rhumkorf coils had left me unconvinced, and in order to settle my doubts I went over the whole ground once more, very carefully, with these improved appliances. Similar phenomena were noted, greatly magnified in intensity, but they were susceptible of a different and more plausible explanation. I considered this so important that in 1892 I went to Bonn, Germany, to confer with Dr. Hertz in regard to my observations. He seemed disappointed to such a degree that I regretted my trip and parted from him sorrowfully. During the succeeding years I made numerous experiments with the same object, but the results were uniformly negative. In 1900, however, after I had evolved a wireless transmitter which enabled me to obtain electro-magnetic activities of many millions of horse-power, I made a last desperate attempt to prove that the disturbances emanating from the oscillator were ether vibrations akin to those of light, but met again with utter failure. For more than eighteen years I have been reading treatises, reports of scientific transactions, and articles on Hertz-wave telegraphy, to keep myself informed, but they have always imprest me like works of fiction.



Alternator of 10,000 Cycles p.s., Capacity 10 K.W., Which Was Employed by Tesla in His First Demonstrations of High Frequency Phenomena Before the American Institute of Electrical Engineers at Columbia College, May 20, 1891. Fig. 1.

The history of science shows that theories are perishable. With every new truth that is revealed we get a better understanding of Nature and our conceptions and views are modified. Dr. Hertz did not discover a new principle. He merely gave material support to a hypothesis which had been long ago formulated. It was a perfectly well-established fact that a circuit, traversed by a periodic current, emitted some kind of space waves, but we were in ignorance as to their character. He apparently gave an experimental proof that they were transversal vibrations in the ether. Most people look upon this as his great accomplishment. To my mind it seems that his immortal merit was not so much in this as in the focusing of the investigators' attention on the processes taking place in the ambient medium. The Hertz-wave theory, by its fascinating hold on the imagination, has stifled creative effort in the wireless art and retarded it for twenty-five years. But, on the other hand, it is impossible to over-estimate the beneficial effects of the powerful stimulus it has given in many directions.

As regards signaling without wires, the application of these radiations for the purpose was quite obvious. When Dr. Hertz was asked whether such a system would be of practical value, he did not think so, and he was correct in his forecast. The best that might have been expected was a method of communication similar to the heliographic and subject to the same or even greater limitations.



Electric Transmission Thru Two Wires and Hydraulic Analog. Fig. 3.

In the spring of 1891 I gave my demonstrations with a high frequency machine before the American Institute of Electrical Engineers at Columbia College, which laid the foundation to a new and far more promising departure. Altho the laws of electrical resonance were well known at that time and my lamented friend, Dr. John Hopkinson, had even indicated their specific application to an alternator in the Proceedings of the Institute of Electrical Engineers, London, Nov. 13, 1889, nothing had been done towards the practical use of this knowledge and it is probable that those experiments of mine were the first public exhibition with resonant circuits, more particularly of high frequency. While the spontaneous success of my lecture was due to spectacular features, its chief import was in showing that all kinds of devices could be operated thru a single wire without return. This was the initial step in the evolution of my wireless system. The idea presented itself to me that it might be possible, under ob-

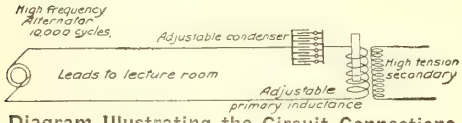
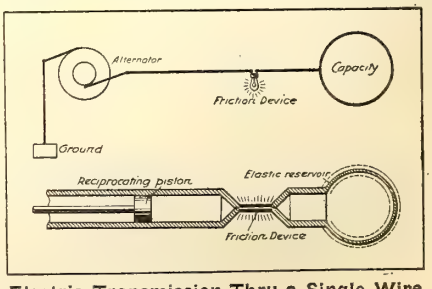


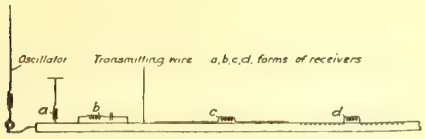
Diagram Illustrating the Circuit Connections and Tuning Devices Employed by Tesla in His Experimental Demonstrations Before the American Institute of Electrical Engineers With the High Frequency Alternator Shown in Fig. 1. Fig. 2.



Electric Transmission Thru a Single Wire Hydraulic Analog. Fig. 4.

IN this remarkable and complete story of his discovery of the "True Wireless" and the principles upon which transmission and reception, even in the present day systems, are based, Dr. Nikola Tesla shows us that he is indeed the "Father of the Wireless." To him the Hertz wave theory is a delusion; it looks sound from certain angles, but the facts tend to prove that it is hollow and empty. He convinces us that the real Hertz waves are blotted out after they have traveled but a short distance from the sender. It follows, therefore, that the measured antenna current is no indication of the effect, because only a small part of it is effective at a distance. The limited activity of pure Hertz wave transmission and reception is here clearly explained, besides showing definitely that in spite of themselves, the radio engineers of today are employing the original Tesla tuned oscillatory system. He shows by examples with different forms of aërials that the signals picked up by the instruments must actually be induced by earth currents—not etheric space waves. Tesla also disproves the "Heaviside layer" theory from his personal observations and tests.

EDITOR.



Illustrating Typical Arrangements for Collecting Energy in a System of Transmission Thru a Single Wire. Fig. 5.

servance of proper conditions of resonance, to transmit electric energy thru the earth, thus dispensing with all artificial conductors. Anyone who might wish to examine impartially the merit of that early suggestion must not view it in the light of present day science. I only need to say that as late as 1893, when I had prepared an elaborate chapter on my wireless system, dwelling on its various instrumentalities and future prospects, Mr. Joseph Wetzler and other friends of mine emphatically protested against its publication on the ground that such idle and far-fetched speculations would injure me in the opinion of conservative business men. So it came that only a small part of what I had intended to say was embodied in my address of that year before the Franklin Institute and National Electric Light Association under the chapter "On Electrical

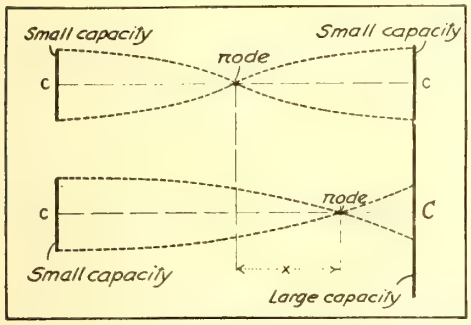
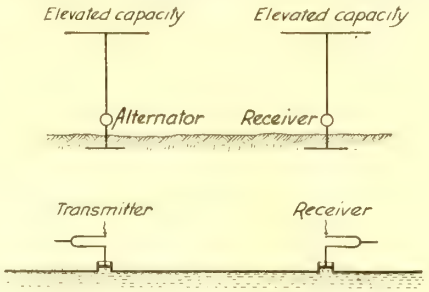


Diagram Elucidating Effect of Large Capacity on One End. Fig. 6.

Resonance." This little salvage from the wreck has earned me the title of "Father of the Wireless" from many well-disposed fellow workers, rather than the invention of scores of appliances which have brought wireless transmission within the reach of every young amateur and which, in a time not distant, will lead to undertakings overshadowing in magnitude and importance all past achievements of the engineer.

The popular impression is that my wireless work was begun in 1893, but as a matter of fact I spent the two preceding years in investigations, employing forms of apparatus, some of which were almost like those of today. It was clear to me from the very start that the successful consummation could only be brought about by a number of radical improvements. Suitable high frequency generators and electrical oscillators had first to be produced. The energy of these had to be transformed in effective transmitters and collected at a distance in proper receivers. Such a system would be manifestly circumscribed in its usefulness if all extraneous interference were not prevented and exclusiveness secured. In time, however, I recognized that devices of this kind, to be most effect-

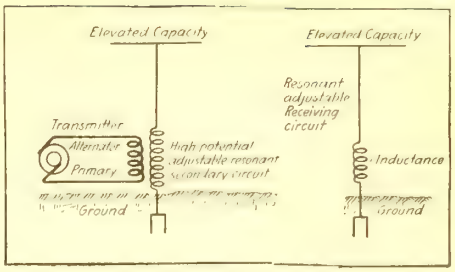


Transmission of Electrical Energy Thru the Earth as Illustrated in Tesla's Lectures Before the Franklin Institute and Electric Light Association in February and March, 1893, and Mechanical Analog of the Same. Fig. 7.

ive and efficient, should be designed **with due regard to the physical properties of this planet and the electrical conditions obtaining on the same.** I will briefly touch upon the salient advances as they were made in the gradual development of the system.

The high frequency alternator employed in my first demonstrations is illustrated in Fig. 1. It comprised a field ring, with 384 pole projections and a disc armature with coils wound in one single layer which were connected in various ways according to requirements. It was an excellent machine for experimental purposes, furnishing sinusoidal currents of from 10,000 to 20,000 cycles per second. The output was comparatively large, due to the fact that as much as 30 amperes per square millimeter could be past thru the coils without injury.

The diagram in Fig. 2 shows the circuit arrangements as used in my lecture. Resonant conditions were maintained by means

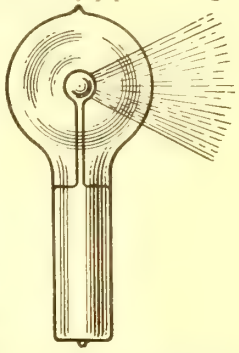


Tesla's System of Wireless Transmission Thru the Earth as Actually Exposed in His Lectures Before the Franklin Institute and Electric Light Association in February and March, 1893. Fig. 8.

of a condenser subdivided into small sections, the finer adjustments being effected by a movable iron core within an inductance coil. Loosely linked with the latter was a high tension secondary which was tuned to the primary.

The operation of devices thru a single wire without return was puzzling at first because of its novelty, but can be readily explained by suitable analogs. For this purpose reference is made to Figs. 3 and 4.

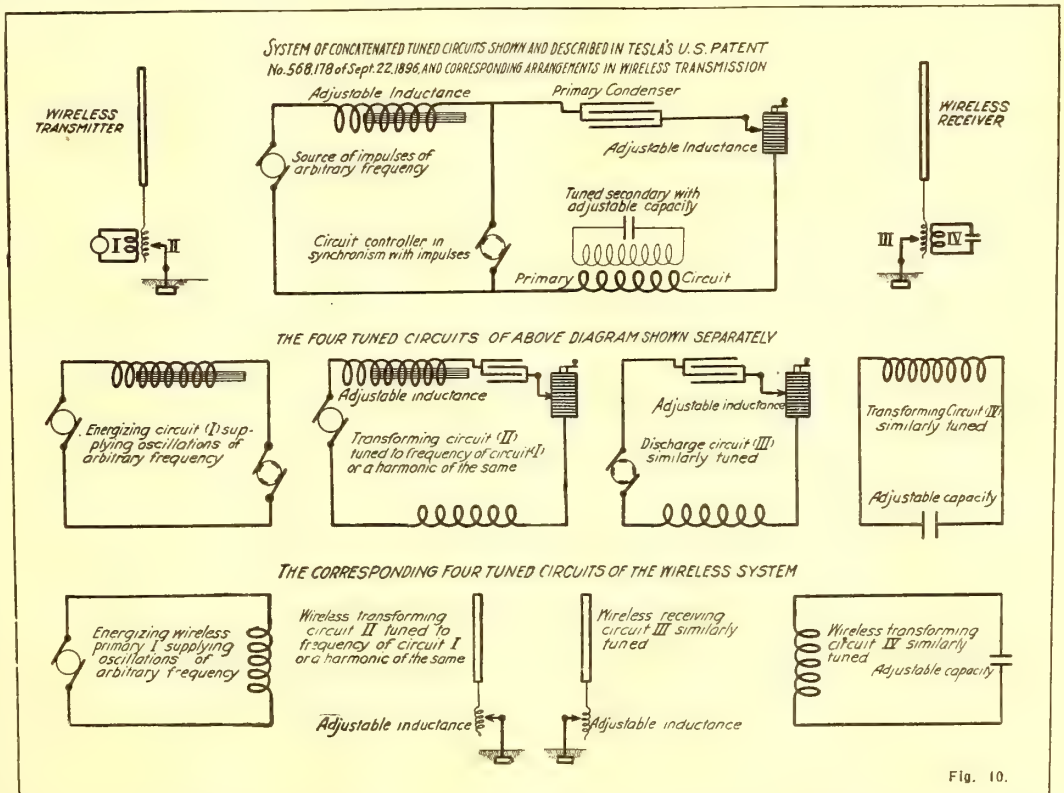
In the former the low resistance electric conductors are represented by pipes of large



The Forerunner of the Audion—the Most Sensitive Wireless Detector Known, as Described by Tesla in His Lecture Before the Institution of Electrical Engineers, London, February, 1892. Fig. 9.

section, the alternator by an oscillating piston and the filament of an incandescent lamp by a minute channel connecting the pipes. It will be clear from a glance at the diagram that very slight excursions of the piston would cause the fluid to rush with high velocity thru the small channel and that virtually all the energy of movement would be transformed into heat by friction, similarly to that of the electric current in the lamp filament.

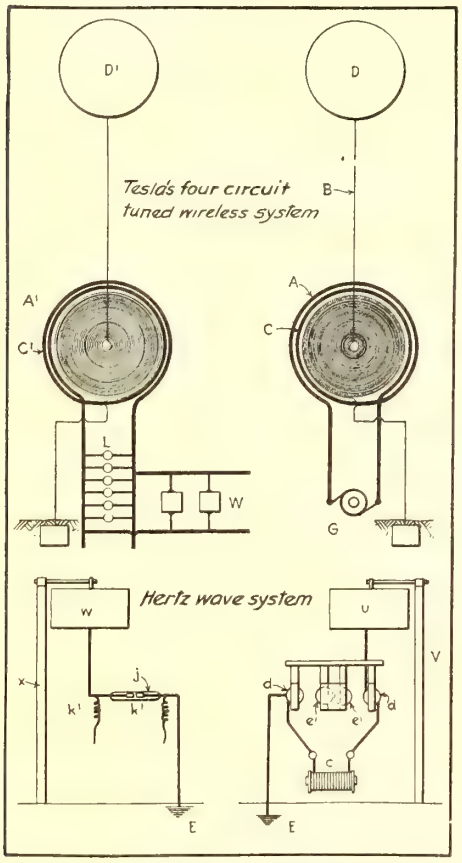
The second diagram will now be self-explanatory. Corresponding to the terminal capacity of the electric system an elastic reservoir is employed which dispenses with the necessity of a return pipe. As the piston oscillates the bag expands and contracts, and the fluid is made to surge thru the restricted passage with great speed, this



Tesla's System of Concatenated Tuned Circuits Shown and Described in U. S. Patent No. 568,178 of September 22, 1896, and Corresponding Arrangements in Wireless Transmission.

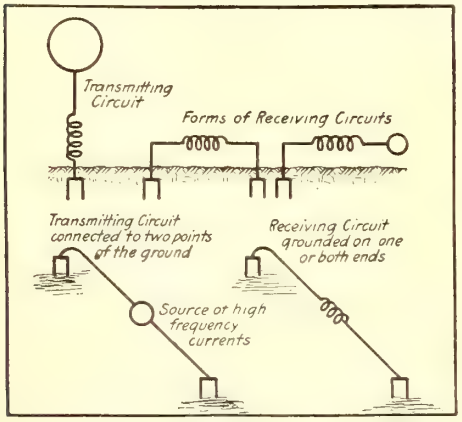
resulting in the generation of heat as in the incandescent lamp. Theoretically considered, the efficiency of conversion of energy should be the same in both cases.

Granted, then, that an economic system of power transmission thru a single wire is



Tesla's Four Circuit Tuned System Contrasted With the Contemporaneous Hertz-wave System. Fig. 11.

practicable, the question arises how to collect the energy in the receivers. With this object attention is called to Fig. 5, in which a conductor is shown excited by an oscillator joined to it at one end. Evidently, as the periodic impulses pass thru the wire, differences of potential will be created along the same as well as at right angles to it in the surrounding medium and either of these may be usefully applied. Thus at *a*, a circuit comprising an inductance and capacity is resonantly excited in the transverse, and at *b*, in the longitudinal sense. At *c*, energy is collected in a circuit parallel to the conductor but not in contact with it, and again at *d*, in a circuit which is partly sunk into the conductor and may be, or not, electrically connected to the same. It is important to keep these typical dispositions in mind, for however the distant ac-



Arrangements of Directive Circuits Described in Tesla's U. S. Patent No. 613,809 of November 8, 1898, on "Method of and Apparatus for Controlling Mechanism of Moving Vessels or Vehicles." Fig. 12.

tions of the oscillator might be modified thru the immense extent of the globe the principles involved are the same.

Consider now the effect of such a conductor of vast dimensions on a circuit exciting it. The upper diagram of Fig. 6 illustrates a familiar oscillating system comprising a straight rod of self-inductance $2L$ with small terminal capacities cc and a node in the center. In the lower diagram of the figure a large capacity C is attached to the rod at one end with the result of shifting the node to the right, thru a distance corresponding to self-inductance X. As both parts of the system on either side of the node vibrate at the same rate, we have evidently, $(L + X)\ c = (L - X)\ C$ from which $X = L\ \frac{C - c}{C + c}$. When the capacity C becomes commensurate to that of the earth, X approximates L, in other words, the node is close to the ground connection. *The exact determination of its position is very important in the calculation of certain terrestrial electrical and geodetic data* and I have devised special means with this purpose in view.

My original plan of transmitting energy without wires is shown in the upper diagram of Fig. 7, while the lower one illustrates its mechanical analog, first publisht in my article in the *Century Magazine* of June, 1900. An alternator, preferably of high tension, has one of its terminals connected to the ground and the other to an elevated capacity and impresses its oscillations upon the earth. At a distant point a receiving circuit, likewise connected to ground and to an elevated capacity, collects some of the energy and actuates a suitable device. I suggested a multiplication of such units in order to intensify the effects, an idea which may yet prove valuable. In the analog two tuning forks are provided, one at the sending and the other at the receiving station, each having attached to its lower prong a piston fitting in a cylinder. The two cylinders communicate with a large elastic reservoir filled with an incom-

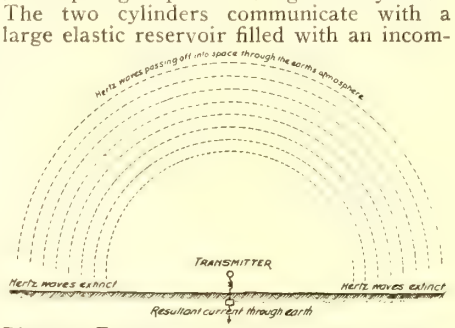


Diagram Exposing the Fallacy of the Gliding Wave Theory as Propounded in Wireless Text Books. Fig. 13.

pressible fluid. The vibrations transmitted to either of the tuning forks excite them by resonance and, thru electrical contacts or otherwise, bring about the desired result. This, I may say, was not a mere mechanical illustration, but a simple representation of my apparatus for submarine signaling, perfected by me in 1892, but not appreciated at that time, altho more efficient than the instruments now in use.

The electric diagram in Fig. 7, which was reproduced from my lecture, was meant only for the exposition of the principle. The arrangement, as I described it in detail, is shown in Fig. 8. In this case an alternator energizes the primary of a transformer, the high tension secondary of which is connected to the ground and an elevated capacity and tuned to the imprest oscillations. The receiving circuit consists of an inductance connected to the ground and to an elevated terminal without break and is resonantly responsive to the transmitted oscillations. A specific form of receiving device was not mentioned, but I had in mind to transform the received currents and thus make their volume and tension suitable for any purpose. This, in substance, is the system of today and I am not aware of a single authenticated instance of successful transmission at considerable distance by different instrumentalities. It might, perhaps, not be clear to

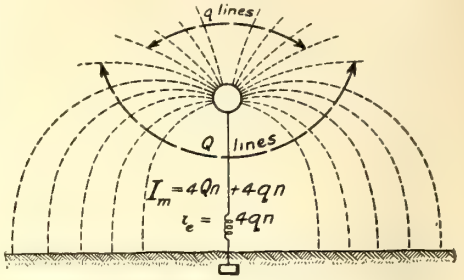


Fig. 14. Diagram Explaining the Relation Between the Effective and the Measured Current in the Antenna.

those who have perused my first description of these improvements that, besides making known new and efficient types of apparatus, I gave to the world a wireless system of potentialities far beyond anything before conceived. I made explicit

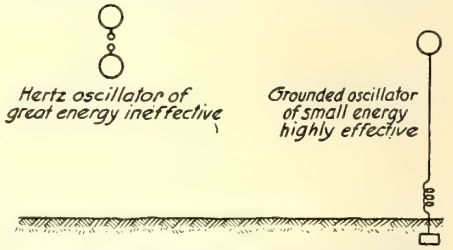


Fig. 15. Illustrating One of the General Evidences Against the Space Wave Transmission.

and repeated statements that I contemplated transmission, absolutely unlimited as to terrestrial distance and amount of energy. But, altho I have overcome all obstacles which seemed in the beginning unsurmountable and found elegant solutions of all the problems which confronted me, yet, even at this very day, the majority of experts are still blind to the possibilities which are within easy attainment.

My confidence that a signal could be easily flashed around the globe was strengthened thru the discovery of the "rotating brush," a wonderful phenomenon which I have fully described in my address before the Institution of Electrical Engineers, London, in 1892, and which is illustrated in Fig. 9. This is undoubtedly the most delicate wireless detector known, but for a long time it was hard to produce and to maintain in the sensitive state. These difficulties do not exist now and I am looking to valuable applications of this device, particularly in connection with the high-speed photographic method, which I suggested, in wireless, as well as in wire, transmission.

Possibly the most important advances during the following three or four years were my system of concatenated tuned circuits

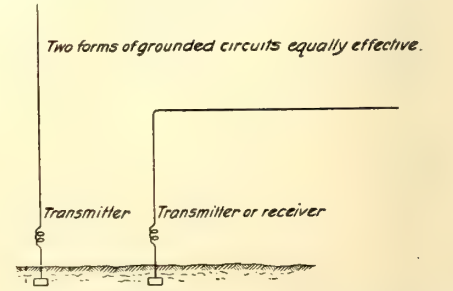


Fig. 16. Showing Unimportance of Relative Position of Transmitting and Receiving Antennae in Disproval of the Hertz-wave Theory.

and methods of regulation, now universally adopted. The intimate bearing of these inventions on the development of the wireless art will appear from Fig. 10, which illus-

(*Continued on page* 61)

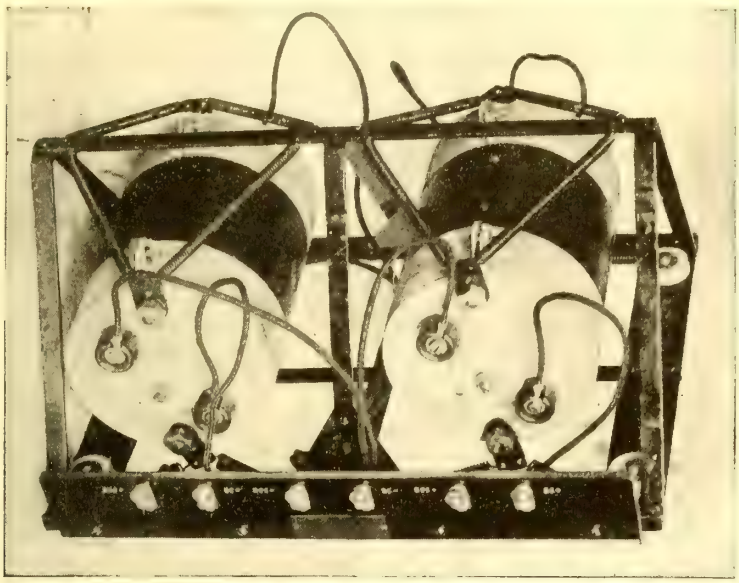
Novel Generators

IMAGINE yourself wearing a set of head receivers and a telephone transmitter and listening to a voice saying, *"I am right over R 7 and your shells are all bursting 'short.' Increase range 50 yards."* That was the experience of American radio operators during the latter part of the war, for radio telephone sets were developed that enabled men on the ground to talk with airplanes flying over the enemy lines and aim the guns according to their directions.

An essential feature of the radio telephone set is a small generator to deliver direct current at from 275 to 350 volts. For airplane use, these generators also delivered current at 25 volts. One is mounted on the landing gear of each 'plane, so that the air "back-wash" of the propeller drives a small two-blade wooden fan on the generator shaft. Thus the generator runs whenever the 'plane is in motion, and also while it is on the ground with the engine running. Constant voltage with variable speed is secured by an ingenious arrangement of differential fields controlled by a two-element vacuum tube mounted in the *stream-line* housing of the generator.

At stations on the ground or on shipboard, power is taken from storage batteries, and here a small dynamotor, driven by 10-volt current, gives the required high voltage. In the field one of these sets was originally mounted on a light metal frame carrying a voltmeter, fuses and terminals. Quite recently an aluminum carrying-case was developed which was watertight when closed. All the switches, fuses, etc., are mounted inside.

A submarine chaser often lies motionless, waiting for a U-boat to stick its nose above the surface. So sensitive are the listening devices on the submarines that even the slight hum of one of these dynamotors, transmitted to the chaser hull, would betray its position. Hence the dynamotors furnished to the Navy are mounted in a cradle of coil springs as here illustrated. *Photos courtesy Westinghouse E. & M. Co.*



Above:—Spring Cradle Suspension of the Wireless Generators Used on U. S. Naval Submarine Chasers and Destroyers, to Eliminate the Transmission of the Humming Sound Produced by Their Operation, to the Steel Hull of the Vessel and Its Subsequent Interception by a Lurking U-boat. The Sub-sea Sound Detector Used by the German Submarines Was so Sensitive That This Precaution Was Necessary.



Ground Officers of the U. S. Army Talking to Airplanes in Flight by Means of Wireless Telephone. The Range of Such Communication Has Recently Been Increased to 150 Miles by Official Test.

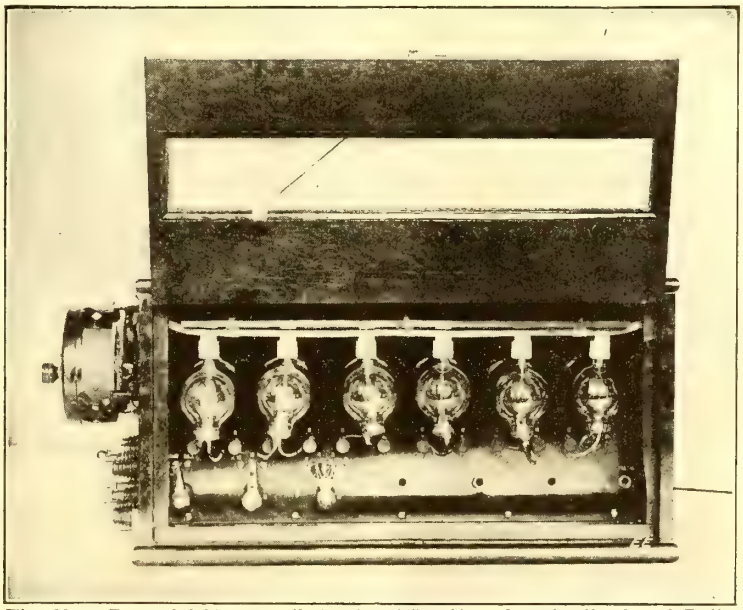


At Right:—Lower Right-hand View Shows the Wind-driven Airplane Radio Generator Developed During the War. Its Speed, of Course, Varies with the Velocity of the 'Plane and How Its Voltage Is Maintained Constant with Variable Speed Is One of the Interesting Problems That Radio Engineers Had to Solve Before Anything Else Could Be Done.

Boosts Signals 1,000,000 Times

The six-step audion amplifier set here shown represents the latest development in amplifiers, and its intensifying qualities are enormously in excess of any similar apparatus produced heretofore. Under ordinary conditions, this set will *amplify* 1,000,000 *times,* so it is especially well adapted for use in connection with the reception of the very weak signals set up by the small portable transmitters used in modern warfare. As a matter of fact, the set has been designed strictly with an eye towards military field work, and similar purposes, and has already proved its efficiency along such lines. An entirely new departure in design is seen in the fact that only one "A" battery, and one "B" battery are employed. In addition, these batteries are practically free of adjustment, which greatly enhances the value of this set, and is a unique feature in amplifier construction.

In connection with the above apparatus, it may be mentioned that the success of the French armies was in part due to the wonderful results achieved with such amplifiers on the various battle-fronts. Amplifiers using as many as nine steps were employed with marked success in trench communication, aërial communication, and similar work.



The Most Powerful Vacuum Tube Amplifier Now Standardized and Built. It Is a Six-stage Amplifier and Possesses an Amplifying Power of 1,000,000 Times. It Solved Many Knotty Problems During the War.

In the lower left-hand corner of the panel is mounted a simple two-way switch, by means of which the first bulb can be made either a detector for radio signals or the first-step amplifier for audio-frequency currents. When used as a detector, the connections from the tuner are made to the upper pair of external binding posts. When used as an amplifier, the connections from the detector (or the two-ground terminals, in case one is receiving conduction or induction currents thru the earth) are made to the lower pair of external binding posts. To the other pair of binding posts is connected the six-volt storage battery.

The telephone cord terminates in a plug, which can be plugged into the third, fourth, fifth or sixth jack cord to the degree of amplification which is desired.

U. S. Adopts Multiplex Radio

THE recent announcement that the Government had decided to adopt the multiplex system of radio telegraphy and telephony, makes possible some entirely new methods of communication.

The multiplex radio system is a complex one. The multiplex system of ordinary telegraphy permits the sending and receiving of eight different messages on one wire at the same time. Thus it may be seen what a great advantage it holds over the old method of Morse telegraphy.

Radio messages are sent by the same method. The trans-Atlantic Radio Room in the Navy Department illustrated herewith is completely equipt with a multiplex radio outfit. By this new system Secretary Daniels is able to keep in communication with several vessels out at sea at the same time. Likewise, President Wilson, on his voyage to France, was able to keep in immediate communication with Washington.

This photograph is the first to be released showing the trans-Atlantic Radio Operating Room of the Navy Department.

This is the receiving room of the radio station in the Navy Department. Four receiving machines constitute, with the four perforating machines, one complete unit of multiplex radio-telegraphy. As a result, four messages may be sent and four received over one antenna at the same time.



A Recent Photo Taken of the U. S. Navy Department's Trans-Atlantic Radio Operating Room. Multiplex Radio Signaling Is Now Carried on in Both Directions across the Ocean.

RADIO LINKS 3,000 MILES BETWEEN OMSK AND LYONS.

Omsk, in which are centered the hopes for the rebuilding of a new Russia, after months of isolation, is now actively in wireless communication with the outside world. Hourly reports, containing a complete news service, are received in Omsk direct from the French wireless station at Lyons, France. Outgoing communication will be inaugurated soon.

From Omsk to Lyons is 3,000 miles on a direct air line over Bolshevik Russia and Central Europe. Omsk is about midway between the Atlantic and Pacific oceans.

AN OMISSION.

We wish to state that credit for the photographs accompanying the article entitled "The City of Splendid Night" by Amos Stote, publisht in the January, 1919, issue, should have been given to the New York Edison Co.

New French and American Audions

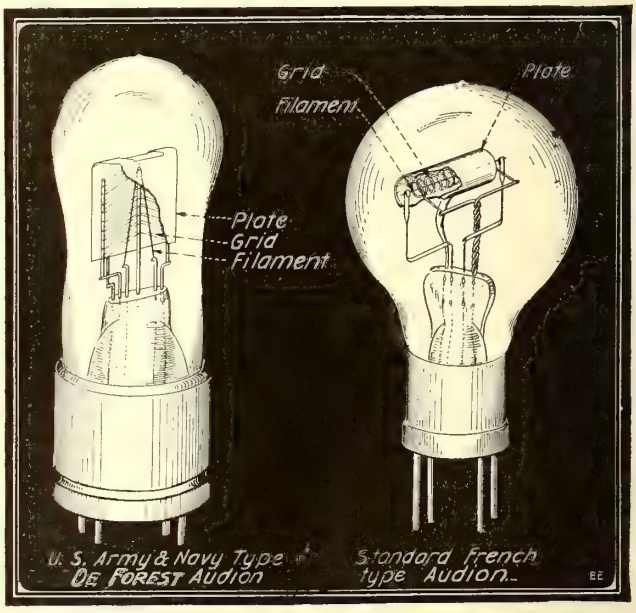
UNDOUBTEDLY the radio amateur and experimenter has often wondered what form of audion or vacuum detector and amplifier was being used both by the American and European armies. Thru the courtesy of Dr. Lee de Forest, we are enabled to show herewith the standard form of three-electrode audion in use by the French Army signal corps, as well as by the French Navy, and also the standard form of three-electrode audion in use by the United States Army Signal Corps.

As we have heard but very little concerning the French and other European wireless apparatus for several years, owing to the war conditions existing, we find considerable interest in the French type of vacuum bulb detector and amplifier, and so we will consider it first.

As the illustration shows it comprises a spherical form of glass bulb, which is eventually pumped out to a very high degree of vacuum. One thing decidedly noticeable about both the French and American tubes, is the simplified and highly improved form of base which incorporates four contact pins, which form a juncture with four sockets in the bayonet-joint receptacle supporting the audion. Two of the contact pins lead to the incandescent filament, while the other two connect to the grid and the plate respectively. It is thus but a moment's work to snap a bulb out of its socket and replace it with another one.

The French audion is unique in its general design, as will be noted from the accompanying illustration, the filament being in the form of a fine straight wire passing thru the center of the grid, which takes the form of a helical coil of non-oxidizing wire. Outside of the helical grid, we find the wing or plate element, which is made in the form of a small cylinder or tube. Each of the three distinct elements comprising the audion are spaced about 3/32 inch apart. It is stated on good authority that during the war the French Government manufactured five thousand of these audion bulbs every day, or almost two million of them in a year. This rate of audion production was carried on during the last two years of the war. The French bulb here shown is particularly interesting as being efficient and suitable in all three functions, — detector, amplifier and oscillator.

The Standard United States Army type of three-electrode audion here shown comprises filament, grid and plate, rigidly secured in place in the manner indicated. Particular attention has been given in this design to the manner of supporting the inverted "V" type filament as well as the grid and plate elements, so that as a matter of fact these rugged bulbs can be handled without any particular pains, and none of the electrode elements can move as they could in the older types. A still better construction is involved in a modified and improved form of audion being developed for the United States Signal Corps by Dr. de Forest. It will be seen how the plate member is bent into the shape of an inverted "U" and rigidly secured by two wire members securely molded or fused into the glass stem. The fine wire grid is securely mounted in place inside of the plate member on two upright wire legs as shown, and the top of the filament is anchored and supported by a third wire secured in the glass stem. There is still a slight chance for a little movement between the electrode elements in this detector, and in the improved form aforementioned and which is now being developed and perfected, the filament, grid and plate are still further strengthened, so that no matter how much the bulb is jarred or shaken, no variation whatsover can occur in the spacing between any two of the three electrodes.



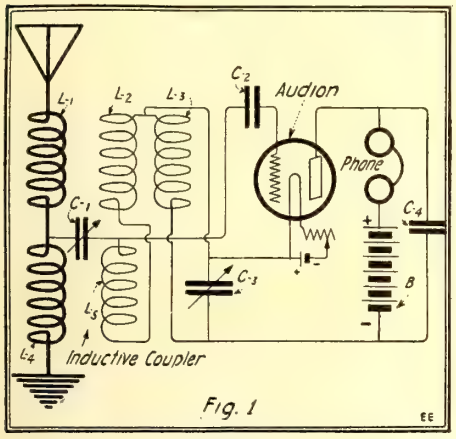
At the Left—U. S. Army and Navy Type de Forest Audion. At Right—the Famous French Type of Three Electrode Audion, Five Thousand of Which Were Manufactured Every Day during the Last Year of the War. It Serves as Detector, Amplifier and Oscillator.

New Regenerative Vacuum Tube Circuits

By SAMUEL D. COHEN

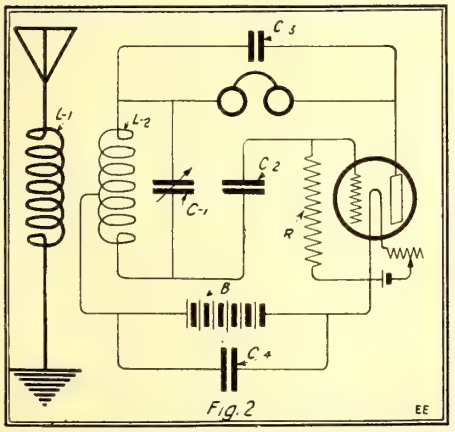
DURING the war the vacuum tube has gone into very extensive use in radio communication and other allied electrical fields. The regenerative circuits used until now have been found satisfactory. However, certain improvements were discovered and it is the privilege of the writer to give the results of some of these improvements that were made on regenerative vacuum tube circuits for the reception of long distance stations using long wave lengths.

One of the schemes tried by the writer was to couple the grid to the plate of the vacuum tube directly in the antenna system of the oscillating circuit, in order that heterodyne method of reception might be accomplished with maximum efficiency. For this work it was essential to construct a coupled magnetic system in order to accomplish the desired effects and the accompanying photograph shows a special type of inductive coupler utilized thruout these experiments. It will be noted from the

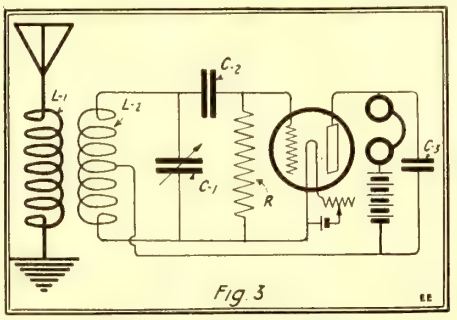


This New Audion Regenerative Circuit Utilizes a Five Coil Loose Coupler, Which Is Described in Detail by the Author. By This Arrangement the Grid and Plate Circuits Are Coupled Magnetically. There Are Two Secondary Coils Which Form a Variometer.

photograph that the primary winding consists of two distinct coils *wound on the same tube* and in the same direction. The third coil which is swung on a pivoted arm as indicated moves into the magnetic field of one of these coils. The secondary of the coupler also consists of two coils, moving one inside of the other, thus comprising



In This Audion Circuit, the Plate and Grid Are Coupled Magnetically Thru Coil L_2, and the Central Tap Should Be Accurately Taken Off.



This Circuit for a Regenerative Vacuum Tube Is Similar to That Given in Fig. 2, and Needs no Special Comment.

a variometer. The coupling of both of these coils can be changed at will, both within the main primary and outside of the primary. This was essential in order to eliminate the use of switches for the control of the inductance of the coils.

The coils were built with great care, in order to eliminate the undesirable oscillations produced within the coil circuits, due to the inherent distributed capacity of the coils.

A circuit giving remarkable results in amplifying received signals is that shown in Fig. 1. The main inductance L_1 is the main primary connected in series with the small coil wound on the same tube L_4, which is thereafter connected to the ground as indicated. L_2 and L_3, which comprises the secondary of the coupler are connected in a variometer manner as indicated. The joint point of these coils is connected to the filament terminal of the vacuum tube. The end of the coil is linked to the battery B, of the plate, while coil L_2 is connected

ROGERS UNDERGROUND ANTENNA

Since the publication of the Rogers underground antenna in our March issue we have been flooded with letters from amateurs all over the country who desire to have further information on this wonderful radio development. The standard question asked by most of these correspondents is, how large is the antenna, how to connect it, etc. In a few words, we might say that a satisfactory method is to use about 100 to 300 feet of ordinary standard automobile rubber cable, burying same in a 3-foot earth trench. The cable is then covered up entirely. One end is insulated, the other end goes to the instruments *taking the place of the former aerial.*

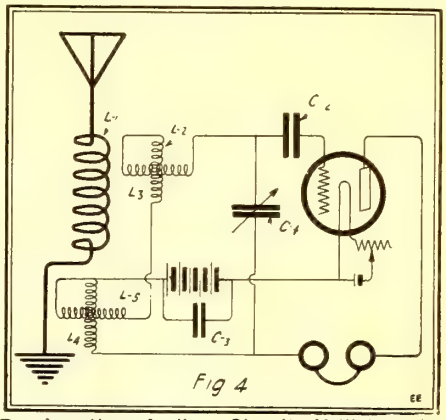
In our next issue we shall have a comprehensive article specially prepared for amateurs on the Rogers Underground System.—*Editor.*

to the tertiary coil L_5, which coil is the one mounted on the moving arm as indicated on the right of the photograph. Coils L_5 and L_4 are coupled magnetically and electrostatically thru the condenser C_1. It will thus be seen from the diagram that the plate and grid are coupled thru the inductance L_3 and which said inductance is coupled to the antenna system L_1. A critical adjustment is necessary between L_4 and L_5, and between L_2 and L_3, to give maximum radio frequency amplification in the circuit. Condenser C_3 has a magnitude of the order of two microfarads and is used in general to permit the high frequency current to readily pass to the plate.

Another circuit is shown in Fig. 2, which gave excellent results. In this circuit, the plate and grid are coupled magnetically thru coil L_2. In this particular case, it is very essential to note that the filament coil line should be tapt off exactly at the center of coil L_2 in order to give best results. This is done in order to equalize the potentials between the grid and plate circuits. Coil L_2 can be made as a variometer as will be shown later. Condenser C_1 is a regular oscillatory secondary tuning condenser. The resistance R is a grid leak-resistance and its magnitude depends upon the operating characteristics of the tube.

A similar circuit to that of Fig. 2 is shown in Fig. 3, and needs no comment.

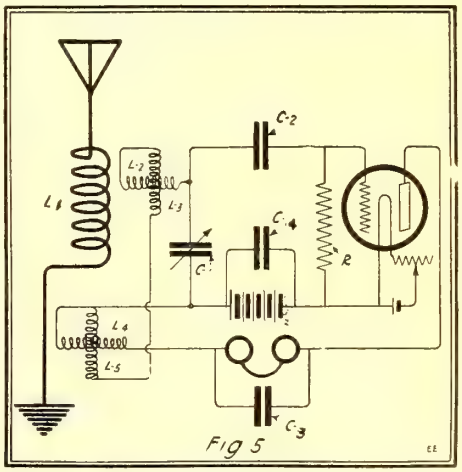
In Fig. 4 is shown another circuit for accomplishing the necessary results for regenerative effects for better efficiency. It will be noted that the inductances L_2 and L_3 comprise a variometer secondary coupled to the primary L_1. The inductance L_4 is coupled magnetically to the antenna inductance L_1 and to inductance L_5, which comprises another variometer of both L_4 and L_5, coupled magnetically to the plate and wing circuit of the vacuum tube. Con-



Regeherative Audion Circuit Utilizing All Five Coils on the Loose Coupler. Variable Condenser C_1 Is Used to Tune the Complete Secondary Oscillatory Circuit in the Manner Indicated.

denser C_1 is used to tune the complete secondary oscillatory circuit, which comprises the inductances L_2, L_3, L_4, L_5. With this arrangement it is possible to receive wave lengths from different magnitudes ranging from 150 up to 4,000 meters. It is, of course, to be understood that to receive

(*Continued on page* 74)

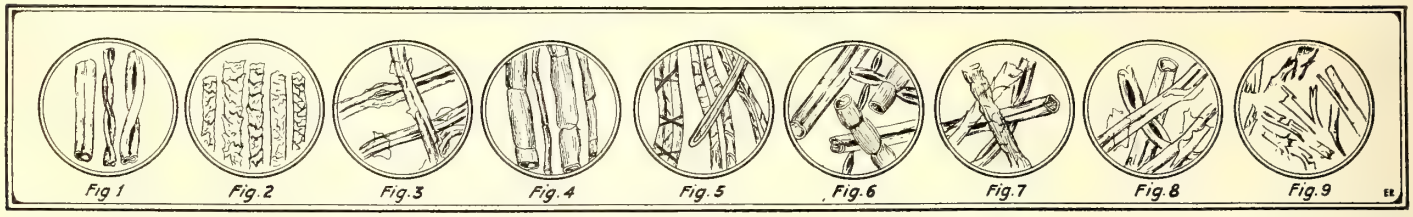


Another Regenerative Circuit Resembling Fig. 4. Here the Radio Frequency Bridging Condensers C_3 and C_4 Are Used to Permit Radio Frequency Currents to Pass Freely to the Plate.

Practical Chemical Experiments

Testing of Wool, Cotton and Linen

By ALBERT W. WILSDON



The Two Long Illustrations on This Page Show How Various Textiles Such as Cotton, Silk, Linen, Etc., Look Under the Microscope. Microscopic Examination of Such Textiles is Considered One of the Best Methods of Determining Just What a Certain Fabric is Composed of. Microscopic Drawings of the Various Fabrics Shown in the Illustration Above are:—1—Cotton, 2—Wool, Various Kinds, 3—Silk, 4—Linen, 5—Hemp, 6—Cotton and Linen Mixed, 7—Cotton and Wool, 8—Cotton and Silk, 9—Shoddy, Made from New, Fine, Blue Worsted Clips.

IN order that the layman may be more familiar with methods of making quick and accurate tests of varied textiles, this article is written, and not with an object of a complete treatise on "Textile Testing," which work in its entirety may be written in several volumes.

A person buying a piece of material, let



Fig. 19. The Burning Test Applied to Various Cloth Materials to Determine Their Composition, Particularly the Presence of Wool. Vegetable Fibers May Be Readily Distinguished from Animal Fibers By Burning, Animal Fibers Such as Silk and Wool Giving Off the Smell of Burnt Horn. They Do Not Fire Like Vegetable Fibers, But Cease to Burn When Removed from the Flame. Vegetable Fibers Give Off a Slight Odor of Burnt Wood When Ignited, and They Burn Away Very Rapidly With a Flash, leaving No Hard Cinder, But a White or Gray Ash Only.

us say for a suit, does not want to feel that he is being imposed upon by having inferior substitutes sold him when he believes it is all wool. He must, therefore, have immediately available some means of testing.

Textiles may be separated into two main divisions, as we may call them. VEGETABLE FIBERS, under which heading appear *Cotton, Flax, Hemp,* etc., and ANIMAL FIBERS, as *Wool* and *Silk*.

COTTON appears under the microscope as a wide band, generally twisted, as shown in Fig. 1. Chemically, cotton fiber, separated from all impurities, may be looked upon as pure Cellulose, similar in composition to the Cellulose in starch. Ordinary raw cotton is not pure Cellulose, containing as it does, various impurities such as wax, oil, coloring matter, water and about 1 per cent. of mineral matter.

The appearance of various kinds of WOOL under the microscope is shown in Fig. 2. Wool differs very considerably in chemical composition from Cotton and Flax. It consists of horny-matter (*Keratin*), Carbon, Hydrogen, Oxygen, Nitrogen and Sulfur. This composition is strikingly noticed when wool is burnt, accounting for the peculiar and disagreeable smell of *burning horn* which is given off. Boiling Caustic Soda or Potash solutions dissolve Wool, and if Acetic Acid in excess is added to the solution obtained Hydrogen Sulfid is given off.

SILK, under the microscope, exhibits no definite structure, but consists of cylindrical or flattened, sometimes helical, compact threads, having the appearance of a smooth cylinder without any contents. Fig. 3 depicts Silk as seen under the microscope. Chemically, Silk is composed of silk gelatine, silk fiber, with fat, coloring matter and mineral substances.

FLAX-LINEN fibers consist of chemically pure Cellulose, and are of regular thickness. The cells are built up in a regular manner, cylindrical in shape, having *nodes* arranged at regular intervals as shown in Fig. 4.

In HEMP the cells are very irregular in form, and do not possess *nodes* as in the former case. The cell walls are not of such constant thickness as Flax, and the ends of the fibers are blunt, having thick walls, frequently branching laterally.

SHODDY is old woolen or worsted materials, torn to pieces by a machine having spiked rollers, which reduces them to fibers. They are then cleaned, and the fiber spun with a certain proportion of new wool.

Broadly, shoddy fibers are of two kinds, namely—those obtained by mechanical disintegration alone from the clippings, and second, those fibers that are obtained from rags that have been carbonized. It thus becomes necessary to consider first the result of a purely mechanical operation, and in the latter case, combined chemical and mechanical operations. Naturally, we con-

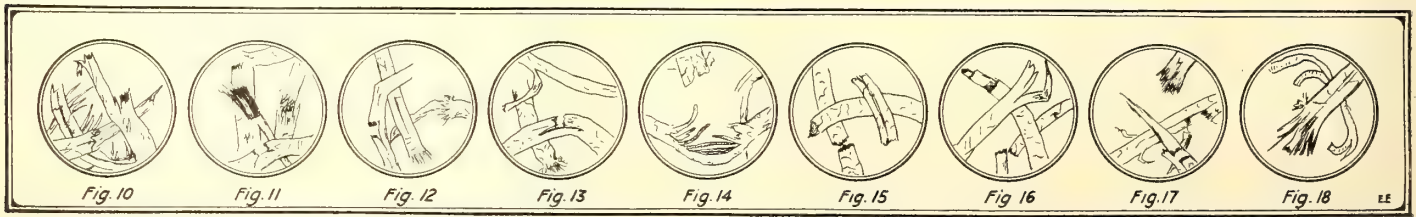


Fig. 20. This Shows Apparatus Arranged for the Accurate Testing of Cotton and Wool Content of Cloth, and One That is Used By Practically All Commercial Cloth Testers. One Glass Contains a Solution of Caustic Potash, or Caustic Soda, Into Which is Immersed a Sample of the Wool to Be Tested. A Precipitat Indicates the Relative Amount of Cotton and Other Substances Present. Likewise When Cotton is Immersed in an Acid, a Precipitat Will Show the Relative Amount of Adulterants. See Also Fig. 7.

sider whether the chemical operation of carbonizing has in any way altered the fibers so that they might differ microscopically from those treated only mechanically.

Pure wool, when first sheared from the sheep, shows that the fibers are terminated at one end with a slightly rounded point, while the other end shows a more or less

(Continued on page 79)



Microscopic Appearance of Various Fabrics Under Microscope, Continued. 10—Shoddy, Made from New, Fine, Black Worsted Clips, 11—Shoddy, Made from Carbonized Brown Serge, 12—Shoddy, Made from Brown Serge That Has Been Carbonized and Subsequently Stript, 13—Fibers Made from Blue Serge That Had Been First Carbonized, Then Stript, and Afterward Dyed Green, 14—Shoddy, from the Same Batch as That Shown in Fig. 12, Except That It Has Been Dyed a Full Red, 15—Originally a Brown Serge That Had Been Carbonized, Then Stript, Afterward Dyed a Deep Orange, and Finally Garneted, 16—Shoddy, Made from Brown Serge Which Had Been Carbonized, Stript and Dyed Olive Shade, 17—Shoddy, Made from Various Knit Goods of Different Colors, 18—Shoddy, Made from Serges That Were Carbonized, Stript and Dyed a Deep Maroon.

Experiments in Radio-Activity

By IVAN CRAWFORD

PART III.

IN the last article ionization by a-rays was discust. The radiations of radium also possess the property of affecting photographic plates. This action of radio-active substances is essentially an ionizing property and the effect produced is



Arrangement of Plate and Uranium Salt in Taking Radiographs.

proportional to the ionizing power of the substance.

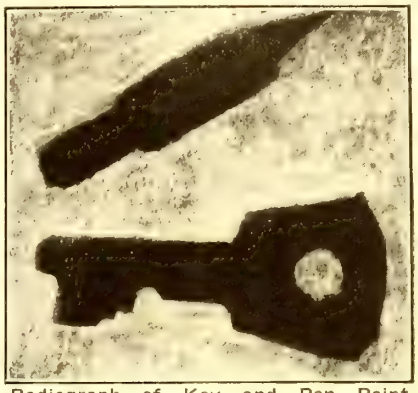
Both the a and b particles ionize the air thru which they pass; however, the a-particles do this to a larger extent. In fact the total number of ions per sec., due to the complete absorption of a-rays from one gram of radium, is 2.56×10^{16}, while the beta rays from the same amount of radium produce only 9×10^{14}. It will be seen from this that the a-rays would affect the plate to a much greater degree than the b-rays. This is only true when there is no obstruction between the substance and the plate. When a solid is interposed the effect is accomplished almost entirely by the b-rays on account of their greater penetrating power.

Geitel, and afterwards Becquerel and Mme. Curie showed that the b-rays were subject to magnetic deflection. The experiments conducted by Kaufmann and Becquerel have shown that the b-particles consist of negatively charged particles projected with an exceedingly high speed, indeed almost approaching that of light. These experiments also proved their mass was equal to that of the cathode particle in vacuum tube phenomena. Really, however, the b-particles are electrons ejected from radio-active substances at a considerably higher speed than that observed for the cathode particle.

To show the effect of b-rays on photographic plates a very simple device suffices. The following experiment may be easily carried out. An ordinary photographic plate is wrapt in black paper; a few metal objects, such as coins, keys, etc., are then placed upon it and covered with a piece of radio-active ore. Any uranium or thorium salt may be used instead. The exposure should last several days. The action is much slower than X-rays and the results much less clearly defined. A plate with uranium salts on it is shown in Fig. 1. This lack of definition makes this method ill-adapted for practical radio-graphy. The salts of uranium and thorium have been found to give off the beta particles which affect the photographic plate. An interesting experiment is to take an incandescent gas mantle which contains thorium, and spread it evenly over a photographic plate. After a long exposure the plate will be seen to be affected.

Niewenglowski has shown that phosphorescent calcium sulfid after being exposed to sun-light, assumes the power of emitting beta particles. These particles are extremely penetrating, and are capable of affecting photographic plates even thru comparatively thick sheets of intervening metal. This property, however, differs from ordinary radio-activity. The sunlight seems to cause a disintegration of the calcium atom, causing an emission of beta rays.

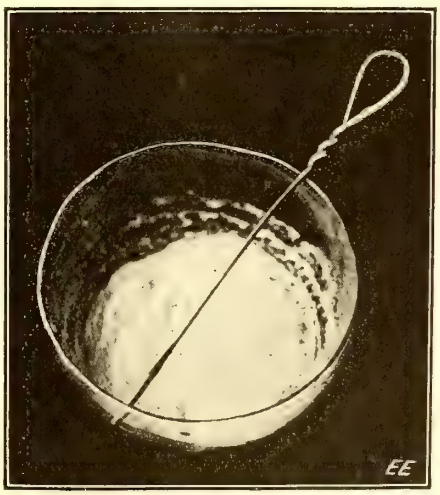
Much better radiographs may be obtained if the ionizing agent is the active portion from a spinthariscope. This is a wonderful little instrument and should be in the hands of every experimenter of radio-activity. Considering the great variety of experiments which may be performed with it, and the comparatively small sum for which it may be procured from several leading houses, the experimenter, if at all possible, should possess himself of one. It is, while being an extremely interesting and instructive apparatus, a very simple one. In its common form it somewhat resembles the eyepiece of a microscope. The distal lens is removed, and in its place is put a metal plate upon which a thin layer of phosphorescent zinc sulfid is glued. Just above this screen and with its end about over the middle of it, a small watch hand is secured. To the extremity of this a small quantity of radium salt is fastened. In some spinthariscopes the arm which supports the active substance is removable, allowing it to be utilized in the making of radiographs. Those, however, which are fitted with stationary arms or those in which the active substance is placed directly on the screen, may be employed by removing the lens portion and using the case alone. When using a spinthariscope for making radiographs the exposure need only last about two days. This is because of the much greater activity of the substances used in the construction of these instruments. If figures such as letters be cut from heavy lead foil or some metal sheet and interposed between the spinthariscope element and the plate, their shadow will be clearly discernible. Many interesting photographs may be made in this manner. The author has found that it is impractical to attempt the construction of such an instrument as they are more cheaply bought. Of course there are many variations of the experiments just described which will not be given here as they will doubtless suggest themselves to the reader's mind.



Radiograph of Key and Pen Point Taken with Radium Ore. Exposure Three Days.



Method of Preparing Radium in Tubes For Use in Medical Work. The Three Small White Tubes Contain Radium Sulfate and Have Respectively 2,550 and 100 Milligrams of Radium Element Content. Beside them Are the Silver and Platinum Screens Used, Back of Which Is the Brass Carrying Tube, Together with a Package Ready for Shipment.

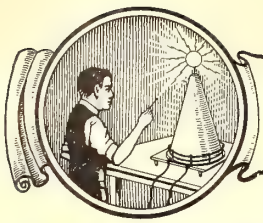


A Small Silica Capsule, Shown in Natural Size, Containing 1,764 Milligrams of Anhydrous Radium Barium Bromid, Having a Radium Element Content of 740 Milligrams. At the Present Market Price of $120 Per Milligram, This Radium Shown in the Dish Has a Cash Value of $88,800.

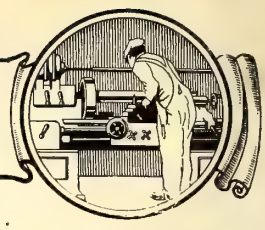
Before closing this article it has been thought fitting, however, to describe several experiments with this remarkable little instrument—the spinthariscope. If the experimenter will take the spinthariscope into a dark room he will be able to see wonderful flashes of light resembling shooting stars. It is best for the observer to remain for several minutes in the dark before attempting his observations, so to allow the eyes to become accustomed to the darkness. Upon further observation a pulsating nebula of light surrounded by flashing meteors will be seen. This is caused by the fluorescence due to the ions from the disintegrating atom striking the zinc and sulfid screen. The spinthariscope clearly shows the constant shower of particles given off by radio-active substances without any sensible depreciation in their weight or power.

The spinthariscope may be used in another very interesting and instructive experiment. The earlier experimenters with

(Continued on page 68)



THE CONSTRUCTOR



The "Noiseless" Phonograph

By THOMAS REED

I WISH you knew Gladys Doolittle. No I don't, either. I've got no grudge against you. The Doolittles live in the next wing of my hotel, and as their parlor windows face mine I know all about the family, except who they are. "Gladys Doolittle," is only *one* name I call her—among others, yes, many others!

Gladys entertains a young man quite frequently. It isn't the same young man—I wish it was. She's "looking 'em over," and the specimens come on in a remarkably even procession, one at a time, some way she has it fixt. No fights, or jostling in the ante room; never any novelty like that.

Her entertainment is a stock sketch, always the same. From 8 to 9, the visitor engages in conversation with "Pa" Doolittle about what they've both read in the newspaper, while Gladys butts in occasionally with remarks on the sock she's trying to knit. Thus "Pa" samples him, and at the same time the victim makes up his mind whether he likes this better than the hall bedroom on the whole. About 9, he tries to pet the dog—one of these micro-dogs it is—and it bites him; the cake hound has to have his sample, too, I suppose. At 9:15, "Pa" retires. He's a nervous wreck or something, and needs the sleep; if he forgets he needs it, Gladys reminds him. Then, new scene: she turns off all the bulbs except the pink reading-lamp, chases the knitting off the davenport, and trails over and opens up the phonograph. The "vamping" is about to begin.

So far the performance has been confined to the home, but from this on it invades the neighborhood, and atrocities come hard and fast. Gladys uses "haunting" melodies in her vamping business, and as the vampees are always different, one haunter is all she needs at a time. When she first came it was "Memories," but that wore out on her, and ever since then it's been "Poor Butterfly." Does it haunt? Well, look: when Gladys laps her lily finger and gives that record the initial twirl, and old "But" soars out into the community with his ragtime triplets fluttering around him, we know too well it'll be an hour before the trusty insect will be allowed to fold his painted pinions and beat it back to the envelope. Does it haunt? Woof!

I'm slowly getting crazy from it. Perhaps you've noticed signs of it in my writings. What's that, somebody says—"What d'ye mean *slowly?*" Well, all right, you know the cause of it, anyway. I have an idea I could sue Gladys or her father or somebody and get damages—if the jury should decide I was less valuable crazy than the way I was before. If anybody wants to buy my claim, I'll make an attractice price on it, for cash "or what have you?"

I suppose it isn't really Glad's fault that the instrument she's using in her "laboratory" operates on the neighbors as well. Phonographs are loud! all of 'em. The manufacturers took pains to make 'em so, out of an absolute misconception. They got the idea very early that several or more people would like to hear 'em at once. Why, even now, when they ought to know better, they publish those pictures showing the whole family sitting spellbound, mother dropping her sewing and Johnny his Meccano or volume of Browning, and all that.

The facts are just the other way. Johnny delights in the jangled jazz that nobody can follow but himself, that makes the baby cry and the others want to. If Little Sister starts the well-worn maxixe, and falls to dreaming of the slim-waisted lounge-lizard she's seen in the movies, mother fidgets and glances at her offspring with apprehension; and when Big Sister puts on the $7.00 "operatic," father picks up his paper and stealthily makes for the kitchen. And so it goes. The Home has been endangered by these instruments ever since the "Pup first heard His Master's Voice," and you know it.

It's a "Noiseless Phonograph" that's needed, and as usual I have to invent it—nobody else will waste the time. Sometimes I get almost discouraged raking around after the big inventors and clearing up the poisonous by-products they leave. Everything falls on Patsy Bolivar. However, here's your new phonograph, not only *inaudible* except to the persons who want to hear it, but one that you can make yourself with hardly any trouble. With this and the prohibition law in operation, I feel as tho the Home might straighten out and survive for several years.

This machine has become possible, in a practical sense, only lately, thru the invention of the Skinderviken transmitter-button, a complete transmitter in itself; and right here I sure won't object if Mr. Skinder makes one simoleon on his part of the rinktum, because he advertises in our "Mag." like a regular fellow, and will sell you a single button if you want it.

Fig. 1 shows the general layout. For the whirling table, take one of these round shallow tin pans they use for baking Washington-pie sections — or strata, I guess you'd call 'em. The Five and Ten 'll have 'em. Take some pains to fix it true on the spindle.

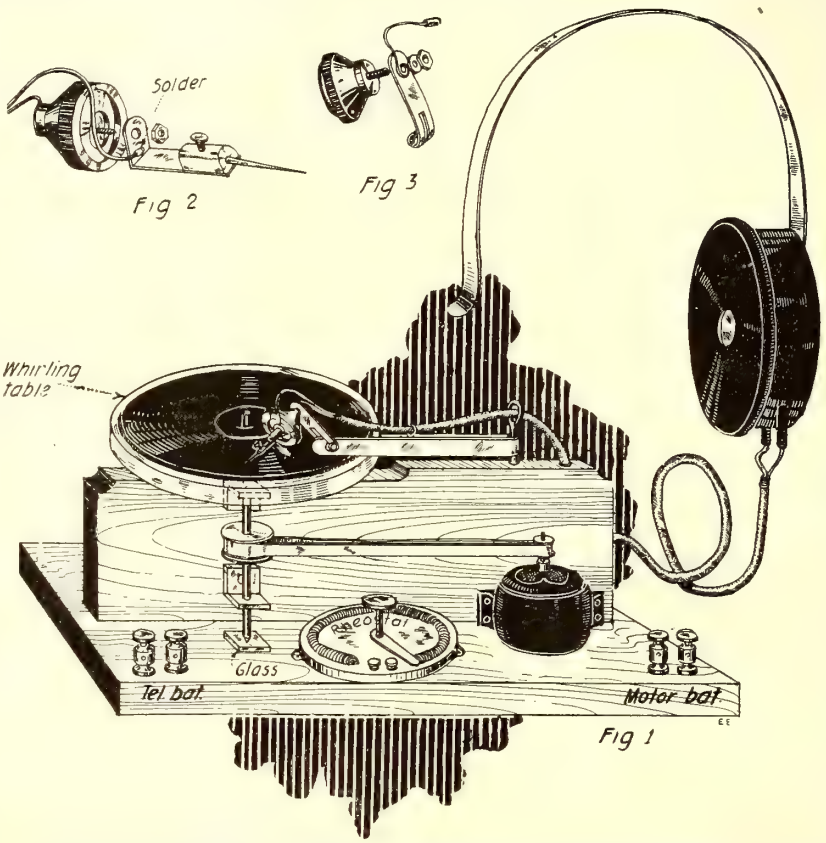
The spindle runs in holes thru two brass elbows. At the lower end, to reduce friction, point it off and have it bear on a piece of glass.

As the transmitter-button is so much lighter than the ordinary reproducer, the pressure of the needle on the record will be negligible, so you won't need a governor. Your battery motor will run it evenly enough, and the speed is regulated by your rheostat.

Fig. 2 shows the method of attaching the needle to the front stem of the button.

Fig. 3 shows the short arm for perpendicular play and method of attachment to the back stud of the button.

Of course it's understood you can connect up as many receivers as there are folks who want to listen. But say—if any fellow starts to laugh at you or me for our "silent phonograph," just remove the gentle little receivers altogether and hitch on a couple of audion amplifiers from your old wireless set, then sick "Poor Butterfly" on that critic, magnified up till he'll think the pretty creature is a night-flying airplane with a ton of bombs on its chest. Oh! Boy!

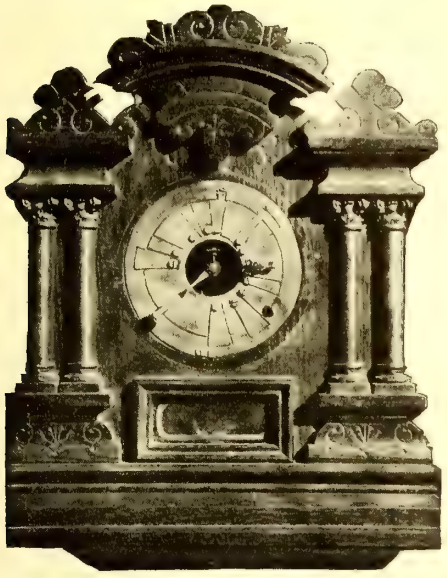


Well—Fellow Constructors—Here's the Original "Noiseless" Phonograph. First You'll Need One of Those Transmitter Buttons That's All the Rage Now-a-Days. You Stick a Needle Holder On Said Button, Rig Up a Pie Tin Turn-Table, Hook Up a Battery and 'Phone to the Button, and Let 'Er Go!

Automatic Bell-Ringing Attachment

By T. A. NEELIN

THE present diagram illustrates a simple home-made attachment for an ordinary eight-day clock, for the purpose of automatically ringing a bell or working a relay at certain fixt times. It was primarily designed for use in a small



The Clock Fitted with Automatic Electric Bell-Ringing Switch. This Arrangement Has Given Entire Satisfaction in a High School for Some time, and Provides 18 Rings Between 9 A. M. and 4 P. M.

high school where it was not thought desirable to purchase an expensive clock especially designed for that purpose. The clock in question has given entire satisfaction and rings at intervals of about 35 minutes with intermissions of three minutes between periods, making some 18 rings between 9:27 a. m. and 4 o'clock p. m. An attachment constructed according to the enclosed diagram should cause the bell to ring at the following times: 8:55, 9, 9:55, 10, 10:55, 11, 11:55 and 12 noon; 1:25, 1:30, 2:25, 2:30, 3:25, 3:30 and 4 p. m. The accompanying photograph shows the clock as it is in use at the present time.

CONSTRUCTION

A wooden disc bounded by the inner and outer circles c^1 and c^2 was cut from whitewood and finished to about ⅜ of an inch in thickness. A copper strip of the form c^3 was then cut and attached to the wood by means of a screw at s^1 and a coating of shellac to hold it in place in the other parts. A narrow slit s^2 just wide enough for insulation purposes, separates the ends of this strip. The screw s^1 serves to connect the bare end of an insulated copper wire c^4 to the copper strip c^3. This wire connects to one pole of the battery B as shown. Copper plates of the form c^{11} c^5 c^6 c^7 c^8 c^9 c^{10} were next cut and in c^6, c^8, c^9, c^{11} holes just large enough to admit a ⅜ inch screw were bored. Corresponding holes were bored in the wood disc. The copper plates were then laid down in shellac and insulated from each other by narrow spaces as shown; c^6 and c^9 were connected by a wire attached by means of the screws s^6 and s^9, and passing behind the wood disc; c^8 and c^{11} were similarly connected. The dial was then removed from the clock and the disc inserted in its place. The hands were next prepared.

To the outer extremity of the hour hand was attached a little brush made of fine strands of copper wire obtained from a piece of "lamp cord" and bound tightly about the hand. The hand was then adjusted in place so as to press the brush evenly on the surface it past over. A small brass wheel w^1, say 5/16 of an inch in diameter rotates freely and smoothly on the pin which fixes it to a piece of wood as shown. Into the other end of this piece of wood the outer end of the minute hand was inserted. The object of the wood was to insulate the minute hand from the wheel. The minute hand was then curved upward in the middle to allow the whole to freely pass over the hour hand while at the same time the curved minute hand acts as a spring to hold the wheel firmly against the copper parts beneath. The minute hand was then put in place; c^{12} is an insulated copper bell wire attached from the rear to the metal works of the clock, and continuing to the bell, or relay if a number of bells are to be worked at the same time, and thence to the battery B.

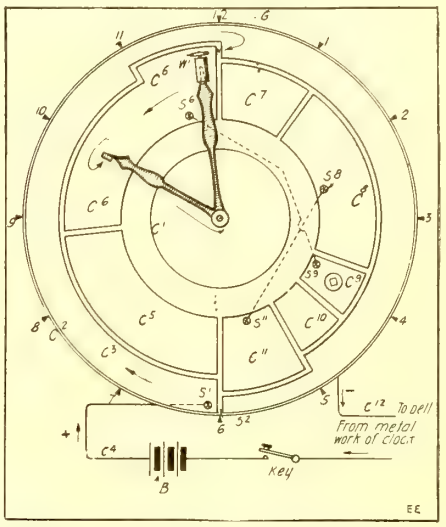
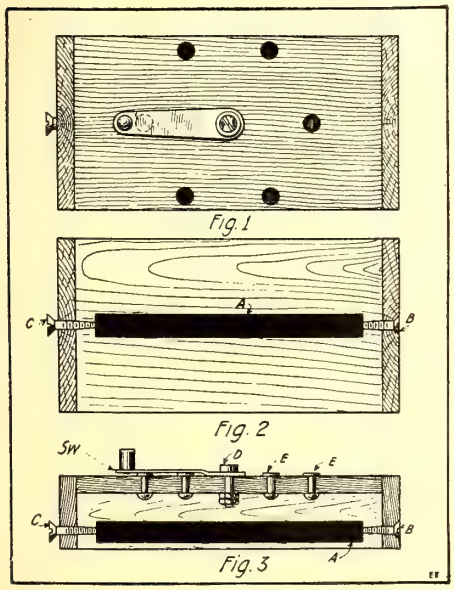


Diagram of Electrical Circuits and Contacts Fitted to Hands of Clock for Ringing One or More Bells at Different Hours.

ACTION

From the battery B the current may be thought of as travelling thru the wire c^4 to the copper plate c^3. As soon as the wheel w^1 bridges the gap at G the current can then pass to c^6, thence thru the brush and hour hand, the works of the clock, thru the wire c^{12} completing the circuit and thus ringing the bell or working the relay. In a few seconds the circuit is broken again at "G" by the minute hand moving on, and the bell stops ringing. The wires shown by the dotted lines are necessary to get the current from the hour hand to the proper plates so that the bell may ring at the times indicated.

A "Lead Pencil" Rheostat



The Lead-Pencil Rheostat. The Pencils, Without Rubber Erasers, Are Supported Between Wood Screws, as Shown, Proper Wire Connections Being Made Between the Switch-Points and Screws.

The accompanying drawing shows a lead pencil rheostat. The idea is new and very simple at the same time. The lead pencils used are in no way spoiled and can be taken out of the frame and used as if new.

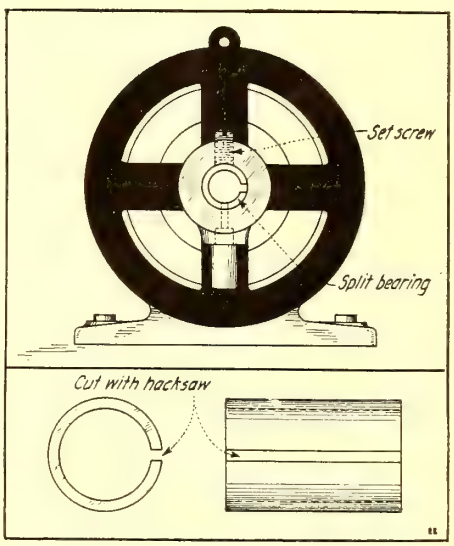
Fig. 2. A, is a pencil (a drawing pencil) which has the lead exposed at both ends. B is a screw which is flush with the wood, F, and makes connections with a wire not shown. C is another screw longer than B. D, E, E are the parts of a switch.

Fig. 3. It shows the switch side of rheostat. The pencil, A, is set between screws B and C. Screw C is screwed down until the both screws make good connections with the exposed lead in the ends of pencil. Connect wires with the screws, connect the wires in the right place on the switch. The number of pencils used and their length will determine the size of the rheostat. It is best to use good drawing pencils as their resistance is higher.

Contributed by JONAS GULLBERG.

USE YOUR OLD MOTOR BEARINGS.

The accompanying sketch illustrates how the bearings of small motors can be easily used when badly worn. Remove bearing from motor and cut with hacksaw as shown in sketch, drill and tap bracket for set-



Why Not Use Your Old Motor Bearings? Cut a Slot in the Lining and Close It Up With a Set Screw.

screw and replace bearing; tighten set-screw until motor runs without vibrating.

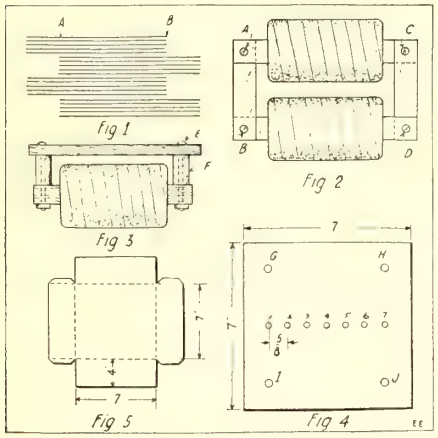
Contributed by HENRY L. BEIMEL.

A HEAVY DUTY 110 VOLT, 60 CYCLE STEP-DOWN TRANSFORMER.

BY RAY SEITZ

With this article I intend to fill the want of the experimenter for a good and efficient transformer.

The first step is to make the core. From a piece of black sheet iron cut enough



A 250-Watt Step-Down Transformer for Use in the Laboratory, in Cautery Work, and General Experimental Work.

strips 5" long 1½" wide to make a pile 3" high and 3¼" long and 1½" wide to make a pile 3" high. Now build four cores like those shown in Fig. 1, two from the the larger size and two from the small size strips. When you have done this clamp tightly in a vise and wrap well with three layers of good friction tape. On the long legs wind three layers No. 12 D. C. C. copper magnet wire, 30 turns to the layer, taking a tap off at each layer. The two legs will require 2¼ pounds of wire. Now wrap two layers of good friction tape over this and begin winding the primary which consists of 6 layers No. 22 S. C. C. magnet wire, 80 turns per layer, using a layer of paper between each layer of wire. This winding, the primary, will require 1½ pounds of No. 22 S. C. C. magnet wire. After you have both of the legs wound wrap again with two layers of friction tape and paint the whole heavily with shellac and bake in an oven for three hours. Now put the four legs together and drill a hole in each corner to pass a ¼" bolt A*B*C*D—Fig. 2.

After the holes are drilled, the next thing to do is to solder the taps on with short pieces of No. 12 R. C. wire and brought to their proper binding posts. No. 1 comes from the beginning of secondary winding, No. 2 from first tap, No. 3 from second tap, No. 4 from end of winding on first leg, (end of winding on first leg and beginning of winding on second leg are joined together, and tap 4 also comes from this joint), No. 5 from first tap on second leg. No. 6 from second tap on second leg, No. 7 from end of winding on second leg.

When connecting the ends of the windings together care should be taken to see that they will help each other along and not "buck" each other. By applying the hand-rule for electro-magnets you can easily figure which ends have to go together. The primary sections are connected up in series with each other, applying the hand rule as in the case of the secondary and the two remaining ends are spliced to a piece of black extension cord for connecting up to the supply. The hole, 8, in Fig. 4, is for this piece of extension cord to go thru, having first bushed it out with a piece of fiber tube from a 30 amp. cartridge fuse.

The top is made from a piece of ½" red birch, cut to the dimensions in Fig. 4. The holes marked 1-2-3-4-5-6-7 are for the binding posts and 8 for the connecting cord. The other holes are for fastening the transformer to top. When fastening transformer to top, four pieces ¼" gas pipe 1½" long, will separate the core at the right distance from the top.

Fig. 5 gives the dimensions and shows how to cut the sheet for making a box to fit the transformer. It is made from 24 gage sheet iron, having the corners riveted together.

Short-circuits and heavy overloads will not harm this transformer, if not left on for too long a time. This transformer, if built the way described, will work perfectly and is absolutely noiseless at low load and at full load produces a slight hum. It consumes about five watts at no load and draws about 250 watts at full load. The secondary has six steps of three volts each, three volts between each terminal. This transformer is designed to operate on the standard current of 110 volts 60 cycles. The writer has built several of these transformers and they work to perfection under many different conditions.

A NEW WRINKLE IN ROLLER BEARINGS.

Most machine bearings are made of the ring-oiling type, that is, the bearing is supplied with a reservoir for oil, into which dip one or more rings that run upon the shaft, and thus supply the journal continually with oil. During the operation of the machine there is a continuous flow of oil thru the bearing, which not only keeps the shaft well lubricated, but tends to wash away any particles of metal that may be worn from the rubbing surfaces.

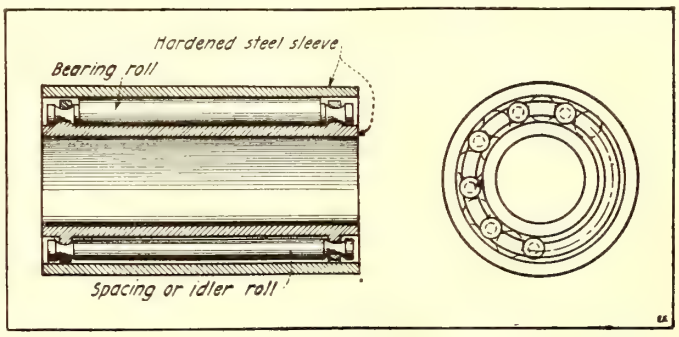
In a dynamo, it is important that the oil from the bearings should not follow the shaft and run out on the armature. The oil itself is not so injurious, altho it tends to destroy the insulating varnishes, but it causes an undesirable accumulation of dust that may greatly impair the insulation.

The accompanying diagram shows a new type of roller bearing, so designed as to run without the use of any lubricants. It is as simple as it is efficient.

This bearing consists of an outer hardened-steel casing and an inner hardened-steel sleeve. Between these are placed two sets of rollers of two different sizes, the smaller serving as the spacing or idler rollers and the larger being the essential bearing rollers. The relative position of these rollers is shown in the sectional sketch. The idler rollers are so designed to run on what may be called a *track*, and are held loosely in place by two retaining rings.

The bearing is suitable for all kinds of work. When used in connection with line shafting, the outer sleeve fits into a shell, held in place in the hanger in the usual manner.

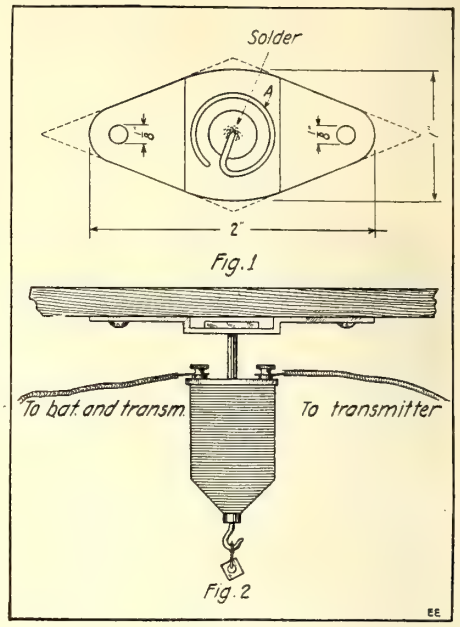
Contributed by
PETER J. M. CLUTE, B.Sc.



A Bearing You Will Want for Motors and Dynamos. It is Particularly Strong and Runs Without Oil or Other Lubricants.

THE "TALKING TABLE."

If the apparatus here described is fastened to the under-side of a dinner table it will set the table in vibration so that any



An Entertaining Wrinkle for the Electrical "Bug" to Try Out—the Talking Table. The Magnet Connects Up with a Microphone and Battery.

number of persons putting their ears flat upon the table, will hear a person talking over the 'phone, if it is connected up as shown in the accompanying sketch.

A small piece of sheet brass is cut as shown in Fig. 1. A piece of soft iron wire, such as that used for cores of induction coils and about 6 inches long, is bent at one end as indicated at (A) Fig. 1 and put thru a hole in the center of the brass plate; the other end is bent into the form of a small hook. Next cut off about 2 inches of a cheap lead pencil and soak it in water till the lead will come out easily, then glue the pieces of pencil to the wire just above the hook. Take a piece of cigar-box wood and cut a piece about 1⅜ inches in the center so it will fit over the leadless pencil on the wire, and 2 holes to receive the two binding posts, Fig. 2. Glue the disc over the pencil on the wire near the upper end. The binding posts are then placed thru the other two holes. The pencil is now wound with No. 24 B. & S. silk or cotton covered wire, the end of the wire being fastened to the two posts. A small weight, weighing about two or three ounces, is hung on the hook. The apparatus is then screwed to the under side of the table and connected up to a microphone and battery.

Contributed by
WADE ROBINSON.

CLEANING PAINT BRUSHES.

For cleaning hard paint brushes make a hot solution of lye water; stand the brush so that just the bristles are in the solution.

For making old corks new. Boil in hot water for one-half hour.

Contributed by AN EXPERIMENTER.

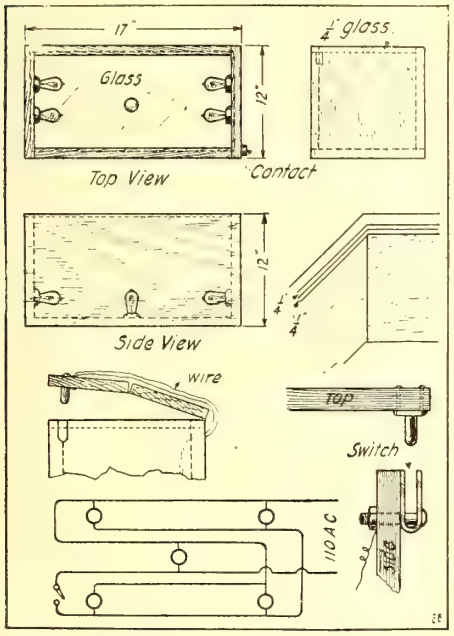
A new thermostatic metal which is remarkably sensitive to heat has been invented. The metal may be used in connection with an electric thermostat to control heating systems and to give the alarm in case of fire.

A PHOTOGRAPHIC PRINTING BOX.

The inconvenience of the printing frame is entirely done away with in this electric printing box. In regard to time the saving is enormous. The necessary material required follows: 1 piece wood 1"/12"/17" (base); 2 pieces wood 1"/12"/15" (sides); 2 pieces wood 1"/12"/12" (ends); 2 pieces wood 1"/6"/17" (top-hinged in the middle); 1 piece glass (plate) 15½"/10½"; 4 tungsten lamps; 1 ruby lamp; 5 sockets, and 1 lamp cord with plug.

The box is assembled as shown in the figure. The sockets are screwed 2" up from the bottom on the ends and are 5" apart. One socket is put in the middle for the ruby lamp. The next step is to wire the sockets according to the diagram, leaving enough wire to go over the top for the automatic switch which now will be taken up. The object of this switch is to turn on the four white lights when the lid is down. It consists of an L-shaped piece of spring brass or phosphor bronze that is screwed to the cover and fits into a V-shaped piece of metal when the cover is down tight. A piece of wire about 2' long runs over the top to the L-shaped switch. The other side can be wired up from the inside of the box.

The remaining step is to put on the glass plate. The glass should be as heavy as possible; plate glass is the best. There is often quite a heavy strain on the plate from printing and consequently a light glass is liable to crack. The top of the box is now rabbited out ¼" deep and ¼" wide from



Amateur Photo Printer Provided with Automatic Switch for Opening and Closing the Light Circuit When the Lid Is Operated.

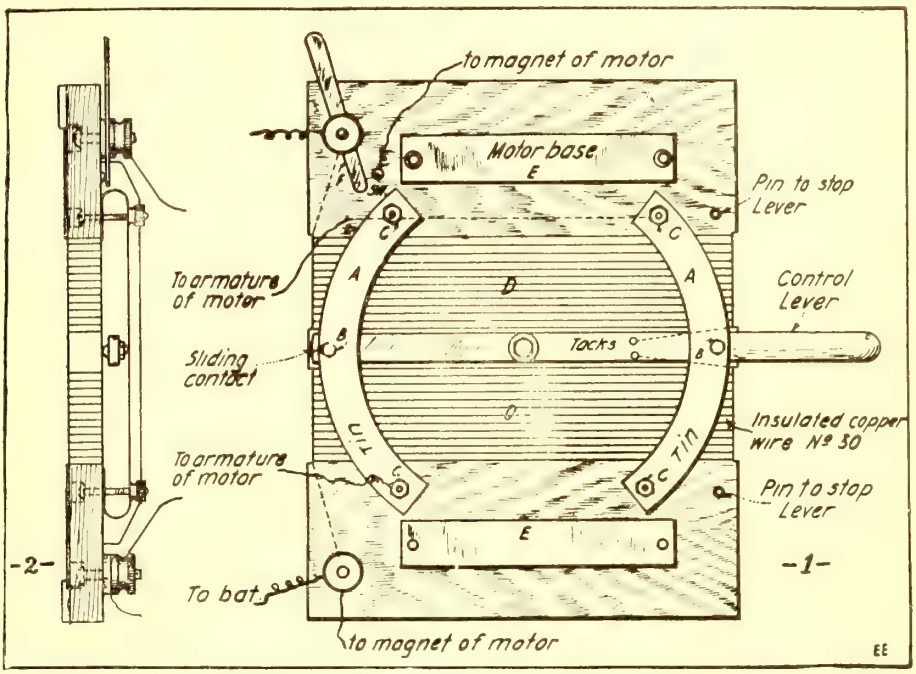
the inside all around, so that the glass will fit in flush with the top. The top is hinged in two places in the middle opening, and two more places on the end to give no play at all to the cover. It is well to cover the inside of the top with a piece of cotton flannel the size of the glass plate. This insures that the negative will be in firm contact with the printing paper.

It is seen from the wiring diagram that the ruby lamp is kept burning all the time. This is to allow for printing masks to be adjusted, the negative to be arranged, etc. This printing box is capable of turning out prints at a rapid speed, doing away with the clumsy printing frame. It is very simple in construction and will repay anyone who constructs it.

Contributed by
MALCOLM MACURDA.

Reversing Rheostat for Small Motors

This rheostat is built under the motor on a wood base 6 x 8 x ½ inches. On each side of the base, 2¾ inches from the ends, cut two grooves ⅛ inch deep and 1 inch wide, leaving a space of ½ inch between. Take about thirty-five feet of No. 28 insulated copper wire, fasten one end to a binding post under the base as shown in Fig. 1, and wind it around the base closely and evenly, gluing it near the place where the sliding contact, B, is to work. The final end of the wire is tacked to the lower side of the base. Wind the other side in like manner. The lever is a thin piece of wood ½ inch wide, carrying two short binding posts, B B, which serve as sliding contact points, connecting the arc, A A, and the coil, D, off of which the insulation has been scraped in the path of the slider, B. The nearer the glue is to this path the better.



A Handy Reversing Rheostat for Toy Motors. It Controls the Speed in Either Direction and Can Be Actuated from a Distance by a String Attached to the Handle.

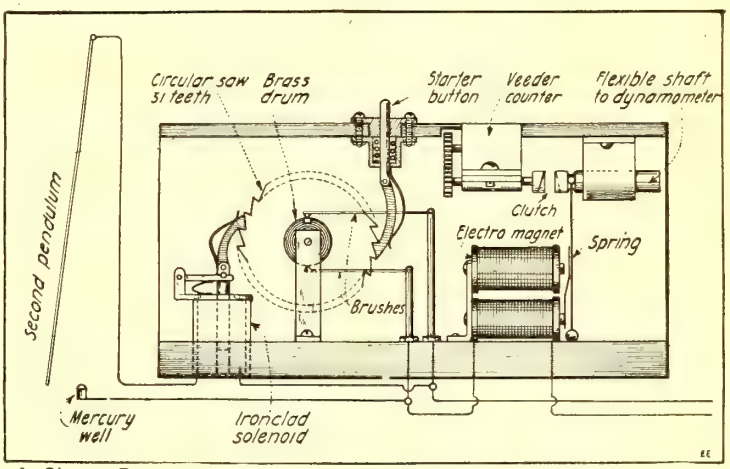
Contributed by OSCAR ROSE.

Revolution Counter for Dynamometer

Electric tachometers have not proven a success where accuracy is demanded such as in dynamometer testing work and therefore several revolution counting apparata have made their appearance on the market. These latter usually take the form of solenoid operated clutches operating in turn revolution counters. When the fuel-weighing apparatus makes contact, the clutch is engaged and a stop watch started. When the weighed quantity of fuel is used up the scale breaks contact, the counter is stopt and the stop watch stops. Thus an accurate method of determining *pounds of fuel per brake horse-power hour* is secured.

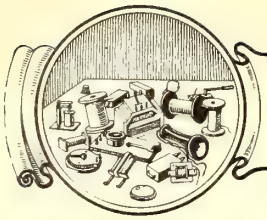
A "seconds pendulum" is a pretty handy piece of apparatus to have in any laboratory. I built such a pendulum so that at every swing the lower end of the pendulum would brush thru a mercury cup fastened on a suitable adjustable support. The requisites are one solenoid with laminated soft iron core, one old electric bell magnet, a circular saw, a few small gears and a little work.

The small brass drum attached to the saw has a piece of insulation in the path of one of the brushes whose length is sufficient to cover the circular distance of all teeth over thirty, so that there will be thirty movements of the saw or a time

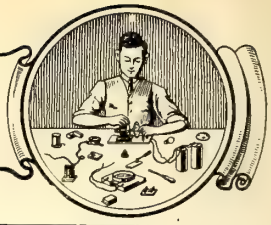


A Clever Revolution Counter for Use with Dynamometer in Testing Work.

(Continued on page 73)



HOW-TO-MAKE-IT



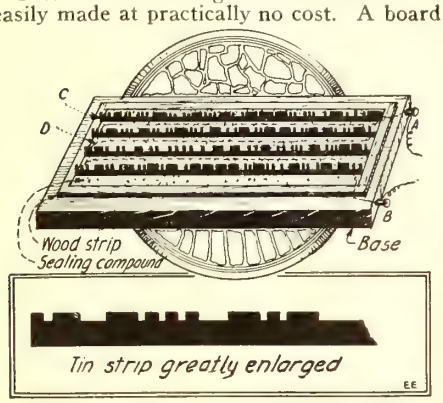
This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

A MANUAL TYPE CODE LEARNER.

I give below drawing of a "code teacher" which I am contributing to the "How to Make It" Department.

This code teaching instrument can be easily made at practically no cost. A board



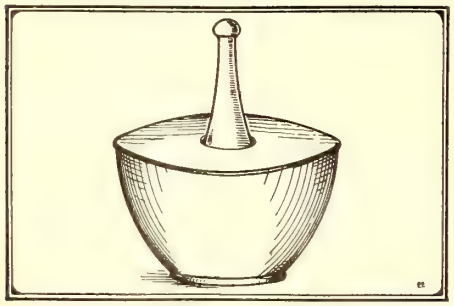
To Make This Simple Code Learner, Cut Out the Dot and Dash Characters On Strips of Tin and Embed Them in Sealing Compound. The Buzzer Circuit is Made and Broken Over These Projections.

(any size to suit the maker) has slits cut into it lengthwise with a knife or saw, as indicated. Tin or brass strips are procured, with a length equal to that of the board. The dots and dashes are cut out along the edges of the strips, as in the drawing. They are put in the slots, then connect all together with a wire. Then take some wood about ¼-inch square and put it around the edge on the top. Melt some sealing compound and pour it in the box just made by putting the wood strip around the board, to within ⅛-inch from the top of the tin. Then cut out a piece of tin to make the "pen;" connect it up to a buzzer or telegraph sounder and slide the "pen" across the tops of the tin strips, which makes the dots and dashes at any speed desired.

Contributed by LOUIS C. KING.

IMPROVED MORTAR AND PESTLE.

When a mortar and pestle are used for grinding chemicals dust often gets into the eyes, or small particles are driven out of the mortar and are lost, particularly in the case of hard crystals requiring a consider-



Make This Simple Cover for Your Mortar and Pestle and Keep Out the Dirt.

able force to break them. A simple but very efficient safeguard consists in making a cover for the mortar from a circle of cardboard, with a central hole just large enough to admit the pestle as sketch shows.

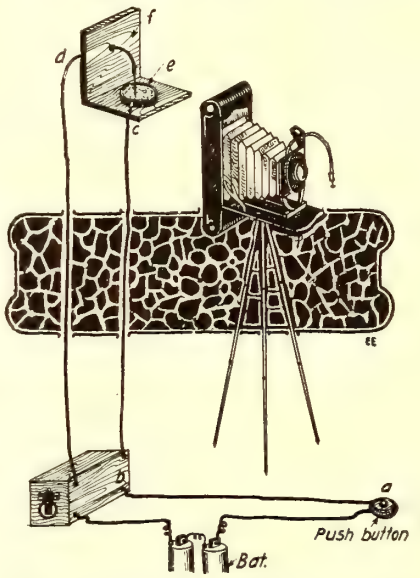
Contributed by H. J. GRAY.

SECOND PRIZE, $2.00

TAKING YOUR OWN "MUG" IN GROUP FLASHLIGHTS.

When taking group photos by flashlight it is often desired that everyone be in the picture, but as someone must hold the flash-pan and set it off at the proper moment, this is often impossible. I have a plan, which is explained below, which allows everyone to be in the photo.

In the diagram *a* is push-button held by photographer; *b* is spark coil, the wires from *a* being connected to the primary side of the coil, with set of dry cells in circuit; *c* is one wire, from secondary side of coil, which is taken thru hole in bottom of holder and soldered to *e*; *d* is other wire from secondary side of coil which is taken thru hole in back of holder *f* and turned down until there is a gap of about one-fourth inch between it and *e*; the covering should be removed from *d* for about one inch from end; *e* is baking powder can cover which should be securely fastened to holder *f* as shown; *f* is holder made of two pieces of



Push the Button and Take Your Own "Mug" with This Unique Electric Flashlight Scheme.

wood about six inches wide fastened together at right angles and covered on the inside with sheet asbestos, which acts as reflector and protects wood. Holder can be placed on either side of camera, but must be *back of camera.*

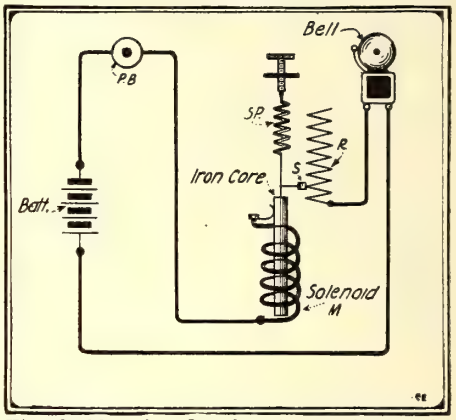
How It Works.—The operator puts the proper amount of flash powder in the baking powder can cover, in and around the point of wire *d*. He then arranges his group, using the camera finder for this purpose, leaving, however, a place for himself. The light in the room should be turned low, leaving only enough to see by. The camera shutter is now opened, the photographer takes his place in the group, and at the proper moment pushes the button. The spark between wire *d* and baking powder can cover sets off the powder, after which the photographer closes the shutter, and the picture has been taken.

Contributed by GLEN M. ROYSTON.

THIRD PRIZE, $1.00

A PROPOSED "BELL SOFTENER."

When some one comes to the door and rings the bell, its sudden sound scares



The Sudden Jar On the Nerves Caused by Ringing the Ordinary Bell Can be Obviated by Inserting a Solenoid-Controlled Rheostat In Series with the Bell and Battery.

everyone. With this device it starts softly and gets louder gradually. The apparatus used is the same as generally employed for this purpose with the exception of the softener, which is a large cylinder wound with resistance (R), which is entirely in circuit at the start, but is varied by the slider S. When the key PB is released, the slider is pulled back to the original position (having been pulled down by the magnet M) by the spring SP.

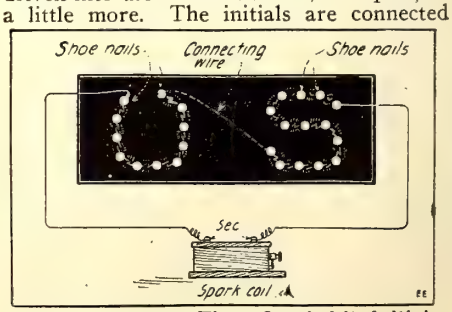
CAUTION: Do not have the slider too far from the magnet; make the cylinder short but large in diameter. Do not use too much resistance; allow enough current to pass so that the magnet will work

Contributed by
ERNEST INNES and ETHBERT REED

SPARK-LIT INITIALS

I here give a description of spark-lit initials formed from old shoe nails, driven into a block of wood so as to form letters.

A piece of wood ¾" x 1½" x 3" is used for the base, initials one inch high are drawn on the base and the shoe nails are driven into the initials about 1/32" apart, or a little more. The initials are connected



What Is Prettier Than Spark-Lit Initials Such as These, Which Can be Lit Up by Even a Small Spark Coil.

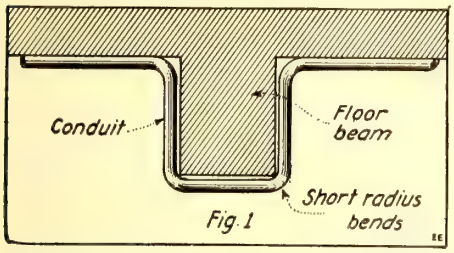
together as shown and wires are connected from the secondary terminals of a spark coil to the letters. When the coil is excited, sparks jump from nail to nail, lighting up the initials in a very pretty way in the dark.

Contributed by
DE FOREST G. STICKNEY.

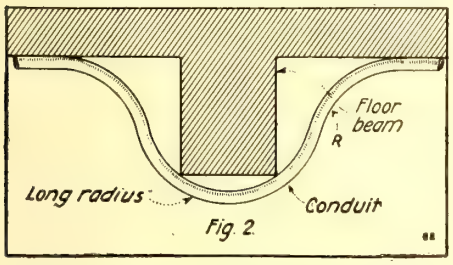
METHOD OF FORMING A SHORT-RADIUS BEND IN CONDUIT.

By George W. Shirley

To make a short radius bend in conduit for a location such as that indicated in Fig. 1, the method to be described can be used. Where turns of the usual radius are



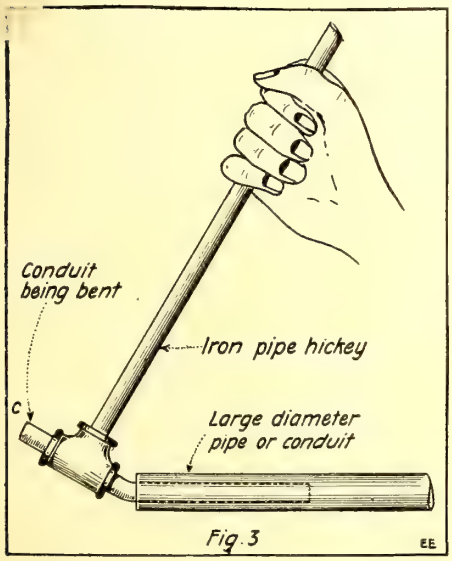
Above: The Electric Conduit Pipe Should Always Be Neatly Bent and Fitted in Place Like This. The Bends Must Be Even Curves, Not Kinked Bends.



Above Is Illustrated How Not to Bend Electric Conduit. Such Pipe Bends Soon Loosen, and Besides Present a Very Unworkmanlike Appearance. How to Bend Conduit Right Is Explained Herein.

made, the conduits do not lie close to the surfaces and present the undesirable appearance delineated in Fig. 2. But with this method, bends of the approximate form diagrammed in Fig. 1 can be so made that the inner face of the conduit will lie not more than 1¼ inches from the faces of the beam. A sleeve, *P*, of a larger diameter than the conduit, *C*, being bent, is slipt over the end of the conduit (Fig. 3) and then the short-radius turn can be formed with a hickey, *H*.

The electrician uses what is known as a *hickey* for bending all small pipe curves. The hickey is nothing more or less than a substantial pipe *tee* fitted with a handle of pipe as shown in Fig. 3. The handle is threaded, of course, so as to screw into the fitting firmly.



In Bending All Small Conduit Use Is Made of What Electricians Call a "Hickey." This Is Made of a Short Length of Pipe Threaded Into a Heavy "Tee."

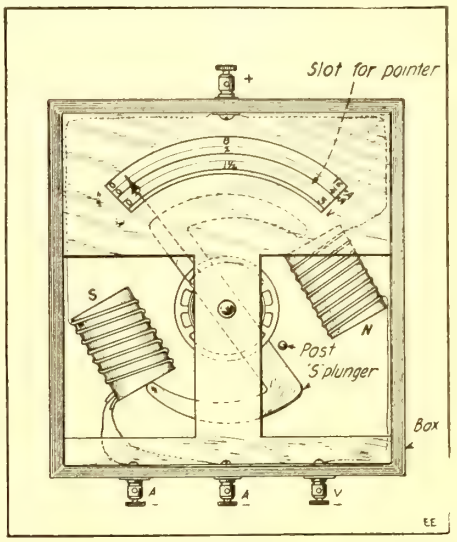
A Low-Reading Volt-Ammeter

Remove the balance wheel, bearings, and hair-spring from an old alarm clock. Using composition wall-board or thin wood, make a box 3x3½ inches and ⅞ in. deep. For ease in adjusting, the front should be cut away as shown, and the front should be easily removable. In the center, both back and front, bore a small hole to receive the bearing screws, which are cup-shaped in the ends. The balance wheel should spin freely when in place.

On a thin sheet of soft iron, taken perhaps from an empty tomato can, draw a circle with a radius of one and one-sixteenth inches. Inside this circle cut an armature like the letter S, as shown in the drawing. Punch a small hole in the center of this "tin" letter S, and slip on the balance-wheel shaft and fasten to it. Push the hair-spring on the shaft above the wheel. The free end of the hair-spring is secured to a small post. The spring must of course be adjusted to the proper tension. A thin pointer made of No. 32 wire is made fast to the balance wheel, letting the end project up thru the slot cut at the top of the instrument. A bit of colored paper should be glued to the end of the pointer.

Around a stick of wood half inch thick and ⅝ wide, wrap a couple of thicknesses of cardboard, gluing carefully. On this form wind one layer of No. 20 four feet. Fasten this with shellac. Over this coil wind 5 turns of heavier wire, say No. 14. For the voltmeter coil 40 feet of No. 32 may be used. This makes 200 turns and has a resistance of nearly 7 ohms. A dry cell giving 1.5 volts will send over 1/5 ampere thru this coil. 200 x .2 amp. gives 40 amp. turns, or 40 feet x .2 amp. equals 8 amp. feet. .2 amp. at 1.5 v gives .3 watt. When the ammeter coil having 20 turns or 4 feet is carrying 2 amperes it too will have 40 amp. turns or 8 amp. feet, and will exert the same magnetic pull as the voltmeter coil at 1.5 volts.

If we wish to measure a little higher voltage we may use 140 feet of No. 36 copper wire, having a resistance of 60 ohms. Now at 4.5 volts the energy absorbed will be nearly .3 watt. One watt should pull the armature or plunger the full distance into the coil. A square of paper covers the opening in the front and a glass fitted into slots excludes the dust. Each coil may be joined to a common post at the top but



Procure an Old Alarm Clock. You Are Then Ready to Start Building This "Triple Scale" Volt-Ammeter, a Most Useful and Desirable Measuring Instrument for the Experimental Laboratory.

to a separate post at the bottom. Instrument will work in either horizontal or vertical position. Calibration should be done last. If no standard instruments are at hand, each dry cell in series adds 1.5 volts. For the ammeter scales, two cells in series will send 6 amperes thru 48 feet No. 20; one cell will give 3 amperes thru the same wire, and 1 ampere thru 9 feet of No. 32. My "battery tester" has been used often during the past year. Tester may be used for a moment on much stronger currents than examples given.

Contributed by H. H. DAVIS.

Converting Small Motor Into a Dynamo

If your motor is not already mounted on a base, it would be well to do so for this experiment. On this base mount two binding posts BB.

Then disconnect the wires which come from the field coil and connect them to two dry cells, as shown in the sketch. Connect two short wires from the brushes to the binding posts BB, the wires being indicated by AA. A switch may be put between the field coil and batteries if desired.

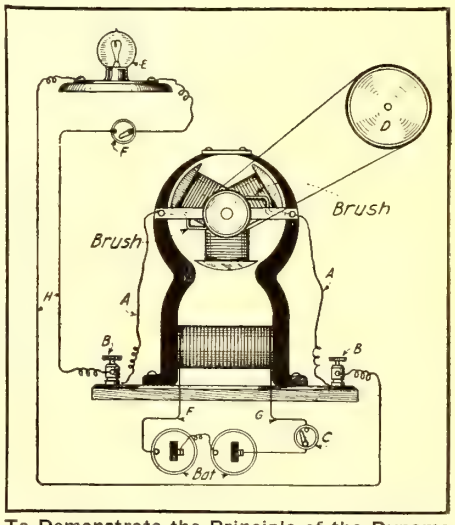
Now belt the motor to any large wheel, D, such as a fly-wheel of a sewing machine. A water motor serves the purpose very well.

When the armature is revolved at a high rate of speed, current will be generated, which will pass thru the wires HH, connected to a small electric bulb, storage battery or to another toy motor.

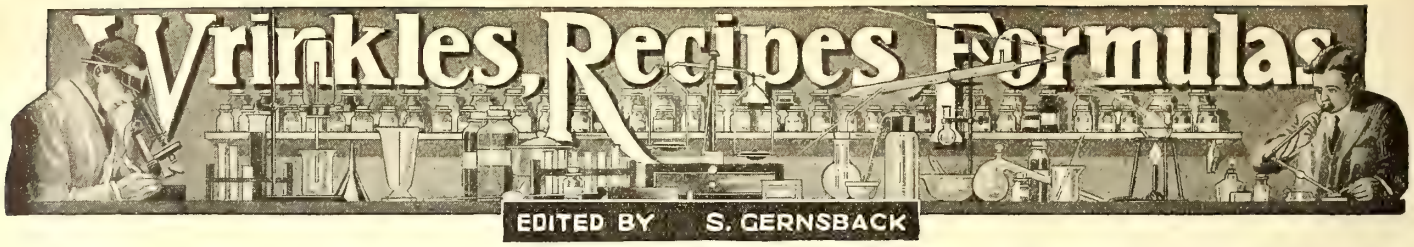
In my case the motor was very small, only three inches high, designed to run on two batteries, and when converted into a dynamo it gave sufficient current to burn out a two and seven-tenths (2.7) volt bulb, which I had taken from a flash-light.

It must be borne in mind, however, that the voltage of a dynamo is controlled by the size and number of wires with which it is wound and the speed at which the armature is rotated, as well as the strength of the field magnet.

Contributed by E. L. DURGEN.



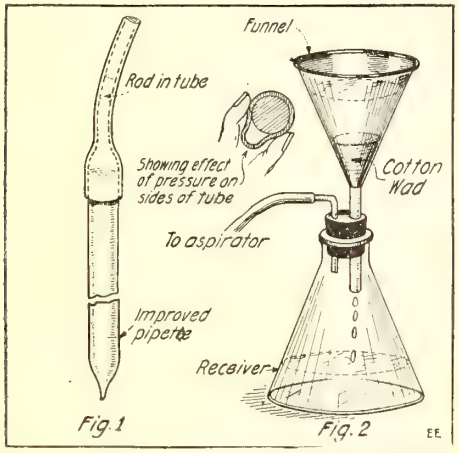
To Demonstrate the Principle of the Dynamo the Experimenter Will Find it Extremely Interesting to Drive a Small Toy Motor with a Steam Engine, a Water Motor, or Another Motor, and Exciting the Field by a Few Dry Cells. A Small Lamp Can be Lighted.



PRACTICAL CHEMICAL LABORATORY DEVICES.

By Thomas W. Benjamin.

THERE are many instruments and operations in chemistry that can be so improved as to make them handier or to shorten the time required for a given

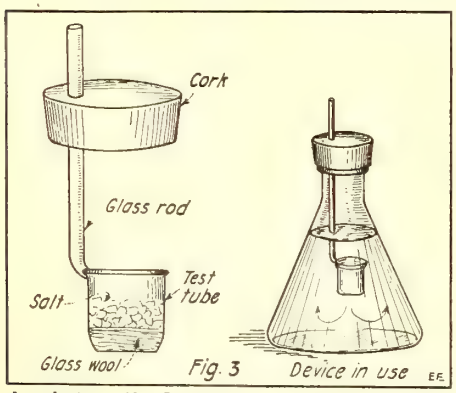


Here Are a Home-made Burette-Pipette and a Vacuum-Filter of Simple and Ingenious Construction Welcome in Every Laboratory.

process. Many of these are in everyday use in large laboratories but the experimenter hears but little of them.

A form of burette, or more properly a pipette, having several advantages is shown in Fig 1. Instead of the usual form with the stop-cock at the bottom, a plain graduated tube is fitted at the top with a 6-inch length of rubber tubing. The valve in this case is made by sliding a short length of glass rod into the rubber tube, locating the same midway of its length. The tube is normally kept closed by this rod but a slight pressure on one side of the rubber will cause the tube to buckle out and form a channel thru which liquids or air can flow.

The device can be filled either by sucking the fluid up into the tube with the mouth or by immersing it into the fluid with the valve open and removing after the valve is closed. This valve will give a finer regulation of the discharge than the usual stop-cock, a drop



An Automatic Saturator Is Easily Made as Shown in Above Diagram and May Come in Handy.

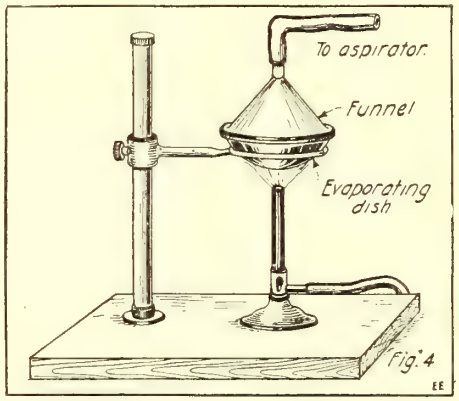
at a time or a steady stream being readily attainable.

VACUUM FILTER: When filtering thick fluids the process may be speeded up by the use of a vacuum filtering device. To create the vacuum, use can be made of the glass aspirators which are procurable at a very reasonable price. To use this for filtering, the receiver is fitted with a cork having two holes. One, large enough to take the spout of the funnel, the other having a short glass tube inserted. See Fig. 2.

A wad of absorbent cotton is placed in the bottom of the funnel and reaching a short distance up the sides. This is to support the filter paper and prevent it breaking under air pressure. The bent glass tube is connected to the aspirator and when the water flow is started a slight vacuum will exist in the receiver. Any liquid poured into the funnel will be filtered at a rapid rate due to the air pressure forcing it thru.

SATURATED SOLUTION APPARATUS: Saturated solutions of salts can be more quickly made by supporting the salt near the surface of the liquid. The idea being that as the salt dissolves the fluid gets heavier and sinks to the bottom, being replaced by other fluid. This circulation is automatic and continues till the saturation point is reached.

A little device, easily made of glass, that can be used with all chemicals is shown in Fig. 3. The body is made by cutting a two inch length from a large test tube and bending in the edges at the cut by heating till soft in a Bunsen flame. A wad of glass



This Suggestion to Get Rid of All Obnoxious Fumes in the Small Laboratory Is Certainly Meritorious and Shows What a Little Ingenuity Will Attain.

wool is placed in the tube, being held in place by the turned-in edge. The glass rod used to support the device is fastened in place by heating the rod and tube where they are to be joined until soft and then pressing them together. A cork fitted over the rod will support the device inside a bottle.

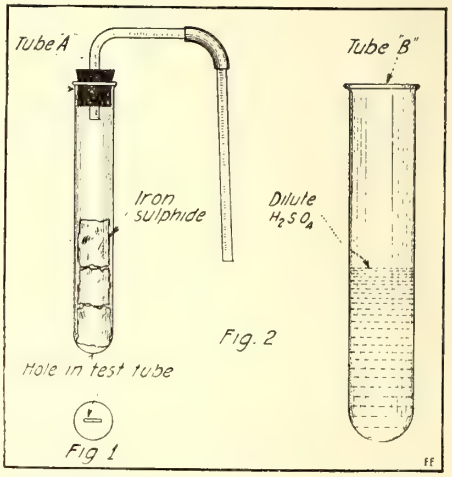
In use the tube is filled with the salt to be dissolved and placed in the bottle containing the solvent at such a height that the top of the tube is just below the surface. Additional salts may be added from time to time as found necessary.

The aspirator mentioned in connection with filtering can be used with advantage when drying or evaporating. In this case the evaporating dish is covered by a funnel the spout of which is connected to the suction tube of the aspirator; see Fig. 4. The vacuum created will draw off all fumes and vapors at a rapid rate. Should the vapor be required for further experiment a condenser can be connected in the line between the funnel and the aspirator to condense the vapor.

A SIMPLE GAS GENERATOR.

Frequently small quantities of gas are desired in the chemical laboratory, and no convenient and simple method of generation can be found. The apparatus described is very simple, yet it serves the purpose admirably.

First, procure two test tubes, one having

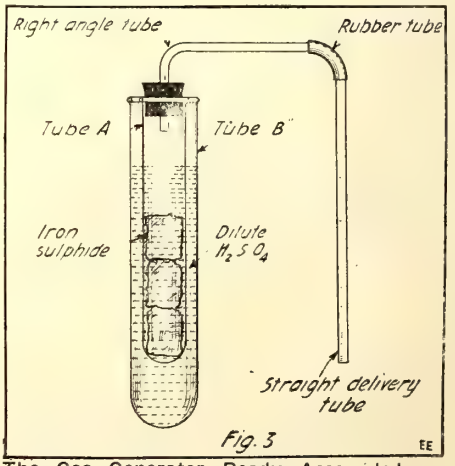


In Simplicity This Little Gas Generator Is Undoubtedly Unrivalled. Two Test-Tubes, a Cork, Some Rubber and Glass Tubing—That's All!

dimensions approximately 5/8" x 7" long, the other approximately 7/8" x 10" long. In the bottom of the smaller test tube file a small hole with a triangular file (Fig. 1), into this test tube fit a one-hole rubber stopper. Fit stopper, with a right angle, connecting tube, and straight delivery tube, as in Fig. 2, and insert in smaller test tube. The smaller tube A, is inserted in the tube B, the flare of tube A prevents it from slipping thru to the bottom of tube B.

In operating: If H_2S is to be generated, a stick of FeS, iron sulfid is placed in tube A, and the cork inserted. Dilute sulfuric acid is put into tube B, filling it about two-thirds full. When tube A is inserted into tube B, a large volume of gas is produced.

If hydrogen is wanted, small clippings of iron or iron filings are put into tube A.



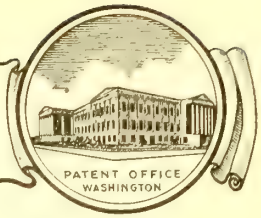
The Gas Generator Ready Assembled for Business. Get the Gas-Mask, Archimedes!

and lowered into the dilute acid in B. Removing tube A stops the generation of gas.

(*Continued on page 87*).



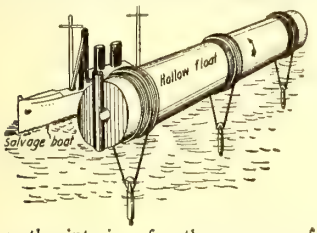
LATEST PATENTS



Electric Device for Raising Sunken Ships.

(1,288,108, issued to Vladimir V. Messer.)

In this novel scheme for raising sunken ships, a number of large floating members or tanks are utilized, which are provided with suitable electric-motor driven propellers

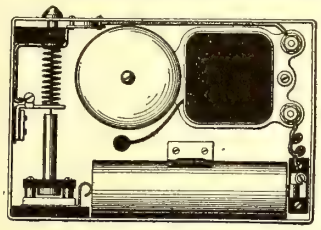


on the interior, for the purpose of causing the float to rotate in the water either in one direction or the other, about its axis. By means of flexible insulated conductors leading from the salvage boat to the float, the motors may be properly controlled, and current supplied to them for their operation. The dependent cables at the bottom of the float are made fast to the sunken vessel, by divers or by other means. These cables can be let out or reeled up by causing the float to rotate, and the cables wound up or reeled off from differentially grooved drums rigidly mounted on the exterior of the float.

Safety-Chest for Valuables.

(No. 1,291,051, issued to James L. McQuarrie.)

By means of an ingenious safety chest, a continuous alarm is sounded in the event of any unauthorized disturbance of the chest. The alarm mechanism is entirely enclosed in a small separate compartment, which may be readily removed, when the chest is open, for repair, etc. The

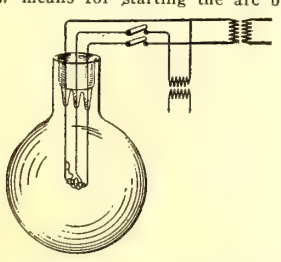


alarm is actuated by a gravity operated pendulum member, which is freely movable in response to any disturbance of the chest, once it has been set and the chest locked. Also magnetic means are provided for holding the gravity operated pendulum when it is thus moved by agitation of the chest, so as to keep the alarm bell circuit closed continuously.

Incandescent Arc-Lamp.

(No. 1,290,930, issued to Philip K. Devers, Jr.)

In this interesting form of incandescent arc lamp, the arc is operated between two electrodes of tungsten or other suitable material, in a gaseous medium of considerable pressure. The inventor provides a new means for starting the arc be-

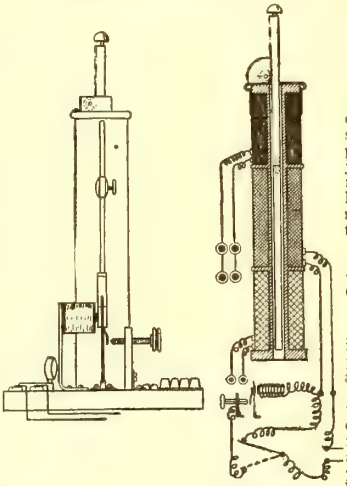


tween the electrodes at low potential, while the electrodes are below a temperature at which the electron emission occurs. Surrounding the gap between the electrodes, there is provided a spiral heating coil, and the arc-supporting current is imprest across the electrodes at the same time that the heating coil is switched into circuit,

Medical Coil Apparatus.

(No. 1,290,628, issued to Louis Mayor.)

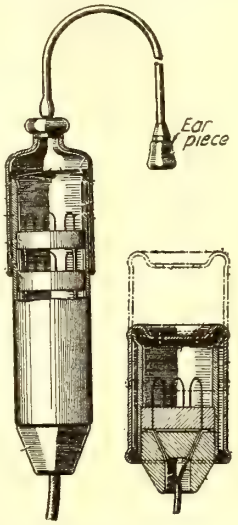
Can be operated from commercial A. C. lighting circuits. There are three windings on the apparatus, one primary and two secondaries. One secondary is connected with sponge or other electrodes for applying the current, while the lower secondary coil provides a low voltage current for operating a small lamp for endo-



scopic work, etc. The soft iron core passing thru the coils is adjustable as to position, by means of a control knob fitted with rack and pinion attachment.

Adjustable Thermic Telephone.

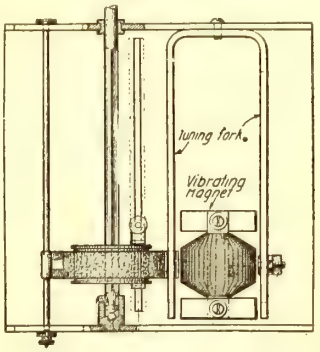
(No. 1,290,114 issued to Pieter de Lange and Robert Aeronut Baron van Lynden.)



An improved form of thermic telephone adapted for certain purposes, or wherever it becomes an object to accurately regulate the intensity of the sound reproduction by varying the volume of the sound chamber. In this particular arrangement the sounding chamber is arranged in two parts, so that one may be slid over the other, thus either lengthening or shortening the chamber,

Constant Amplitude Vibration Motor.

(No. 1,290,264, issued to Leslie R. McDonald.)

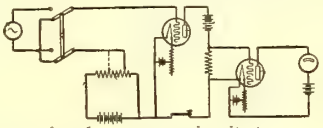


This ingenious motor is made up of a rotary member mounted on a square shaft, which is actuated or propelled about its axis by an adjustable belt member, which is alternately and regularly pulled taut and loosened, by virtue of its attachment to an electrical tuning fork in the manner here illustrated.

A Vacuum Tube Peak Voltmeter.

(No. 1,287,161, issued to Richard H. Wilson.)

An improved method for measuring the peak voltage between two points of an electrical net-work, and a further object of which is to measure a direct or alternating voltage without the necessity of constant calibration of the measuring instrument. These results are accomplisht by connecting the input circuit of the thermionic valve between the net-work terminals, across which the voltage is to be measured, and allowing the resulting uni-directional pulsating cur-

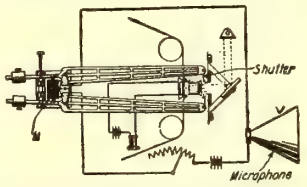


rent in the output circuit to pass thru a resistance or impedance.

Sound Recorder and Reproducer.

(No. 1,290,711, issued to Manuel Calderon.)

In "recording" the sounds on a photographic film by creating variations and graduations in light to dark, the sound waves are picked up by a microphone, or a battery of microphones. These microphones, thru a battery and rheostat, are caused to actuate an electromagnet, M. This magnet operates on two armatures attached to the pivoted levers shown, to the longer ends of which there are attached light beam shutters, which may enter the beam of light in the manner apparent. The variations as aforementioned in the light and dark graduations are photographed on the film, and correspond to the voice waves. In "reproducing" the voice, the film is past before the beam of light, and the variations in light value pass-

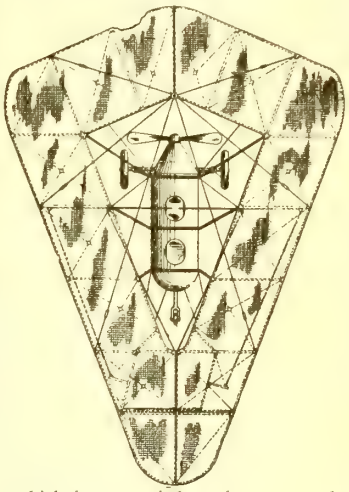


ing thru the film, cause corresponding variations in a battery and telephone receiver circuit, by virtue of their action on a selenium cell placed behind the film.

A Non-Capsizing Airplane.

(No. 1,284,373, issued to Platon Lazarides.)

The design of this airplane may be of the biplane type. The inventor provides a triangular form of wing, both of which are similar in shape and area, the center of the wings being open, so that the aviator can see upward as well as sideways and downward. One of the principal objects of the inventor is to provide a flying machine such that if the engine should stop in mid-air, it would then become possible for the airplane to settle to the surface of the earth in much the same way as a parachute does. This is accomplisht by carefully balancing the entire plane, and the car or body

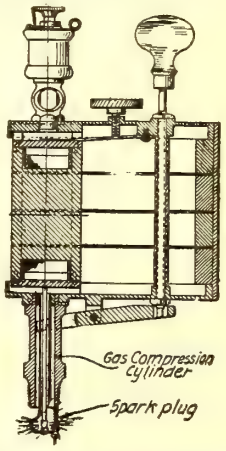


which is suspended at the center of the wings.

Spark Plug and Generator Combined.

(No. 1,290,190 issued to Albert B. Herrick.)

This interesting patent covers a very ingenious gasoline engine spark plug and generator combined, which is operated by the compression of the engine. In other words, this device includes an electro-magnetic generator similar in principle to a magneto which is adapted to be automatically operated by the com-



pression of the gases in the cylinder of an internal combustion engine. In the form shown, the generator constitutes but one coil wound on a soft iron core. This is surrounded by a series of strong steel magnets. At the base of the generator there is a threaded terminal which fits into the spark plug orifice of the gasoline engine, so that the compression can operate therein to push against the piston member.



WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $3.00 each month for the best photos. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $3.00 PRIZE WINNER—N. NUSHAWG

HEREWITH are three views of my "Chemical Laboratory." I think it will be needless for me to give a description of the contents of my laboratory as I had the view so photographed as to cover that part. A brief outline or history of my laboratory I think would not be out of place. The "Lab." as you see it in the accompanying views is an accumulation of five years of experimental work. My first laboratory consisted of an old wash-stand, of which a part can be seen directly behind "yours truly" in the view in which I am standing. Year by year I added to the aforesaid wash-stand, as my finances would permit, until today I have what I consider a model "Amateur Chemical Laboratory."

My laboratory is not only a place which affords me much amusement but is also my "Study Hall" and my "College of Chemistry" combined in one. I maintain a schedule of study which embraces two hours each evening, including the study of chemistry, electricity, biology and other studies interesting to those contemplating a life of science.

Two articles which I would like to call to your attention, noticeable in the general view of my laboratory, are first: the electric furnace constructed from the description found in the April, 1918, issue of the ELECTRICAL EXPERIMENTER. This furnace will be found on the ledge below my apparatus shelf in the right hand side of the picture. The other article is the hydrogen sulfid generator, which will be observed beside my specimen cage just beneath the window (to the left). I am sending a separate description of this apparatus to the Editor, hoping he will see fit to publish the same in "your magazine"; so keep an eye peeled for it.

This laboratory is located in the cellar of my home and is twenty-two feet in length and fourteen feet in width. It is constructed of plaster board and has a four inch air cushion around it on three sides, so as to protect it against any dampness from the cellar. It is heated by a furnace pipe that you will notice running thru the laboratory. It is fitted with electric lights for general illumination and a gas lamp for use in the printing of photos. I have gas and running water at hand. A hood is also among the apparatus; this serves in eliminating all obnoxious odors.

I have been taking the ELECTRICAL EXPERIMENTER since the August issue of 1915, and have each copy since that time. I find it to be the best magazine in its field and have highly recommended it to my friends, gaining the "E. E." quite a few friends by so doing. I have found the "Experimental Chemistry" course by Albert W. Wilsdon very interesting, having followed and studied each lesson since the first.—N. Nushawg, 534 Arbor Ave., Dayton, Ohio.



Science in Slang

3. The Specks in Space

By EMERSON EASTERLING

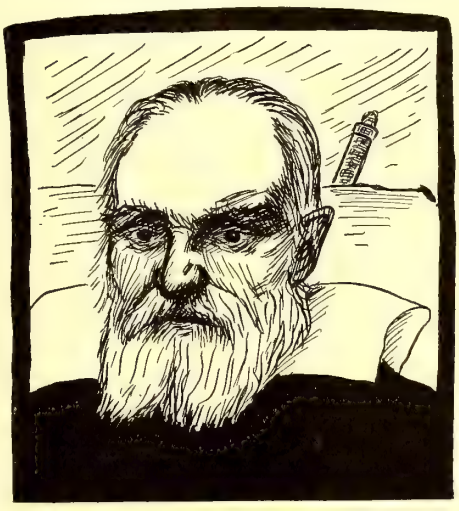


T was one of those clear bright summer nights when the moon and stars stood out against the black background of the sky, casting a silvery light upon the faint landscape. We were motoring along a highway, and as the sky loomed out as the cynosure of the time, our conversation drifted to astronomy, being of the scientific trend, and our company being more or less scientifically inclined. Pointing to the moon, Stokes made the remark, "Old girl, since Adam quit rubbing his eyes and became aware that he was a sentient being your reflections have permeated space and we have become familiar with your lunar highness. Lovers have sworn their LOVE by you, and coyotes have howled under your rays. But not until the spectroscope shows up and dissects the moon beam, laying its vibratory secrets bare before us, we were not so sure after all but that you were green cheese, as the story book affirmed.

"The old time Chinks were the first guys to finger around and get on to the ways of the welkin—in fact they looked right thru the welkin and got wise to such things as eclipses and other primary stuff of the great all-around. It was reported that two old timers named Hi and Ho who profest to be 'there' on the astronomical dope failed to inform their boss, the Emperor of Cathay, of the eclipse that came around unannounced, and it is further stated that according to the regulations of the country, the men were forced to suffer the amputation of their heads.

"Next in order came the Chaldeans, who claimed to be wised up on the aerial phenomena, and who were able to predict eclipses and so forth. They blew their horn and left some records that are real amusing and historically instructing, but they started the ball so that we hear from such guys as Thales, Anaximander, Pythagoras, Anaxagoras and Eudoxus, Hipparchus, Meton and a few choice more astronomers and not from other lines—of course we have heard from some of the birds in other lines, but as a whole they were star gazers and dreamers.

"Then we read of the endeavors of the Egyptians, from the school at Alexandria, and of Ptolemy and his ideas. You know he was the duck that was guilty for the Epicyclic System, which has it down in such a manner that the believer is led to accept the statement concerning the revolution of the planets around a center that is itself doing the merry-go-round stunt. From his standpoint he was right—the only trouble with him was that he overlooked, while gazing so far into the heavens, that our little elongated spheroid was one of the ethereal company in motion with the rest. But the old boy unhitched the old plugs with which Apollo had pulled the old glare around and run the brow wrinkles in other directions when he let loose with his treatise 'Almagest'. All this was way back in B. C. about 200.



Galileo, the Bird Who Defied the World by Telling It that It Turned Around Instead of Standing Still, as Was Thought.

"On astronomy, and more so on astrology, the Gypsies were 'there', but to the Greeks we owe the coining of the word 'ASTRONOMY', from the word *νόμος*, or nomos, which means LAW; and *ἀογρον*, or astron, which means star or + we get the same which means Star-Law. From the Greeks sprung Thales, the man who stands out in the first discoveries of the electrical phenomena, and who was so good at the heavenly twinklers that he was termed the Father of Astronomy. It was him and not Chrissy Columbus that told the World in general that the globe that we now know as the 8,000 mile in diameter ball of dirt and water (which is not necessarily mud) was round instead of a flat chunk upon the shoulders of Atlas. It was he who determined when the equinoxes and the solstices were due to arrive, and he knew beforehand when the famous eclipse of the Sun was to occur—the one that caused the Lydians and the Medes to throw up the sponge in their famous battle, you've read of the incident in history. Then the sundial was invented by a Greek, Anaximander.

"Getting back to the history of the thing we see a poor guy gazing up thru a dilapidated old farmhouse roof—where there was no roof—and thinking. Well, he thought so hard that we now still read of the Copernican theory of the universe. He stuck our planet in with the rest of the whirling globes and fireworks. He got a hunch from Pythagoras.

"Brahe then came along and modified the theory of Copernicus and cut out the 'cycles and epicycles' stuff, and as he was not housed up in a farmhouse he built a magnificent observatory. Then came the apt pupil of Brahe's, Kepler, who compounded a pile of laws and stamped his cognomen on history,

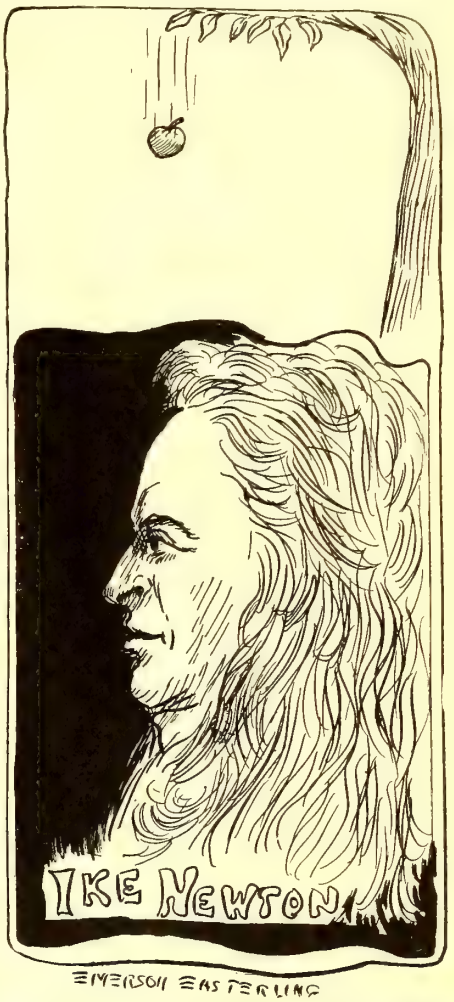
"After a while Galileo grew up from the skipping rope and marbles age and invented the telescope and pendulum. Looking thru the glass instrument he found that Jupiter had a moon—not the kind that showed up when some of his marbles collided with too much force, tho. After he slipt us a handful of physics and astronomy and the like we become aware that from the dressing room of Life there steps out a Sir Isaac Newton, who saw the apple fall and told us all about gravitation. Of all the 'Big Bugs' in astronomy, as well as mathematics, we lift our hat a little higher to Ike."

"I once read of the Arabians as being up on the Astronomical dope," I ventured.

"Yes, they were," Stokes replied. "A duck by the name of Ulugh Beg, who was not an ugly beggar but an astronomer, catalogued a bunch of stars. They took to that and astrology, like the Egyptians and Moors.

"Then Laplace topt off Newton's 'Principia' with his *Mécanique Céleste*.

"Naturally, the first thing to be considered is the Sun. The savages recognized it as the means of life on our planet (of course they knew of no other) and worshipt it as their God, in the same manner as we do the $, only they openly acknowledged it. In plant life we are aware of an attraction by it. Only the blind cannot see the effect it has upon everything in general. Now, with a lot of the experiments behind us, we have it figured out that we are 93,000,000 miles from Old Sol, and that the hot old



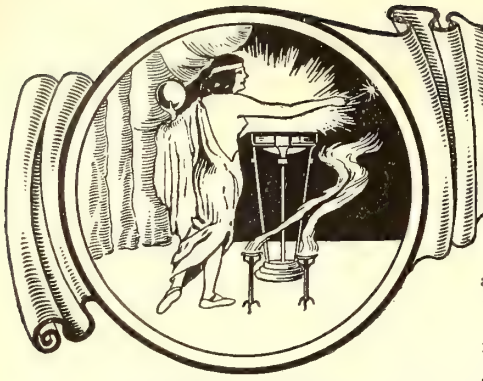
Ike Newton, the Gink Who Invented Gravitation by Means of the Cider-Fruit.

boy is composed of much the same material as our Earth, and we also have it doped out that the temperature up at the Sun arrives at the twelve thousand mark, F. It has a 'photosphere' where we have our hydrosphere and a 'Chromosphere' where we have our atmosphere. The mathematical wonders have it down in their note books as follows for the weights of the Earth and Sun, respectively: 6,000,000,000,000,000,000,000 and 2,000,000,000,000,000,000,000,000,000 *tons*. To reduce that down to ounces would take Steinmetz at least a second—you know him. Then the candle-power looks like this on paper: 1,575,000,000,000,000,000,000,000,000,000.

"How would you say that if you did not have your pencil along" asked Bender.

"Well, the first, replied Stokes, looking down at his paper, "is six sextillion. The

(*Continued on page* 69)



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

REWINDING TELEPHONE MAGNETO.

(993) Walter F. Hawley, Buffalo, N. Y., writes us:

Q. 1. How can he rewind a 3 bar telephone magneto to produce 10 volts?

A. 1. This question cannot be answered exactly, excepting on one condition, and that is that you would need a magnetomometer at hand with which to measure precisely the strength of the magnetic flux in maxwells per square inch of pole-face area.

We can suggest from our experience in this line, however, that the armature be wound full with No. 17 to 18 B. & S. gage S. C. C. or enameled magnet wire. This would be suitable for a potential of 8 to 10 volts. Of course, the voltage can always be increased by raising the speed, but naturally there is a limit to this, as the machine will not safely stand too high a speed.

A. C. SOLENOID.

(994) Stanley Dohrzynski, Cuyahoga Falls, Ohio, asks the Oracle:

Q. 1. For data on winding a small A. C. solenoid about 3 inches in diameter and 3½ inches long, with a ⅝ inch iron core.

A. 1. Unless such an A. C. electromagnet is very carefully designed, which would require elaborate calculations, and also unless it is carefully and very exactly built according to these specifications as computed, then the current taken will vary considerably from that calculated. Also in the case of the solenoid, with a movable core, the current will vary from a very high value when the core is just entering the coil, down to a certain minimum value, when the core is pushed all the way into the coil.

The only thing we can suggest in your case would be to experiment with several sizes of wire. For the size of solenoid you have in mind, you might try winding it full with No. 18 D. C. C. magnet wire. The weight which such a solenoid could lift with the core all the way in the coil would probably be in the neighborhood of one-half pound. The iron core must be laminated, not a solid piece.

1 K. W. WIRELESS TRANSFORMER DATA.

(995) J. R. Johnson, McConnelsville, Ohio, writes this department:

Q. 1. Please give data for winding a 1 K. W. radio step-up transformer.

A. 1. We are pleased to give you herewith data on 1 K. W. close core step-up transformer.

The laminated sheet iron core should measure 15 inches long and 8¼ inches wide, and have a cross-section of 2 × 2 inches, or 4 square inches. The primary winding which should have taps taken off from each layer should comprise 344 turns of No. 10 B. & S. gage D. C. C. magnet wire. The secondary should comprise about 12 pounds of No. 32 D. C. C. magnet wire, thoroly impregnated with paraffin and beeswax while being wound into pies. There should be 24 pies or coils, each ¼ inch thick. This secondary winding should give 14,176 volts with 300 turns in the primary; 21,265 volts on 200 turns in the primary, and 42,530 volts with 100 turns in the primary in use. Of course, when the normal number of primary turns are reduced in order to raise the secondary voltage, a suitable iron core choke coil or impedance must be used in series with the primary winding in order to control the current, so that the transformer will not over-heat and burn out the windings.

The "June" Number of the Electrical Experimenter

Electrifying Our Battleships—The electrically driven U.S. battleship "New Mexico," by Charles M. Ripley, of the General Electric Co.

Problems of Telephotography—Written by an authority on the subject—Leroy J. Leishman.

"My Inventions"—No. 5, by Dr. Nikola Tesla, himself.

In the Wonderland of "Tin Can Toys"—by George Holmes.

Photographing Nauen's Radio Signals in America—A Startling Scientific Achievement.

Close-Ups of the Newest Scientific Movies—The Rôle of Electricity and Science in Photoplays.

How American Electricians Solved the "Submarine Detector" Problem.—Illustrated.

A New "Pocket Wireless" That Actually Works—with photos of the Apparatus in Use.

Rogers Underground Wireless for the Amateur—by H. Winfield Secor. Don't miss this article—It answers all the "Radiobug's" questions.

Improved Capillary Battery—by Thomas Reed.

The New Kolster Direct-Reading Wave Meter and Decremeter.

Choke Coils—How to Design and Build Them, by Prof. F. E. Austin.

Experimental Mechanics.—Lesson 12. Twist Drill Practise, by Samuel D. Cohen.

The Audion—How to build and exhaust them, with Graphs for different tubes, by C. Murray.

2 K. W. STEP-DOWN PIPE THAWING TRANSFORMER.

(996) Joel H. M., Carney Point, N. J., inquires:

Q. 1. Can you supply data on a 110 volt, 60 cycle, A. C. step-down transformer for pipe thawing, the secondary giving about 12 volts.

A. 1. We give herewith data on the construction of a 2 K. W. transformer suitable for operation on 110 volt, 60 cycle, A. C. The secondary is suited to develop a current of about 13 volts and 150 amperes.

The primary winding of this transformer consists of 13½ pounds or 244 turns of No. 8 B. & S. D. C. C. magnet wire, or 2 No. 11 D. C. C. wires can be wound side by side and connected in parallel. The laminated sheet iron core, on one leg of which the primary is wound, should measure 17½ inches long by 8¾ inches wide, and have a cross-section of 2¼ × 2¼ inches.

The secondary winding for this transformer should comprise 31 turns of No. 0 B. & S. gage D. C. C. magnet wire, and will develop a current of about 13 volts and 150 amperes. If this is too difficult to wind on, 2 No. 3 wires may be used or 4 No. 6 wires, connecting these wires in parallel.

REWINDING DYNAMO.

(997) A. C. McLellan, La Porte, Ind.:

Q. 1. I want to know what size wire the armature or field or both will have to be wound with to get 40 volts and as much amperage as possible from a dynamo as follows:

Field is 6 pole, now wound with No. 20 D. C. wire, 1¼ pound to the pole. The armature has 28 slots, wound with 28 coils, parallel lap winding, and has 2 brushes at an angle of 60 degrees from each other. Each coil is wound with 20 turns of No. 20 D. C. wire. Commutator has 28 bars, diameter is 4¾ inches, length 3 inches, and at a speed of 2,000 R.P.M. it now generates 105 volts and 9 amperes. The dynamo is shunt wound, and when wired for 40 volts I want it shunt also. It seems to pull very hard now without any load on it at all.

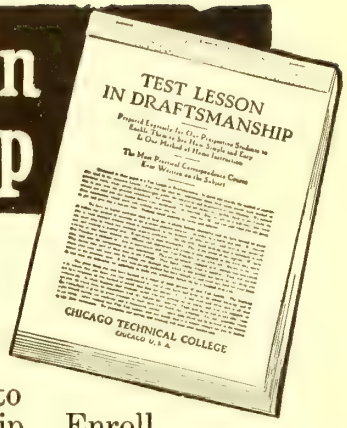
A. 1. We would advise as follows concerning the rewinding of your 105 volt, 9 ampere dynamo:

For 40 volts the field should be rewound with the same amount of wire, or 1¼ pounds per pole of No. 15 B. & S. gage D. C. C. magnet wire. The armature should be rewound with the same number of coils and in the same fashion or style of winding as previously used, but each coil should be composed of 7 turns of No. 15 B. & S. gage D. C. C. magnet wire.

You mention that the dynamo armature seems to turn very hard without any load on it at the present time. This most likely is not due to any electrical reasons, but merely mechanical ones. We would suggest that the bearings be carefully inspected; also on some small dynamos fitted with a number of brushes, the brush friction is made too great, and they should be readjusted so as to have just sufficient spring tension against the commutator to eliminate any undue sparking. In some cases,

(*Continued on page* 50)

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Thousands of Wonderful Opportunities in the Electrical Field

The Trained Man Is Needed Everywhere

By L. L. COOKE,
Chief Engineer, Chicago Engineering Works

BUSINESS conditions throughout America and even the world today are such that there are now truly wonderful opportunities for trained men in the electrical field. The electrical business has grown so fast and electricity is being continually applied to so many new uses that the demand for trained electrical men is growing faster than the supply.

Even on the farm electricity is now becoming common and thousands of farm lighting and power plants have already been installed. This shows how broadly electricity is applied today, and suggests something of the very great demand for hundreds of thousands more of trained electricians.

"Where will we get the men," is the question heard on every side. Electrical Manufacturers are spending thousands of dollars a week advertising merely for help. Look at the "Help Wanted" columns of any newspaper and see for yourself the demand for trained men. The salaries paid to young men with a thorough knowledge of electricity are unbelievable. The size of the pay envelopes going into the pockets of electrical workers every week reflects the scarcity of men to fill these responsible positions. So, not only is the electrical field greatly vacant now due to the absence of electrical men enlisted in the war services of our government, but it will be more greatly vacant when war's results are counted, and the need for men to fill the industrial places of our soldiers and sailor boys will swell the demand.

Moreover, the reconstruction and readjusting periods to follow in the war's wake are going to increase the employment of electrical workers beyond even the natural immense requirements. Electricity is yet to do its biggest services to the world after the war. Tho unlimited are its boundaries now, electricity and men who know its functionary phases and operations will have even wider scope and opportunity for years after peace is declared.

The most vital question for the young man of today to answer is not "Shall I enter the electrical profession?" but "What is the quickest, easiest and surest way to become a trained electrical man?" Time was when it took from three to four years to turn out an accomplished electrician who could be entrusted with any job that came along. Only a few years ago it used to cost thousands of dollars to make an accomplished electrician, which amount was made up in expensive tuition, board, etc., as well as money lost in non-production while the student was learning. Hundreds of thousands of dollars were lost in this manner because the student, seldom, if ever, is a producer while studying. This means a tremendous loss to the nation, as a minute's reflection will readily show.

Correspondence instruction has changed all this. By this method the student wastes no time on unnecessary branches. He gets exactly the training he will use in practical work and throughout his entire course he has the direct personal instruction of specialists in the branch he has selected.

Further, he can do his studying at home, in his spare time. He does not have to give up his regular job until he has qualified as a Certificated Electrician and is ready to enter his new profession. Think of the thousands of dollars this one great feature of correspondence instruction has saved this country in the past year alone.

I urge every young man with ambition and pluck to grasp the opportunity that present conditions offer the electrically trained man. Don't hesitate because of age or experience. Young men, boys and old men are needed and must fill the gaps to keep business going. Do your part. Prepare yourself for a real position by specializing in some branch of electricity. All you need is a few months' practical, snappy instruction from a competent engineer and you will be ready to go after some real money. But do it now. Our boys are returning filled with ambition, strong and healthy after two years' out-door living. How can you hope to compete throughout the reconstruction period without the special knowledge and advantages training will give you?

The Chicago Engineering Works are ready to help you. A specially designed course has been prepared that will fit you in the shortest possible time to take up the extremely interesting and profitable work as a Certificated Electrician. The course is the result of many years' teaching of young men in this vast field. It is intensely practical. It is highly condensed, simplified, up-to-date and complete. You can make a splendid success in this study, and the school will guarantee, under bond, to return every cent paid for tuition, if you are not entirely satisfied when you receive your Electrician's Certificate granted you as a graduate of the school. We teach contracting and electrical drafting along with the course and hundreds of our graduates are now successful contractors.

You can take the entire course in your spare time. No interference with your regular duties. We understand just what you must know and have devised a really wonderful way of instruction by mail. We have trained thousands of men and will train you to your complete satisfaction or the course will not cost you one cent.

Remember, that you will not be under the slightest expenses except the tuition price. A splendid Electrical Outfit is given free to every student and much of the training is done by actual work with this outfit. You have no car-fare or living expenses as you would have if you studied at a trade-school. You don't have to buy your outfit, or pay for the maintenance of expensive school equipment as you would elsewhere. The electrical outfit which we give every student includes Electrical Tools, Instruments, Materials, etc., and is given absolutely free.

The price of the course, you can pay in small installments if you want to—in other words, you can pay as you go along. These payments you can take out of your salary which you receive from your regular employment, it not being necessary to give this up until you are fitted and ready to take a good position as a real electrician.

One excellent feature of the assistance the Chicago Engineering Works is giving young men to help them succeed is the free employment service. The standing of the school is so high and the quality of students so well known that many firms rely entirely upon our graduates to fill vacancies in their staffs. We are continually receiving requests from employers to send them trained Electrical men. We assist our students to good positions and keep in touch with them for years, helping and advising them in every way possible.

I cannot urge all young men too strongly to get into the field of electricity. I know the vast opportunities for bright men and the opportunities have never been better than they are now and will be for the next ten years. The industry needs you and will give you a good chance to make a success of your life. Write us and let us tell you all about what we can do for you.

We have just prepared a new book on Electricity and its Opportunities and I want to send you this wonderful book—FREE. Write me personally telling me just what you are doing and what you would like to do. I'll gladly answer your letter myself and give you the benefits of my many years' experience in this field. But whatever you do, don't neglect the golden opportunity now offered live men. Address L. L. Cooke, 443 Cass St., Chicago, Ill.—Adv.

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Send for this Book

My book, "HOW TO BECOME AN EXPERT ELECTRICIAN," has started thousands of young men on the way to splendid success. A new edition of this has just been printed. I want every young man interested in Electricity to have a copy, and will send you one, ABSOLUTELY FREE and PREPAID. Write me today.

How I Train My Students

As Chief Engineer of the Chicago Engineering Works I know exactly the kind of training a man needs to enable him to get and hold good positions, and to earn big pay. I have trained hundreds of men who are holding splendid electrical jobs.

I give each of my students personal attention and a complete and thorough training. I give him a SPLENDID ELECTRICAL OUTFIT FREE, and much of the training is done by actual work. When my students graduate and receive their Certificate, they are ready for a real position. But *still more,* at any time you wish you can come to our splendidly equipped Electrical Shops for special training. No other school can give you this.

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L. L. COOKE, *Chief Engineer*

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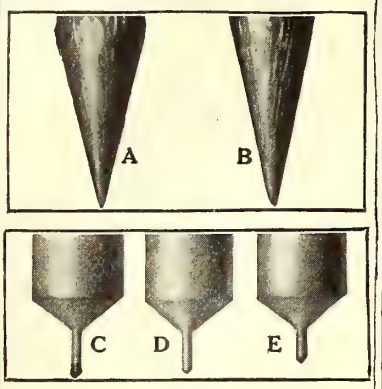
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A—New ordinary steel needle.
B—Ordinary steel needle after playing *one* record. *Note the worn point!*
C—New Sonora Semi-Permanent Silvered Needle. Note that the parallel sides (which are *not* tapered) always fit record groove perfectly.
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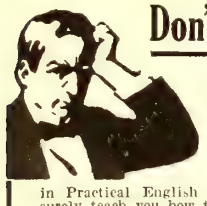
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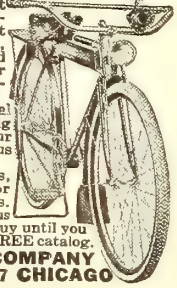
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SEND NO MONEY but tell us exactly what you need. Do not buy until you get our prices, terms and the big FREE catalog.



MEAD CYCLE COMPANY Dept. D107 CHICAGO

THE ORACLE

(*Continued from page* 46)

also, the armature may rub against the field poles, and this can be easily ascertained by removing the armature and noting if there are any shiny spots on the field poles or armature core.

ELECTRIC ARC TEMPERATURE

(998) James G. Peck, Elmira, N. Y., says:

Q. 1. What is the temperature of the electric arc produced between two ½ inch carbons?

A. 1. In regard to data for building an arc light from two ½ inch diameter carbons to give you a temperature of 3,500 degrees Centigrade, any arc, large or small, gives about the same temperature roughly speaking; the large arcs using larger carbons simply giving a greater quantity of heat, but not a higher temperature. The electric arc will give you the greatest temperature of any ordinary source of heat known. The average arc, using ½ inch carbons, either cored or solid, consumes about 5 amperes, on 110 volts, and the candle power is about 1200.

Appended are some interesting high temperature sources of heat:

Bunsen burner	1,870 deg. C.
Oxy-coal gas flame	2,000
Oxy-hydrogen flame	2,800
Oxy-acetylene flame	3,500
Electric arc (furnace)	3,500

RADIO LOOSE COUPLER DESIGN

(999) Alvin Harrison, Albert Lea, Minn., asks:

Q. 1. Several questions on designing loose couplers for wireless receiving circuits.

A. 1. In standard practice it is usual to provide both primary and secondary coils with loading inductances, these inductances being either a separate part of the circuit, or else combined with the coupler windings themselves, preferably the latter.

The primary as well as the secondary circuits are, in the most efficient design of coupler, made so as to form a continuous coil capable of being tuned to the highest wave length which it is desired to receive. Any other form of loading inductance which is separate from the windings of the coupler only form a source of loss, for it requires a certain amount of energy (I^2R) to excite this separate loading inductance, and, as it does not form a part of the main coupler winding, and is not useful in producing a part of the common electromagnetic field which transfers the energy from the primary to the secondary circuit, as you will see, in any event then it must be a source of *unrecoverable loss.*

We would refer you to a very good article on "Building a 20,000-meter Undamped Receiving Set," by William Burnett, Jr., page 258, August, 1917, issue; also

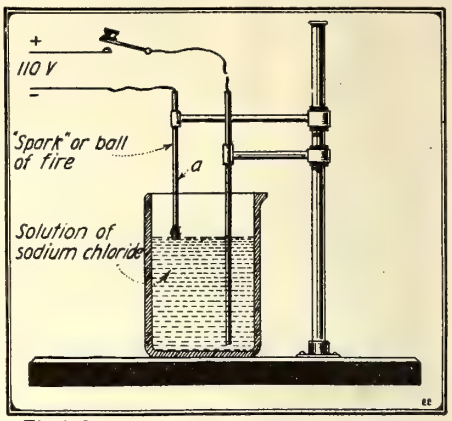
"The Design of Large Radio Receiving Transformers," by Chas. S. Ballantine, Radio Engineer, page 732, February, 1917, issue.

"The Calculation and Measurement of Inductance," by H. Winfield Secor and Samuel Cohen, parts 1, 2 and 3, which appeared in the March, April and September, 1917, issues.

PECULIAR SPARK BALLS.

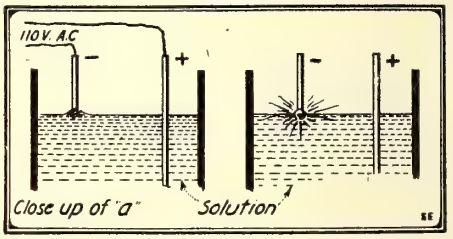
(1000) R. J. O., San Antonio, Texas, writes:

Q. 1. I am a reader of the ELECTRICAL EXPERIMENTER and desire some information regarding an experiment performed in my "Lab" some time ago which I am at a loss to know "the why and wherefore" of. Thus: I made a solution of Sodium Chlorid and water, in a small beaker. (See sketch.) Using a current of 110 volts and a small telegraph key to open and close the circuit, I connected it as shown in the "hook up." I proceeded as in sending a telegraph message and found that a rapid movement of the key produced a stream of what appeared to be sparks between the neg. (—) pole about 1/32 of an inch above the solution. The so-called "sparks" will continue to appear as long as the copper wire lasts. (It melts rapidly). My question is "What are those sparks?" If not sparks, what is it?



First Stage of "Spark Ball" Experiment.

A. 1. The experiment which you describe is nothing new and is well known to those who have experimented with electrolytic interrupters a good deal. This experiment can be performed not alone with sodium chlorid, but with almost every acid. Providing the current is strong enough, a ball of fire will appear at the end of one wire which touches the surface for the following reason: As soon as the point touches the liquid which has a more or less high resistance, the solution at this point immediately starts to boil. At the same time hydrogen gas is evolved, and the electric current setting fire to it explodes this minute quantity of gas, thereby giving rise to a small explosion. This phenomenon occurs in very rapid succession, and the explosions take place several thousand times per second. Mr. H. Gernsback some years ago obtained quite large "fire balls" of this sort by using a fine carbon pencil as one electrode.



Second and Third Stages of "Spark Ball" Experiment. The Theory of Its Action Is Very Interesting.

200 WATT TRANSFORMER DATA.

(1001) James Dicks, Delhi, La., inquires:

Q. 1. Please give me data on 200 watt step-up wireless transformer for operation on 110 volts, 60 cycles.

A. 1. The laminated sheet iron core for this transformer should measure, for a 200 watt transformer, 10½ inches long by 6½ inches wide and 1 x 1 inch in cross-section. The primary winding, placed on one of the long legs, should comprise 660 turns No. 15 B. & S. gage D. C. C. magnet wire. Before winding on the primary coil, the iron core leg should be insulated with four layers of oiled linen or Empire cloth.

The secondary winding should comprise 17 pies or sections, each ¼ inch thick, with paraffin paper discs between them when assembled. The size of the secondary wire should be No. 34 B. & S. gage D. C. C. and 3.7 pounds of secondary wire are required. There should be about 35,000 turns in the secondary, and the secondary voltage with

(*Continued on page* 52)



How Would You Train 50,000 Employees?

Western Union's Big Problem Think of an army of 50,000 men and women, differing greatly in ability, adaptability and previous training — remember that all of them were self-supporting wage-earners, who could not afford to let anything interfere with their regular occupations — consider that it was their employer's desire to make intensive training practical for all, without lessening their present efficiency—and you have some idea of the complex employe-training problem that confronted the WESTERN UNION when it undertook to make it possible for any of its 50,000 employes to acquire a higher degree of efficiency in their work.

How it was Solved As WESTERN UNION found that there were no courses covering completely and thoroughly the highly specialized telegraph business, it had special texts written by its own experts, who thus became the personal instructors of its employes. After careful inquiry, the Company decided that the correspondence instruction method would give all employes an equal opportunity, while its flexibility would meet any individual needs and circumstances. And finally WESTERN UNION arranged to loan the price of the Course to deserving employes who might be unable to meet even the moderate fee asked for training.

The actual conduct of courses and instruction was entrusted to the American School of Correspondence, Chicago, whose Educational Charter and 22 years' successful experience eminently fitted it to carry out WESTERN UNION'S plans to make special training possible to any of its 50,000 employes.

Don't Dodge Promotion

Whatever occupation you would prefer to follow you can't dodge the fact that you're dodging promotion — dodging the job ahead, with its guarantee of better pay — so long as you refuse to train yourself thoroughly for the work you want to do. The man or woman with training is bound to succeed—for trained workers are the scarcest commodity in industry. A glance at the "Help Wanted" columns of your daily paper — *a question put to your boss* — will quickly prove this. The American School can properly develop your natural ability —make you a thoroughly skilled worker. A small part of your spare time—some of the hours you now waste—invested in systematic study will soon fit you for the position, and pay, you want.

Make This Test

We will train you on a make-good basis—allow you to test out the practical value of any Course by covering the first ten textbooks without risking one cent. This means that if you're not satisfied with your progress — if you find you're not getting money-earning training from the course — we'll refund every cent you've paid us. Full satisfaction or your money back is the only basis on which we accept students. If the fairness of this offer appeals to you—as it has to thousands—check and mail the Coupon for Free Bulletin. You assume no obligation.

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THE ORACLE

(*Continued from page* 50)

all primary turns in use is 5,890. The secondary voltage is increased in proportion as the number of primary turns in circuit at any time are decreased. The secondary leg of the core should be well insulated with 10 layers of oiled linen before placing the pies in place.

NEUTRAL POINT OF D. C. DYNAMO AND A. C. MOTOR SPEED CHANGES.

(1002) R. G. LeTourneau, Stockton, Cal., asks the Oracle:

Q. 1. Several questions concerning the shifting of the neutral point on a D. C. generator and speed changes of induction motors.

A. 1. The neutral point on the commutator of the D. C. generator changes at least slightly with changes in speed of the armature as you mention, unless the machine has one of the following precautions taken in its design: The machine might have a very powerful field, which would cause a very even and rigid distribution of the flux at the pole tips; the machine might be provided with *interpoles*, such as provided on any one of the leading machines on the market at the present time, which tends to preserve an even distribution of the field flux, and thus to preserve a practically fixt neutral point, thus obviating the necessity for shifting the brushes, even on overloads of 50 per cent. Or again the machine might be provided with variable air gaps between the field pole tips and the armature, such as in the Stow design, where all of the field poles are geared together by means of worms and gear rods to a common handwheel on the top of the machine, which enables the field poles to be advanced toward or receded from the armature and the air-gap flux distribution varied.

You are correct in assuming that several different speeds can be obtained from an A. C. motor by changing the groupings of the field poles, i.e., by changing the number of poles, such as by causing the field to produce 4 poles, 6 poles, 8 poles, and so on. This system is adopted in some of the leading A. C. motors now on the market. You will find data on this subject by referring to books on A. C. machinery.

A. C. TEST FOR "SHORTED" ARMATURE COILS.

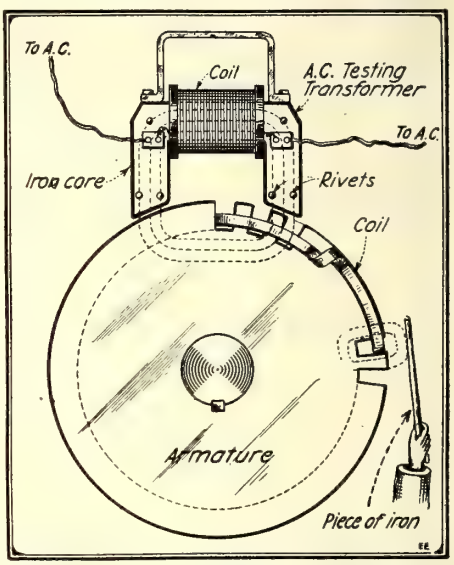
(1003) Earl E. Teater, Wheeling, West Va., writes the Oracle:

Q. 1. For data on a simple A. C. testing scheme for short-circuited armature coils.

A. 1. Herewith we describe an A. C. testing device for determining whether armature coils are short-circuited or not and which is used in repair shop work. The small transformer has a single winding on it, which is excited with alternating current suitably controlled by connecting it in series with a lamp bank or choke coil, etc. Using this transformer primary, as it may be called, and holding it in contact with the armature, in successive positions, as the armature is turned from coil to coil, there is set up thru the armature core a magnetic flux, which induces a current in the armature windings. If one of the coils happens to be short-circuited, as becomes apparent, this current will heat up the coil. Also by turning the armature a complete revolution and holding a small piece of iron against it, the coils being tested for short-circuits will be easily located, as the piece of iron held near the coil will vibrate, due to the resultant magnetic field set up by this coil and the current passing thru it. The transformer device should not be put in position nor removed while current is flowing thru the magnetizing coil of course.

To make this testing transformer, a laminated sheet iron core of the shape indicated in the diagram is built up, and it may be riveted at several points. It should have a width equal to the approximate length of the armature, and also a pole-face curvature as nearly like that of the armature core as possible. The winding on this transformer may, for a small size device to be used in testing out small magneto or auto lighting dynamo armatures, be composed of about 75 turns of No. 14 B. & S. insulated magnet wire.

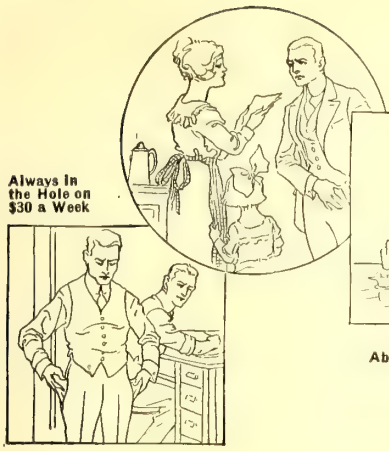
A very satisfactory and simple test for short-circuited as well as open-circuited armature coils can be carried out by connecting a buzzer across the brushes, and thus testing from bar to bar with a 75 ohm telephone receiver. If a coil is short-circuited or partially short-circuited, then no sound or a weak sound will be heard in the telephone receiver. It has been found that this test will give better and more accurate



Home-Made A.C. Tester for Short-Circuited Armature Coils. The Materials Required to Build It Are Available About Any Shop. Its Action Is Simple, Yet Positive.

results in a minimum of time, than is the case where the Wheatstone bridge is used. Open-circuited coils will manifest their presence when the proper bars are bridged by a very loud noise in the receiver. It is common practice in many shops to use this test in connection with the 110 volt, 60 cycle A. C. lighting current, the necessary current being past thru the armature in series with a 110 volt lamp.

If you have a good voltmeter on hand or posibly an ammeter without the shunt on it, you can also make tests quickly for open or short-circuited coils or grounds by the bar-to-bar test, passing direct current thru the brush points on the commutator. For this work the armature is usually mounted in a testing cradle, comprising a wooden frame and one upright which carries a pair of adjustable copper or other brushes which will transmit the testing current to diametrically opposite points on the commutator, for the two-pole armature, or four points ninety degrees apart for a four-pole armature. In any case where the telephone receiver and A. C. or buzzer method are used, or the voltmeter method, the criterion of the tests for a perfect armature is to obtain a similar or very closely similar degree of sound in the receiver for each coil, or an equivalent similarity in the voltmeter readings for every coil on the armature. If any appreciable difference is noted in the meter readings or in the telephone, then the connections of the commutator, and also the leads of the coils should be carefully examined. Sometimes a high reading will result from a poorly soldered lead connection to the commutator bar, which on a superficial examination may appear to be a first-class soldering job.













"At Dawn the Answer Flashed on Me!"

How a young man jumped from $30 a week to $50,000 a year. His remarkable success he attributes to the way he uses his will. "What I've done, I believe anyone can do," he says.

THERE are only a few $50,000 jobs—yet of all the men in the country it is difficult to find enough to fill the few big jobs available. There are plenty of men for the $25-a-week positions—but the thousand-dollar-a-week openings "go begging." How this young man trained himself for earnings of $50,000 a year is one of the most interesting chapters in the annals of even present-day fortune making. This is the story told me, almost word for word, by the young man *who did it.*

"Three short years ago I was $5,000 'in the hole'—and earning $30 a week. I had a wife and two children to support, and I used to worry myself sick about the future.

"Today—it seems like a dream—all my troubles are over. I am worth $200,000—enough to keep me and my family in comfort for the rest of our lives. I own two automobiles. My children go to private schools. I have just purchased, for cash, a $25,000 home. I go hunting, fishing, motoring, traveling, whenever I care to.

"LET me say in all sincerity that what I have done I believe any one can do. I am only an average man—not 'brilliant'—have never gone to college—my education is limited. I know at least a hundred men who know more than I, who are better educated and better informed—and their earnings probably average less than $50 weekly while my income is over $1,000 weekly. I mention this to show that earning capacity is not governed by the extent of a man's education—to encourage those who have not had the advantage of a comprehensive education.

"What, then, is the secret of my success? Let me tell you how it came about.

"One day, about three years ago, something happened that woke me up to what was wrong with me. It was necessary for me to make a decision on a matter which was of little consequence. I knew in my heart what was the right thing to do, but something held me back. I said one thing, then another; I decided one way, then another. I couldn't for the life of me make the decision I knew was right.

"I lay awake most of that night thinking about the matter—not because it was of any great importance in itself, but because I was beginning to discover *what was wrong with me.* Along towards dawn the answer flashed on me and I resolved to make an experiment. I decided to cultivate my will power, believing that if I did this I would not hesitate about making decisions—that when I had an idea I would have sufficient confidence in myself to 'put it over'—that I would not be afraid of myself or of things or of others. I felt that if I could smash my ideas across I would soon make my presence felt. I knew that heretofore I had always begged for success—had always stood, hat in hand, depending on others to give me the things I desired. In short, I was controlled by the will of others. Henceforth, I determined to have a strong will of my own—*to demand and command what I wanted.*

"WITH this new purpose in mind, I applied myself to finding out something more about will power, and in my investigation I encountered the works of Professor Frank Channing Haddock. To my amazement and delight, I discovered that this eminent scientist, whose name ranks with James, Bergson and Royce, had completed the most thorough and constructive study of will power ever made. I was astonished to read his statement, 'The will is just as susceptible of development as the muscles of the body!' My question was answered! Eagerly I read further—how Dr. Haddock had devoted twenty years to this study—how he had so completely mastered it that he was actually able to set down the very exercises by which anyone could develop the will, making it a bigger, stronger force each day, simply through an easy, progressive course of training.

"It is almost needless to say that I at once began to practice the exercises formulated by Dr. Haddock, and I need not recount the extraordinary results that I obtained almost from the first day. You already know the success that my developed power of will has made for me.

"People sometimes worry because they cannot *remember* or because they cannot *concentrate.* The truth is, will power will enable them to do *both.* The man who can use his will can not only concentrate and remember, but can *make use* of these two faculties. And I want to leave this one word with you—no knowledge, no plan, no idea is worth a penny unless it is used—and it cannot be used unless some one's power of will does it!"

PROF. Haddock's rules and exercises in will training have been placed in book form, and I have been authorized by the publishers to say that any reader who cares to examine his startling book on will power may do so without sending any money in advance. In other words, if after a week's reading you do not feel that "Power of Will" is worth $3, the sum asked, return it and you will owe nothing.

When you receive your copy for examination I suggest that you first read the articles on: The law of great thinking; How to develop analytical power; How to guard against errors in thought; How to drive from the mind unwholesome thoughts; How to develop fearlessness; How to use the mind in sickness; How to acquire a dominating personality.

It is interesting to note that among the 225,000 owners who have read, used and praised "Power of Will" are such prominent men as Judge Ben B. Lindsey; Supreme Court Justice Parker; Wu Ting Fang, ex-U. S. Chinese Ambassador; Gov. McKelvie of Nebraska; Assistant Postmaster-General Britt; General Manager Christeson, of Wells Fargo Express Co.; E. St. Elmo Lewis; Senator Arthur Capper, of Kansas, and thousands of others.

As a first step in will training, I would suggest immediate action in this matter before you. It is not even necessary to write a letter. Use the blank form below, if you prefer, addressing it to the Pelton Publishing Company, 30-J Wilcox Block, Meriden, Conn., and the book will come by return mail. This one act may mean the turning point of your life as it has meant to me and to so many others.

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Popular Astronomy

Astronomical Distances

(*Continued from page* 25)

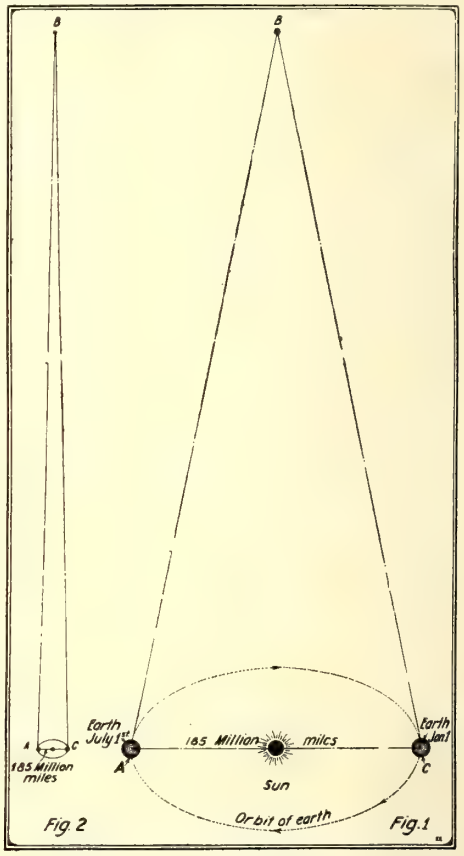
ured with considerable accuracy and is known to be four and a third light years. Tho there may be a few faint stars or non-luminous stars nearer to us than Alpha Centauri, and there is, in fact, one inconspicuous star known to be slightly nearer, the distinction of being the nearest of the brighter stars has long been held by Alpha Centauri. As our own sun continues his journey thru the universe the two stars (our sun is a star just like Alpha Centauri) will finally draw away from each other after many ages have past and some other sun of space will be our nearest star. The distances that separate the stars from each other probably average as great as the distance from the sun to Alpha Centauri. Within a sphere whose center is at the earth and whose radius is five parsecs, or about sixteen light years, there are only about twenty known stars. There is therefore small chance of collision among bodies that are so small in proportion to the tremendous intervals of space that separate them from each other. There is ample room for the individual stars to pursue their journeys thru space without interfering with each other's motion so long as they are as widely scattered as they appear to be in this portion of the universe. That our own sun has continued its journey thru the universe for some hundreds of millions of years without any catastrophe such as would result from closely approaching or colliding with another sun of space shows on how grand a scale our sidereal system is fashioned.

Stars that are ten, fifty or even one hundred light years from the earth are our near neighbors in space. They are the stars that show a slight displacement in the heavens or measurable parallax viewed from opposite sides of the earth's orbit. There are probably a thousand stars among the hundreds of millions of stars within reach of the greatest telescopes whose distances have been determined in light years by direct measurement of their displacement in the heavens resulting from the change of position of the earth in its orbit. The most distant of the stars are apparently immovable in the heavens showing neither the effect of the sun's motion or their own motion thru space. Methods for ascertaining the distances of many far remote stars and star-clusters have been devised, however, and some comparatively recent investigations have yielded determinations of the distances of these objects indicating that the diameter of the system of stars to which our sun belongs approximates to at least three hundred thousand light years. It is difficult to grasp the full significance of this fact. It means that hundreds of millions of the suns of space throng the visible universe at distances from us and from each other running into hundreds, thousands and even hundreds of thousands of light years. The light waves from some tiny object that we can just barely glimpse in one of our great reflectors may have started on their journey thru space over one hundred thousand years ago when men of the Old Stone Age inhabited our planet earth!

Astronomers have found as a result of their investigations that the sidereal system to which our solar system belongs is in the form of a flattened spheroid with its longest axis in the plane of the Milky Way. We have shown in a preceding article on the Milky Way how all the various units of our system, stars, nebulae and star clusters are distributed with reference to this plane, including our own sun. The extent of this star system composed of hundreds of millions of individual suns in addition to nebulae and clusters is, as we have said, at least three hundred thousand light years along its longest axis, while globular star clusters distributed above and below its central plane have been found to be at distances from it ranging from ten thousand to two hundred thousand light years. This entire organized system is our sidereal universe. Space beyond is unexplored. The globular star clusters are the most distant celestial objects so far discovered. The spiral nebulae may be entirely within the limits of this system or future determinations of the distances of the fainter spirals may extend the limits set by the globular clusters to include spirals found to be still more distant.

We can conceive the possibility that our sidereal universe, vast as it is known to be, may be but a unit in some still greater organization and that other similar systems lie beyond the reach of existing telescopes at unimaginable distances of a higher order.

The mind of man is overwhelmed by the thought of sidereal systems as vast as our own lying far beyond our ken. Whether or not such external systems do exist and are with our own sidereal system units in some still vaster creation we cannot know.



How Star Distances Are Measured by Means of Parallax.

We have attempted to grasp feebly the vast expanses of time and space that are to be found within our own sidereal system, but the finite mind of man cannot grasp the wonders of a creation in which our entire sidereal system may hold a position as subordinate as does our own planet in the sidereal universe to which our sun belongs.

The distances of stars are almost inconceivable to the human mind. They are computed by what is known as the parallax. In order to make this plain to the non-technical reader, Fig. 1 shows the method used. When the astronomer wishes to measure the distance of a distant star, he takes an exact observation of the star on January 1st when the earth is in position C. Then on July 1st he again observes the same star with very accurate instruments. Then he will have an angle A, B, C. The

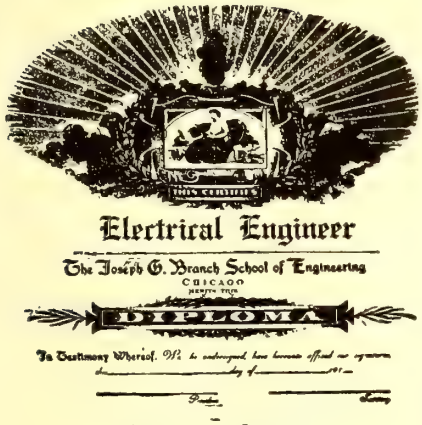
(*Continued on page* 56)

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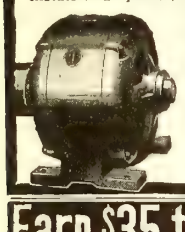
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ASTRONOMICAL DISTANCES.

(*Continued from page* 54)

distance from A to C being roughly 185,000,000 miles, and the angle being known, it is easy to figure the distance from B to A by means of trigonometry. But if the star B is at an immense distance such as is shown in Fig. 2, the angle A, B, C becomes very small. As some of the stars are billions upon billions of miles removed from the earth, it will be readily seen that there will come a point when the angle A, B, C ceases to exist. In other words, the distance A to C, altho 200,000,000 miles, will practically vanish—as it is so little—and the angle becomes so sharp that A, B, C is practically nothing but a straight line. As a matter of fact most of the stars which we see are so far removed from the earth that they have no appreciable parallax, and it is therefore impossible to know how many billion miles such a star is removed from the earth. As a matter of fact only a comparatively few stars exist that show an appreciable parallax, even with the extraordinary degree of perfection attained in measuring instruments. Such is the inconceivable magnitude of interstellar distances.

Distances from the sun to the planets and to the nearest star in terms of the astronomical unit (distance from earth to sun) and in millions of miles.

Table I.

	In Astronomical Units	In Million Miles
Mercury	0.39	36.0
Venus	0.72	67.2
Earth	1.00	92.9
Mars	1.52	141.5
Jupiter	5.20	483.3
Saturn	9.54	886.0
Uranus	19.19	1,781.9
Neptune	30.07	2,791.6
Alpha Centauri (nearest star)	273,000.00	26,000,000.0
Value of light year	63,000.00	6,000,000.0
Parsec	206,265.00	20,000,000.0

Table II.

Time required to travel from the earth to sun, moon, planets and nearest star by airplane, (at the rate of 200 miles per hour), and with velocity of light, (at rate of 186,324 miles per second).

To	By airplane	With velocity of light
Moon	7 weeks	1¼ seconds
Sun	52.99 years	7 min. 59 sec.
Venus	14.37 years	2 min. 18 sec.
Mercury	32.46 years	5 min. 6 sec.
Mars	27.72 years	4 min. 21 sec.
Jupiter	222.68 years	35 min. 15 sec.
Saturn	452.37 years	1 hour 11 min.
Uranus	963.38 years	2 hours 32 min.
Neptune	1,539.30 years	4 hours 2 min.
Alpha Centauri (nearest star)	14½ million years	4.35 years

Note: The above results were obtained by using the *mean* distances of the planets from the sun and the nearest approach of the planets to each other.

RELIEVING THE CAR CRUSH.

(*Continued from page* 15)

lide! The westerner wants to get off and the easterner wants to get on, naturally.

Now an old axiom says that one mass can't take the place of another mass without displacing that first mass. But tho we have learned in our physics class that water is not compressible, Subway passengers are compressible to the NTH degree.

Then after a homeric battle in which both sides display a titanic amount of muscular effort the "westerner" is finally ejected forcibly from the car and a half dozen "easterners," with the "gentle" help of the subway gladiator, are packed into the train, which proceeds on its way until the next station, where the same little game of forcible subtraction and addition is enacted all over again.

The cure? There are three doors on each New York subway car: Two on each end and one (about the same size as the front and end door combined) in the center. If the outgoing passengers could use, say, the end doors only and the incoming travelers the middle doors only, and if this rule would be strictly enforced, don't you think that this would help to make the Subway a better place to travel in?

And, besides, Kipling *would* be right. "East and West, they never shall meet!" Anyway, not so rudely!

ELECTRIC VIOLIN-VIRTUOSO A MARVEL.

(*Continued from page* 21)

is obtained by means of a third magnet which vibrates the tail piece thru the medium of the shaker bar.

To produce the wonderful orchestral effects achieved by the Violano-Virtuoso, as the instrument is called, it is necessary to use not one but *four* bows—one for each string.

These bows consist of numerous conical discs of specially prepared flexible celluloid, the edge of each disc acting as the hair of a bow. And it is possible for these revolving bows *to play simultaneously on all of the four strings.* These 4 bows are operated by bow magnets and are mounted on a bow shaft extending over the bridge. This, in connection with the fact that the instrument has sixty fingers against the *four* available to the human violinist, is the reason why this instrument can, with facility, render the most difficult concertos, etc.—the master-pieces of the world's musical literature—some of which it is manifestly impossible for any save the greatest human virtuosi to achieve.

The bows are automatically rosined. Suspended above the strings is the *rosin box* from which the strings automatically obtain the proper supply of rosin. This box is controlled by a governor and according as the speed of the motor raises or lowers—the greater the bow speed and the closer the box comes to the bows, which by their revolutions against the surface of its rosin, automatically obtain a greater or less supply as required.

Our illustration shows the electrically operated violin, as well as its accompanying player piano. Both instruments playing together, thus give rise to a very creditable musical performance.

ALL KINDS OF LIGHTNING.

(*Continued from page* 20)

denly took it into his head that he was going to take some superlative lightning photos on a certain summer day. In this particular instance, the thunder storm had not been behaving very nicely, according to the photographer's notions, but he thought he would take a chance any way. We might mention before going further, that the thunder storm did not come up in the usual way, and proceed to discharge veritable forked "Bolts of Thor," but satisfied itself with merely hanging around in the offing, and giving a perfect imitation of the best flash, or so-called "heat" lightning, you ever saw. What happened was this. The photographer waited until several of these flashes had occurred and the rain had begun to fall, when he thought the lightning discharges would sharpen up enough to photograph most beautifully. However, he miscalculated the extent and the frequency of the flash lightning, which in this particular case hung on for a long time, and accompanied each flash of forked lightning, which was rather slight in quantity, with the total result that after six 8x10 negatives had been exposed, and then rushed expectantly into the dark room and developed, they showed,—what do you suppose? Well, sir, those six plates turned out to be six of the finest snap-shots of the surrounding landscape and buildings that you ever laid eyes on. By actual comparison you could not tell them from a sunny mid-day snap-shot of the surrounding country taken with the same camera.

Thus the motto would seem to be, that to obtain good lightning photos, one should take advantage of a very dark overhanging storm which gives the greatest contrast of course, for the lightning flashes to appear against. At night would seem to be a most opportune time to photograph lightning discharges, but many excellent pictures have been obtained in the day time as well, under suitable conditions as just outlined.

ELECTRICITY



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I am teaching electricity and electrical drafting to many men, young and old, and trust you will become sufficiently interested after reading this advertisement, that you will send for my catalog which tells what I am endeavoring to do and also places before you the simple way in which the instruction work is handled. The catalog is written in a very plain manner, much in the same style as my lessons are written, and tells you exactly what you get and what the course can do for you. My catalog, as well as my advertisements, is written in a very careful, conservative manner so there is no possibility of you expecting something you will not get.

The Purpose of the Course of Study

I have been designing courses in electrical instruction and teaching electricity, off and on during the past 17 years, and during that time I have had an unusual opportunity to make a special study of the teaching business, from the standpoint of a practical man. This course of my own is designed with a view of reaching those who do not have a lot of time and money to devote to study work, and to give them as thorough a knowledge as possible of electricity, in the shortest possible time. The instruction is given like you were working on various jobs, giving the explanation necessary for the understanding of the theory covered by the subject under discussion. There are many conditions which seldom occur in the every day run of electrical experience, and these conditions I lay particular stress on. This part of the instruction makes the course particularly attractive and valuable to those already engaged in active electrical work.

It Is Up To You

The instruction work is laid out and given in a way easily understood. It is not a cut and dried book plan, but the lessons are prepared especially for the purpose for which they are used and additional instruction is given to the individual student, with a view of meeting his particular needs. I have the information to give and I believe the ability to impart it to others, a fact which is in a way proven by other institutions which have made use of my services in the design and perfecting of instruction courses. To understand this work, IT IS UP TO YOU to stick with me and I will surely stick with you till you understand any part of the work you have gone over.

Practical Men Take My Course and Recommend it to Others

Sixty percent of my students are actively engaged in electrical work and find the instruction I give well suited to their needs. Several of these men have had their fellow workers take the course also and they are taking the instruction together making a class-room proposition of it and the results are in every way satisfactory to all concerned. One of these classes was started by a Chief Electrician, one of my students in Glen White, W. Va., who now has practically all the men under him taking my course. I believe the fact that these men who understand electrical work approve of my course to this extent is one of the strongest endorsements I could get.

What Electrical Men Say Of My Course

In my catalog are letters from men I have taught, some being men I have taught when connected with other institutions years ago, and they are printed with a view of showing you that I have a clear, simple way of getting the information to one so it can be understood. I am printing here extracts from letters received recently from a few of my present students, from which you will note that they are in every way satisfied with the course and the method of handling the instruction.

This letter is from Stanley Dobson, of Moncton, New Brunswick. "I wish to say that I am well pleased with your method of teaching and I trust I will please you as well by my application to the lessons.

"Feeling that in your electrical course you offer a most practical system of training for anyone in the electrical work, I would refer you to a young man here in Moncton from whom you might secure an enrollment in your school. His name is Mr. Walter Stratton.

"I thought I would mention him to you as I have already recommended your school very highly."

This letter is from John Anderson, Farrall, Pennsylvania. "I am writing this so that you may know me better and know I am in earnest in taking this course. I am a foreman in this plant and all I have learned is through practice and that is the reason I want to learn more. The other day the Assistant Chief at this plant said to me that he had taken a course some time ago and I asked him about your course and he advised me to write to you. **This man worked under me sometime ago and now I am working under him and I do not want it to happen again."**

This letter is from Max Engleman, New York City. "Your first installment on the electrical course received and I went to work and liked the method of your instructions very well. You will find the answers to the examination questions attached to this letter. I am occupied as a waiter and would be only too glad to move into a real trade. Hoping to succeed and thanking you for your help, I am, yours very sincerely, Max Engleman."

This letter is from the same man two months later. "In the book review of the Electrical Experimenter, I saw a discription of the Burgess Blue Book, which I would like to possess and wish you would mail me a copy. **I have given up my position as waiter and am now employed as electrician** in the Ritz Carlton Hotel and so far like the work very much. With best regards, I am Yours very truly, Max Engleman."

Another letter from Mr. Engleman about a week later. "Your lessons together with your Blue Book received and I thank you very much, and I think it is like everything else that is connected with your name, really 'A No. 1.' My work in the hotel consists of work on motors, dumb waiters and elevators and from time to time I do repair work on small apparatus. Yours sincerely, Max Engleman."

The following is from J. L. Knight, Chief electrician of the coal mines at Glen White, West Virginia, who is taking my course together with a number of men who work under him. "I am just in receipt of your valued letter and am more than pleased with the suggestions and information therein and you can rest assured that I shall do all that is possible for the school and the boys and at the same time learn much myself. **Speaking of the lessons, I have never seen anything as interesting as they are,** and, as soon as I get a new lesson I get right after it and don't stop until I think I have mastered the subject. Our assistant general manager looked over our lessons last night and he did not hesitate in saying that **the lessons were the best that he had ever seen.** He is a college man with a number of years' experience in the engineering business and knows a good thing when he sees it and I feel sure that he will write you regarding your work within the next days. **We received the returns on the last lessons and all of us are more than pleased with the work that you are giving. I never saw a more enthusiastic bunch of men than they are over the lessons and everyone is buckled down to work and is going to try and make good.** For myself, I wish to say that I took a course some years ago in electric railways and lighting and that I have gotten more out of your lessons thus far, and I know that if I live until I complete this course, with the knowledge that I will get out of it connected with the 14 years of practical experience, I shall be able to hold any kind of a position. Your school has a good write-up in the County paper this week and I have seen that due credit was given Mr. Yorke Burgess. I will send you a copy of this as soon as it is out. All of the boys are better pleased every day with the lessons and there is nothing but compliments for the Burgess Electrical School in this little town of Glen White."

Fifty Fifty

I work absolutely on a 50-50 basis with my students. You pay me the comparatively low price I ask, and I give you the instruction and other help as is stated in my catalog. No student is permitted to pay cash for his entire course on starting, the course being paid for in small monthly payments as you go along. Students have the privilege of discontinuing the work if they should find that it was not just what they were after, and their payments stop at the same time. This is my way of doing business and I would not want your money when I was not giving you the instruction.

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Will Man Freeze the Earth to Death?

(*Continued from page* 8)

Rising prices and increasing scarcity surely will drive us to other fuels. Alcohol has been cited as a probability, mainly because it can be produced anywhere crops are grown. The truth of this matter is that if the fuel requirements of the world were to be supplied by the world's crops there would be no crops left to feed the world's inhabitants.

The final summation simply is that when coal and oil both give out we will have an era of substitutes beside which the war bread of the past year will be heavenly. We will scratch around, burn up all our forests, dig our peat bogs to the bottom, and do what we can to find other substances to supply the deficiency. All the substitutes will be costly, both from point of view of actual price and in point of efficiency. Those who cannot afford to use them will simply have to move toward the equator or freeze to death.

Radium is the one direct answer to the problem raised by this situation. True, it exists only in minute quantities in the earth's crust. True, under our present system of extraction it costs prohibitively. Still, it is the only logical answer.

Why? While radium is present only in proportions of from one to three grains per ton in the outer thirty miles of the earth's crust—excluding the oceans, of course, in which there is only a trace—there is sufficient of it in the upper two miles of crust to supply all possible power wants of man. The fact that it now costs us over a half-million dollars a pound to extract it is no argument. The scientific brains of the world never has been focust on the problem of securing radium. Only the inventive skill of a small number of people has been concerned with the processes of mining and extracting any kind of precious metal. With only a few dozen laboratories in the world knowing anything whatever about radium, the cost of securing the metal has been *cut in half in the last four years.* In the event that radium showed itself to be the only salvation for men outside of the equatorial zone, would not this cost be slaughtered? Would not radium be extracted by the ton instead of by the milligram? When it is considered that by the extraction of all the radium in a belt of land, ten miles wide by three miles deep, extending around the earth sufficient of the metal would be secured to run civilization just as it stands until eternity, without further outlay for power of any kind, does this seem impossible? It would be an undertaking for centuries, undoubtedly, but what of it? There would be little or no depreciation in the metal secured year by year, and every tiny particle mined and extracted would do away with the necessity for just so much other fuel. In case the project were started under Government or other competent supervision, the probability would be strong that the descending price curve of radium would cross the rising cost curve of other fuels in the course of from fifty to one hundred years.

The only alternative to this desperate plan that seems to be offered to our descendants is the piping of steam and hot air from the earth's interior. On a small scale this has been done already in Italy, but scientists have pointed out that serious disturbances, earthquakes, cracking of the crust and other disasters involving huge losses of human life would be certain to follow the experiment of trying this on a large scale. The trouble mainly would be caused by the sudden cooling of certain portions while the other parts remained in a molten state. The great catastrophe of a tremendous crack appearing in the middle of the Pacific Ocean, with the resultant clouds of live steam and poison gas covering the earth and killing all animal and vegetable life, would be the great debacle most to be dreaded. Taking all into consideration, radium seems like the best and safest possibility.

One strange possibility which has an equally queer parallel in the case of radium extraction on a large scale is the quick doom which would face the earth if men piped all their heat from the earth's interior. Providing millions of these vents for power uses on all continents would cool the iron center of the earth speedily.

Under the present scheme of things, Professor Maurier estimates that the earth will cool to the temperature of the moon (—110 degrees Centigrade) in twenty-eight million years. Human life as we know it will have been extinct, in all probability, for twelve or thirteen million years of this term, unless man finds some material in which to clothe himself thru which body heat cannot pass, and grows his crops in huge heat-insulated greenhouses.

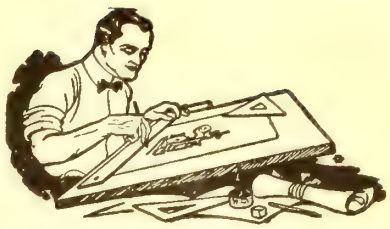
If the vents were opened, however, the heat of the earth's center would flood the atmosphere, even if used as economically as possible. It would rise to the outer edges of our air, coming into contact with the bleak (absolute zero) temperatures of the void, and cooling. Instead of the gradual change extending over millions of years, man would be confronted by a situation to which he probably could not adapt himself. The end of the world would come in ten thousand, yes, perhaps in five thousand years.

Even if the radium power system were inaugurated, something similar might take place, tho by no means as suddenly. Radium apparently was placed in the earth's crust for one particular purpose. That was to keep the earth from cooling off quickly.

We have seen that twenty pounds of radium would equal nine tons of anthracite in a year's time. The amount of radium in the thirty-mile crust of the earth, according to Professor Henri Becquerel of the French Academy, *is sufficient almost to equalize the daily loss of heat thru the atmosphere!* That means that if there were a little more radium in the earth this planet never would cool off at all! Also it means that if the earth were of the same consistency all the way thru, and not mostly molten iron or steel, the amount of radium being of the same proportion as at the surface, the globe would get hotter constantly. In the course of a few decades or centuries it would burst into flames and burn to a cinder.

The big point for us to grasp, however, lies in the fact that we are living now on earth solely because the crust contains radium. If this had not been the case the earth would have become cold and dead eons ago. If man, for any reason, becomes so grasping or in such dire necessity that he extracts all of the radium from the crust, he simply will be limiting his chances of a long stay very definitely.

This, however, is a remote possibility. The radium is scattered thru the whole crust to an average depth of *thirty miles.* Below this there is a highly heated tho solid zone in which there probably is a certain amount of radium. This zone extends *eighty miles* in depth, and below it is molten iron, the *core* of the earth. Man will have his hands full extracting the radium from the upper two or three miles of the crust. Since this will give him all he ever can need, unless the demands of future civilization grow much faster than any of our estimates figure, he would not touch the greater portion.



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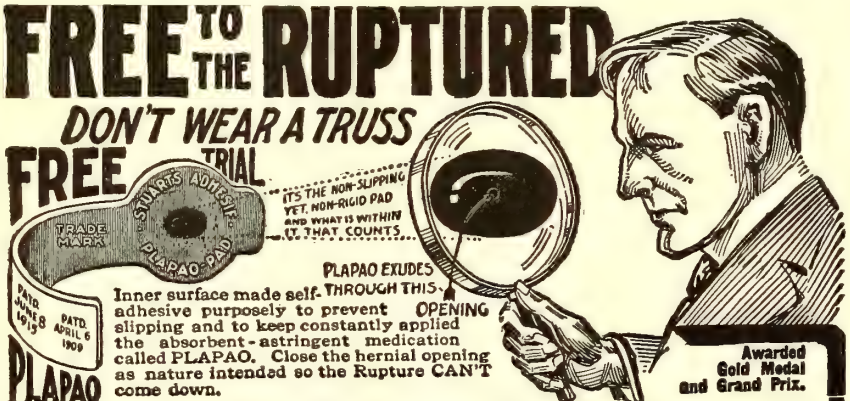
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New York Aëro Show

(*Continued from page* 19)

ily imagined for the visitor was shown a complete composite photographic map of the city of Washington, D. C., which was taken from an airplane in a trip lasting but two hours and fourteen minutes. Hundreds of photos are taken by the rapid-fire cameras, and after developing and printing these have to be evenly matched and assembled. Large photographs taken about New York along the river, showing the ferry boats, etc., were taken during the afternoons of the different days, and the plates would be rushed to the aëro show, there developed and finished and prints made by the Army's photographic experts, the mounted photographs being on exhibit at the show in from one hour to an hour and one-half after they had been taken by the aviator flying above the city.

The machine gun exhibit attracted much attention, particularly the means used for synchronizing two machine guns on the battle-planes, so that they both fired dead ahead and thru the revolving propeller, the bullets passing accurately thru the spaces between the blades every time these spaces came in line with the machine gun barrels. The Packard Automobile Company, makers of the well-known Packard motor car, exhibited a new pleasure and battle-plane fitted with the Packard 12-cylinder aircraft engine, which somewhat resembles the Liberty motor. The Liberty motor, which was on exhibit, attracted considerable attention, and the number of these motors built by each of the large automobile concerns during the war were shown. There was a large sea-plane on exhibit which had flown to the show.

Speed enthusiasts in the flying world had their attention riveted on what was purported to be the fastest airplane in the world, the "Christmas Bullet," a small model of which was exhibited at the Aero Show. It was very well built, and the most remarkable feature of the design of the "Bullet" is that there are no struts between the planes, and also there are no guy wires, as in the usual types of monoplanes. The wings are supported by the cantilever principle, and besides they are *flexible*. The "Christmas Bullet" bi-plane is guaranteed to make 200 miles an hour, and it attained a speed of over 185 miles per hour on a recent trial flight, when equipt with a six-cylinder 185 H.P. Liberty motor. It is claimed by its builders to be the safest and fastest airplane in the world. Not only this, but its lifting capacity compared to its size is greater than that of any other 'plane, it is stated. As will be evident, this ingenious design of 'plane is constructed on the principle of true bird flight, which therefore makes it self-balancing and serviceable in any kind of weather. The wing surface is 170 square feet, and the total weight is 2,100 pounds, which includes fuel for three hours.

This airplane is intended to play the rôle of the first "taxi-plane" ever used in steamship service, and is to be operated at the port of New York by one of the leading steamship companies for overtaking a ship a day out at sea with sacks of belated mail, dispatches, etc.

Among the interesting airplane engines exhibited at the Show was the well-known "Dusenberg." This Company exhibited a powerful new model 12-cylinder aircraft engine, in which each set of six cylinders operated a separate crank shaft of its own. The power from the individual crank shafts was then transmitted to the propeller shaft by means of two gears, one on each side of the main driving gear secured to the propeller shaft.

The True Wireless

By Nikola Tesla

(*Continued from page* 30)

trates an arrangement described in my U. S. Patent No. 568178 of September 22, 1896, and corresponding dispositions of wireless apparatus. The captions of the individual diagrams are thought sufficiently explicit to dispense with further comment. I will merely remark that in this early record, in addition to indicating how any number of resonant circuits may be linked and regulated, I have shown the advantage of the proper timing of primary impulses and use of harmonics. In a farcical wireless suit in London, some engineers, reckless of their reputation, have claimed that my circuits were not at all attuned; in fact they asserted that I had looked upon resonance as a sort of wild and untamable beast!

It will be of interest to compare my system as first described in a Belgian patent of 1897 with the Hertz-wave system of that period. The significant differences between them will be observed at a glance. The first enables us to transmit economically energy to any distance and is of inestimable value; the latter is capable of a radius of only a few miles and is worthless. In the first there are no spark-gaps and the actions are enormously magnified by resonance. In both transmitter and receiver the currents are transformed and rendered more effective and suitable for the operation of any desired device. Properly constructed, my system is safe against static and other interference and the amount of energy which may be transmitted is *billions of times greater* than with the Hertzian which has none of these virtues, has never been used successfully and of which no trace can be found at present.

A well-advertised expert gave out a statement in 1899 that my apparatus did not work and that it would take 200 years before a message would be flashed across the Atlantic and he even accepted stolidly my congratulations on a supposed great feat. But subsequent examination of the records showed that my devices were secretly used all the time and ever since I learned of this I have treated these Borgia-Medici methods with the contempt in which they are held by all fair-minded men. The wholesale appropriation of my inventions was, however, not always without a diverting side. As an example to the point I may mention my oscillation transformer operating with an air gap. This was in turn replaced by a carbon arc, quenched gap, an atmosphere of hydrogen, argon or helium, by a mechanical break with oppositely rotating members, a mercury interrupter or some kind of a vacuum bulb and by such *tours de force* as many new "systems" have been produced. I refer to this of course, without the slightest ill-feeling, let us advance by all means. But I cannot help thinking how much better it would have been if the ingenious men, who have originated these "systems," had invented something of their own instead of depending on me altogether.

Before 1900 two most valuable improvements were made. One of these was my individualized system with transmitters emitting a wave-complex and receivers comprising separate tuned elements coöperatively associated. The underlying principle can be explained in a few words. Suppose that there are n simple vibrations suitable for use in wireless transmission, the probability that any one tune will be struck by an extraneous disturbance is $\frac{1}{n}$. There will then remain $n-1$ vibrations and the chance that one of these will be excited is $\frac{1}{n-1}$, hence the probability that two tunes would

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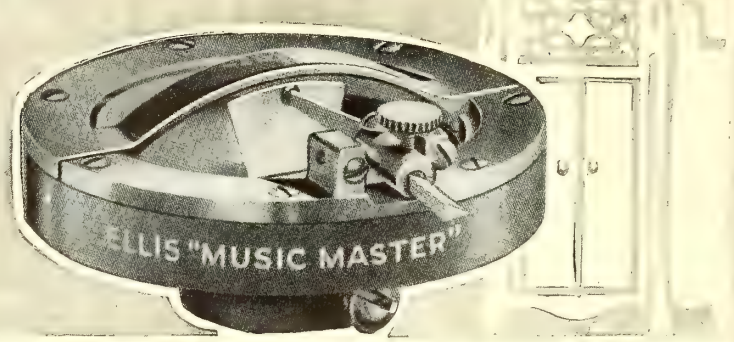
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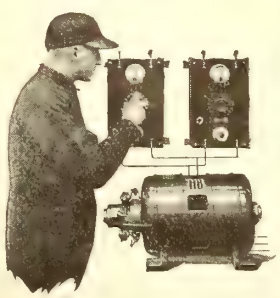
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be struck at the same time is $\frac{1}{n\,(n-1)}$. Similarly, for a combination of three the chance will be $\frac{1}{n\,(n-1)\,(n-2)}$ and so on. It will be readily seen that in this manner any desired degree of safety against the statics or other kind of disturbance can be attained provided the receiving apparatus is so designed that its operation is possible only thru the joint action of **all** the tuned elements. This was a difficult problem which I have successfully solved so that now *any desired number of simultaneous messages is practicable in the transmission thru the earth as well as thru artificial conductors.*

The other invention, of still greater importance, is a peculiar oscillator enabling the transmission of energy without wires in any quantity that may ever be required for industrial use, to any distance, and with very high economy. It was the outcome of years of systematic study and investigation and wonders will be achieved by its means.

The prevailing misconception of the mechanism involved in the wireless transmission has been responsible for various unwarranted announcements which have misled the public and worked harm. By keeping steadily in mind that the transmission thru the earth is in every respect identical to that thru a straight wire, one will gain a clear understanding of the phenomena and will be able to judge correctly the merits of a new scheme. Without wishing to detract from the value of any plan that has been put forward I may say that they are devoid of novelty. So for instance in Fig. 12 arrangements of transmitting and receiving circuits are illustrated, which I have described in my U. S. Patent No. 613809 of November 8, 1898 on a Method of and Apparatus for Controlling Mechanism of Moving Vessels or Vehicles, and which have been recently dished up as original discoveries. In other patents and technical publications I have suggested conductors in the ground as one of the obvious modifications indicated in Fig. 5.

For the same reason the statics are still the bane of the wireless. There is about as much virtue in the remedies recently proposed as in hair restorers. *A small and compact apparatus has been produced which does away entirely with this trouble,* at least in plants suitably remodelled.

Nothing is more important in the present phase of development of the wireless art than to dispose of the dominating erroneous ideas. With this object I shall advance a few arguments based on my own observations *which prove that Hertz waves have little to do with the results obtained even at small distances.*

In Fig. 13 a transmitter is shown radiating space waves of considerable frequency. It is generally believed that these waves pass along the earth's surface and thus affect the receivers. I can hardly think of anything more improbable than this "gliding wave" theory and the conception of the "guided wireless" which are contrary to all laws of action and reaction. Why should these disturbances cling to a conductor where they are counteracted by induced currents, when they can propagate in all other directions unimpeded? The fact is that the radiations of the transmitter passing along the earth's surface are soon extinguished, the height of the inactive zone indicated in the diagram, being some function of the wave length, the bulk of the waves traversing freely the atmosphere. Terrestrial phenomena which I have noted conclusively show that there is no *Heaviside layer,* or if it exists, it is of no effect. It certainly would be unfortunate if the human race were thus imprisoned and forever without power to reach out into the depths of space.

The actions at a distance cannot be proportionate to the height of the antenna and the current in the same. I shall endeavor to make this clear by reference to diagram in Fig. 14. The elevated terminal charged to a high potential induces an equal and opposite charge in the earth and there are thus Q lines giving an average current $I = 4Qn$ which circulates locally and is useless except that it adds to the momentum. A relatively small number of lines q however, go off to great distance and to these corresponds a mean current of $ie = qn$ to *which is due the action at a distance.* The total average current in the antenna is thus $Im = 4Qn + 4qn$ and its intensity is no criterion for the performance. The electric efficiency of the antenna is $\frac{q}{Q+q}$ and this is often a very small fraction.

Dr. L. W. Austin and Mr. J. L. Hogan have made quantitative measurements which are valuable, but far from supporting the Hertz wave theory they are evidences in disproval of the same, as will be easily perceived by taking the above facts into consideration. Dr. Austin's researches are especially useful and instructive and I regret that I cannot agree with him on this subject. I do not think that if his receiver was affected by Hertz waves he could ever establish such relations as he has found, but he would be likely to reach these results if the Hertz waves were in a large part eliminated. At great distance the space waves and the current waves are of equal energy, the former being merely an accompanying manifestation of the latter in accordance with the fundamental teachings of Maxwell.

It occurs to me here to ask the question—why have the Hertz waves been reduced from the original frequencies to those I have advocated for my system, when in so doing the activity of the transmitting apparatus has been reduced a billion fold? I can invite any expert to perform an experiment such as is illustrated in Fig. 15, which shows the classical Hertz oscillator and my grounded transmitting circuit. It is a fact which I have demonstrated that, altho we may have in the Hertz oscillator an activity thousands of times greater, the effect on the receiver is not to be compared to that of the grounded circuit. This shows that *in the transmission from an airplane we are merely working thru a condenser,* the capacity of which is a function of a logarithmic ratio between the length of the conductor and the distance from the ground. The receiver is affected in exactly the same manner as from an ordinary transmitter, the only difference being that there is a certain modification of the action which can be predetermined from the electrical constants. It is not at all difficult to maintain communication between an airplane and a station on the ground, on the contrary, the feat is very easy.

To mention another experiment in support of my view, I may refer to Fig. 16 in which two grounded circuits are shown excited by oscillations of the Hertzian order. It will be found that the antennas can be put out of parallelism without noticeable change in the action on the receiver, this proving that it is due to currents propagated thru the ground and not to space waves.

Particularly significant are the results obtained in cases illustrated in Figures 17 and 18. In the former an obstacle is shown in the path of the waves but unless the receiver is within the effective *electrostatic* influence of the mountain range, the signals are not appreciably weakened by the presence of the latter, because the currents pass under it and excite the circuit in the same way as if it were attached to an energized wire. If, as in Fig. 18, a second range happens to be beyond the receiver, it could only strengthen the Hertz wave effect by reflection, but as a matter of fact it detracts

(*Continued on page 87*)



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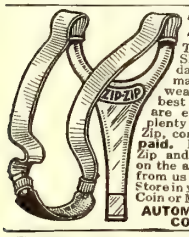
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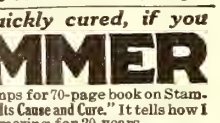
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My Inventions

(*Continued from page 17*)

lamp there. It was the exact spot which I had originally chosen.

So it went day after day with variations, but I was determined to achieve at whatever cost and in the end my efforts were rewarded. By the spring of 1884 all the differences were adjusted, the plant formally accepted, and I returned to Paris with pleasing anticipations. One of the administrators had promised me a liberal compensation in case I succeeded, as well as a fair consideration of the improvements I had made in their dynamos and I hoped to realize a substantial sum. There were three administrators whom I shall designate as A, B and C for convenience. When I called on A *he* told me that B had the say. This gentleman thought that only C could decide and the latter was quite sure that A alone had the power to act. After several laps of this *circulus viciosus,* it dawned upon me that my reward was a castle in Spain. The utter failure of my attempts to raise capital for development was another disappointment and when Mr. Batchellor prest me to go to America with a view of redesigning the Edison machines, I determined to try my fortunes in the Land of Golden Promise. But the chance was nearly mist. I liquefied my modest assets, secured accommodations and found myself at the railroad station as the train was pulling out. At that moment I discovered that my money and tickets were gone. What to do was the question. Hercules had plenty of time to deliberate but I had to decide while running alongside the train with opposite feelings surging in my brain like condenser oscillations. Resolve, helped by dexterity, won out in the nick of time and upon passing thru the usual experiences, as trivial as unpleasant, I managed to embark for New York with the remnants of my belongings, some poems and articles I had written, and a package of calculations relating to solutions of an unsolvable integral and to my flying machine. During the voyage I sat most of the time at the stern of the ship watching for an opportunity to save somebody from a watery grave, without the slightest thought of danger. Later when I had absorbed some of the practical American sense I shivered at the recollection and marvelled at my former folly.

Tesla in America

I wish that I could put in words my first impressions of this country In the Arabian Tales I read how genii transported people into a land of dreams to live thru delightful adventures. My case was just the reverse. The genii had carried me from a world of dreams into one of realities. What I had left was beautiful, artistic and fascinating in every way; what I saw here was machined, rough and unattractive. A burly policeman was twirling his stick which looked to me as big as a log. I approached him politely with the request to direct me. "Six blocks down, then to the left," he said, with murder in his eyes. "Is this America?" I asked myself in painful surprise. "It is a century behind Europe in civilization." When I went abroad in 1889—five years having elapsed since my arrival here—I became convinced that *it was more than one hundred years AHEAD of Europe* and nothing has happened to this day to change my opinion.

Tesla Meets Edison

The meeting with Edison was a memorable event in my life. I was amazed at this wonderful man who, without early advantages and scientific training, had accomplished so much. I had studied a dozen languages, delved in literature and art, and had spent my best years in libraries reading all sorts of stuff that fell into my hands, from Newton's *"Principia"* to the novels of Paul de Kock, and felt that most of my life had been squandered. But it did not take long before I recognized that it was the best thing I could have done. Within a few weeks I had won Edison's confidence and it came about in this way.

The S. S. *Oregon,* the fastest passenger steamer at that time, had both of its lighting machines disabled and its sailing was delayed. As the superstructure had been built after their installation it was impossible to remove them from the hold. The predicament was a serious one and Edison was much annoyed. In the evening I took the necessary instruments with me and went aboard the vessel where I stayed for the night. The dynamos were in bad condition, having several short-circuits and breaks, but with the assistance of the crew I succeeded in putting them in good shape. At five o'clock in the morning, when passing along Fifth Avenue on my way to the shop, I met Edison with Batchellor and a few others as they were returning home to retire. "Here is our Parisian running around at night," he said. When I told him that I was coming from the *Oregon* and had repaired both machines, he looked at me in silence and walked away without another word. But when he had gone some distance I heard him remark: "Batchellor, this is a d—n good man," and from that time on I had full freedom in directing the work. For nearly a year my regular hours were from 10.30 A. M. until 5 o'clock the next

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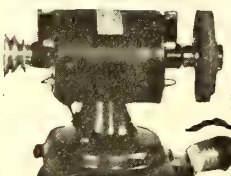
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morning without a day's exception. Edison said to me: "I have had many hard-working assistants but you take the cake." During this period I designed twenty-four different types of standard machines with short cores and of uniform pattern which replaced the old ones. The Manager had promised me fifty thousand dollars on the completion of this task but it turned out to be a practical joke. This gave me a painful shock and I resigned my position.

Immediately thereafter some people approached me with the proposal of forming an arc light company under my name, to which I agreed. Here finally was an opportunity to develop the motor, but when I broached the subject to my new associates they said: "No, we want the arc lamp. We don't care for this alternating current of yours." In 1886 my system of arc lighting was perfected and adopted for factory and municipal lighting, and I was free, but with no other possession than a beautifully engraved certificate of stock of hypothetical value. Then followed a period of struggle in the new medium for which I was not fitted, but the reward came in the end and in April, 1887, the Tesla Electric Company was organized, providing a laboratory and facilities. The motors I built there were exactly as I had imagined them. I made no attempt to improve the design, but merely reproduced the pictures as they appeared to my vision and the operation was always as I expected.

In the early part of 1888 an arrangement was made with the Westinghouse Company for the manufacture of the motors on a large scale. But great difficulties had still to be overcome. My system was based on the use of low frequency currents and the Westinghouse experts had adopted 133 cycles with the object of securing advantages in the transformation. They did not want to depart from their standard forms of apparatus and my efforts had to be concentrated upon adapting the motor to these conditions. Another necessity was to produce a motor capable of running efficiently at this frequency on two wires which was not easy of accomplishment.

At the close of 1889, however, my services in Pittsburg being no longer essential, I returned to New York and resumed experimental work in a laboratory on Grand Street, where I began immediately the design of high frequency machines. The problems of construction in this unexplored field were novel and quite peculiar and I encountered many difficulties. I rejected the inductor type, fearing that it might not yield perfect sine waves which were so important to resonant action. Had it not been for this I could have saved myself a great deal of labor. Another discouraging feature of the high frequency alternator seemed to be the inconstancy of speed which threatened to impose serious limitations to its use. I had already noted in my demonstrations before the American Institution of Electrical Engineers that several times the tune was lost, necessitating readjustment, and did not yet foresee, what I discovered long afterwards, a means of operating a machine of this kind at a speed constant to such a degree as not to vary more than a small fraction of one revolution between the extremes of load.

The Invention of the Tesla Coil

From many other considerations it appeared desirable to invent a simpler device for the production of electric oscillations. In 1856 Lord Kelvin had exposed the theory of the condenser discharge, but no practical application of that important knowledge was made. I saw the possibilities and undertook the development of induction apparatus on this principle. My progress was so rapid as to enable me to exhibit at my lecture in 1891 a coil giving sparks of *five inches*. On that occasion I frankly told the

(*Continued on page* 89)

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She Thinks You Are a Man

She trusts, admires and loves what she THINKS you are—a real MAN, mentally, morally and physically, whom she can *respect* as well as love. She believes you to be a man who can look any other man in the eye and hold your own with him; who is able to protect her under any circumstances; who can make his way in the world and give her the comforts she has a right to expect from her husband; and finally who will ultimately make her the mother of healthy, happy children, a blessing to you both. Think of the kind of children you will make her the mother of if you are one of the great UNFIT! Think of the weak, ailing, rickety, defective boys and girls such men bring into the world—pitiable little creatures, with no chance in life, living reproaches to the father who begot them. Don't close your eyes to these things. They are *facts;* facts thoroughly understood by every breeder of dogs, cattle and horses; facts recognized by the legislators of several states, who would make it a LEGAL, as well as a MORAL, crime to marry when unfit.

Make Yourself 100 Per Cent Fit

Put your past behind you. What if you have led a gay life and sowed a big crop of wild oats? Start NOW to root them out. What if you have burned the candle at both ends and feel now like a human wreck, with your strength of body and mind dissipated and your vitality ebbing away? All the more reason why you should begin *now, TODAY*, to stop that steady loss, build up your strength again, regain your lost vitality and make a manly, red-blooded man of yourself. It's the ONLY thing to do—the only way to have any more happiness in life—the only way to keep from slipping down into the scrap heap of the hopelessly down-and-out—*and you can do it, if you go about it the right way.*

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Don't Be Discouraged

Never mind how low down you have fallen; I don't care a rap what your present condition is or what brought you to it—*I know I can improve you* 100 per cent in a few short months. I am doing it every day for men who had given up all hope; bringing back their health and strength; making them respected members of society again; filling them with life, and ambition, pep and ginger, and enabling them to make a success in the world. I can do for *you* what I have done and am doing for others, and I WILL DO IT, if you will mark NOW, on the coupon below the trouble or troubles that are affecting you, or the points you are most interested in, and MAIL IT TO ME TODAY. My free book, **"Promotion and Conservation of Health, Strength and Mental Energy,"** will show you the quick, easy, sensible, *manly* way out of your difficulties; the way that has brought renewed hope and confidence and joy of living to thousands of other men; it will show you how to make yourself FIT to live; FIT to marry; or, if you are married already, it will help you become the father of healthy, happy, laughing children who will be a joy to you and your wife as long as you live. YOU WANT THAT BOOK.

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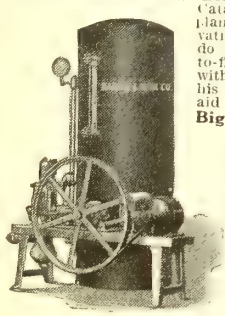
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FUTURE RAPID TRANSIT

(*Continued from page 7*)

an airplane and provided with planes or wings. This provision of planes on either side of the car renders it possible to modify their angle of incidence, to relieve the supporting rail of a larger part of the weight of the vehicle.

The aërial monoflier, as our artist has here depicted, may be propelled by means of one or more propellers placed either at one end of the car or at both ends, and in any case these could be electrically driven, the current necessary for operating the electric motors being taken thru appropriate contact shoes or brushes, resting in contact with insulated conducting rails fixt to the frame-work upon which the monorail is supported. The end view of the monoflier shows clearly the arrangement of the two third rails, one on either side of the monorail, constructed so that they may also serve to insure the maintenance of the car in the proper vertical position, by preventing any lateral displacement thereof. For the purpose of maintaining the car in the proper vertical position by virtue of the third rails just mentioned, there are provided two series of wheels inside the car, as the end view indicates, one set on either side of the monorail structure. From one end of the car to the other, the slot, as it might be called, slightly expands so that the car can negotiate curved sections of rails, which it could not do if the slot running thru the car from front to rear were made perfectly straight. The car is provided with electric lights and the usual protective features, such as electric braking means, electric fans in warm weather, signal lights, etc. The motorman, whose cab is placed in the forward part of the car, has full control of the electric propeller motors, and he can also change the angle of the planes, on either side of the monoflier, so as to cause it to practically float in the air when it is under full headway, the monorail passing thru its center merely acting as a guide rail along which it flies. Electric heaters could be used in the cold weather, and for heating coffee and cooking light meals, etc., in the buffet lunch on board, electric stoves would be available.

In general the monoflier is ovoid in form, thus following the latest practise in the design of dirigible airships, so that it will encounter the minimum of resistance from the air during its displacement. Such a craft should be easily able to attain a speed of 175 to 200 miles an hour and higher, as when it has attained its highest velocity and the planes are properly elevated, the craft will be practically *floating in the air*, without encountering any retarding friction from engagement with the monorail, excepting when passing around curves. Even here the friction which would normally be encountered might be reduced considerably if not entirely obviated by the provision of a proper air rudder at the rear of the car. When the car had reached the end of its run, owing to its peculiar ovoid shape, etc., it would have to be reversed in position before starting back, or else sent back to its destination by a parallel monorail system, which would undoubtedly be the usual practise, much in the manner shown in the accompanying view. Undoubtedly in the years to come, when such highly congested localities as New York City have become more and more built up with towering office structures, with a daily working population of say 12,000,000 to 15,000,000 people, and the subways and street elevated lines have become crowded to the limit of endurance, then it seems that such a system as this should serve a very useful purpose indeed.

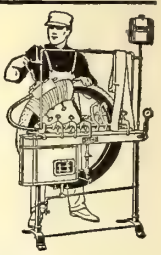
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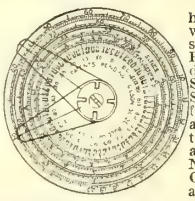
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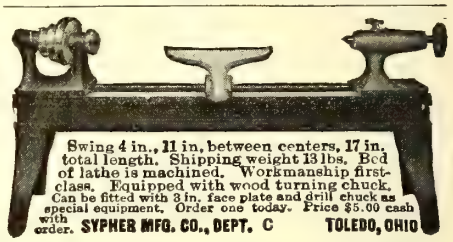


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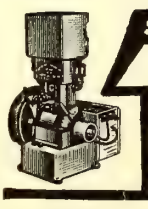


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high speed traveling facilities for suburbanites, who have to travel ten to twelve miles every night and morning to and from business, such as those who live in the rapidly developing Westchester County section, where undoubtedly many hundred thousand of New York's future populance will reside, as well as those who will make their homes on Long Island.

As the illustration shows, the monoflier is divided into several floors, and if desired, each floor may be subdivided into compartments. The lower floor is preferably reserved for luggage, freight and mail, while the upper floor may be very well utilized for the electric motors operating the propellers and lifting planes. Stairways lead from the lower floors to the upper floor or floors, depending upon the size of the car. The main frame-work of the car is composed of rolled steel sections, and the rest of the structure including the floors and outer covering is of aluminum, the seams being electrically welded so as to present a perfectly smooth surface on the entire exterior in order to minimize the resistance to the air. The windows, which afford an excellent view to the passengers as they skim along over the tops of the skyscrapers far above the city and the surrounding country, are fitted with the new unbreakable glass. Also the outer contour of the windows and doors are made so as to fit very tightly and to preserve an even surface both vertically and horizontally for the purposes aforementioned.

Some other novel features involved in the design of this aërial monoflier, which seem to possess great practicability are as follows: The inventor points out that in order to impart greater stability to the car, its longitudinal axis should preferably be located below the top of the monorail. In other words, the greater part of the weight should be distributed on a line below the monorail level, which line is at a point about one-third the height of the car from the top of the same. The large wheels in the interior slot of the car, which rest on the upper or monorail, are heavily flanged. In order to provide against the possibility of the vehicle leaving the track vertically under the influence of the air pressure beneath its wings, the lower portion of the third rail rollers may be given a circular flange, which in the case under consideration would bear against the lower flange of these rails, and thus serve to maintain the car in contact with the rails. The car could be made longer as desired, but, of course, it could not be made too long, or otherwise it would be impossible to turn curves, unless they had very long radii.

Most probably the reader has become interested in the general working principles of such an aërial monoflier system, particularly in the probable arrangement of the stations, which could be of several types, as our illustration herewith shows. Some of the stations could be erected on the roofs of tall buildings where these were of appropriate height for the purpose, and in some cases where the railway past directly thru the tower of the skyscraper, the station could be built in the "hole in the wall", as it might be called. Each station could be designed in several ways—for instance, it might in some cases be provided with one platform, and the passengers on the monoflier in this case would have to descend from the upper to the lower floors by means of the stairways provided in the car, before reaching the station. The station platforms could be enclosed and provided with sliding doors, so as to be draft-proof in the cold weather, and high speed express elevators would carry the passengers from the aërial railway station to the street, or by taking a local elevator, they could alight on any floor of the building—all of which seems very good from a strictly engineer point of view.



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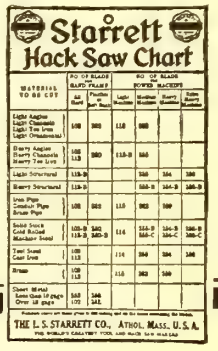
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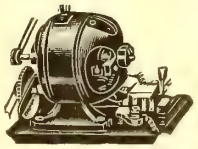
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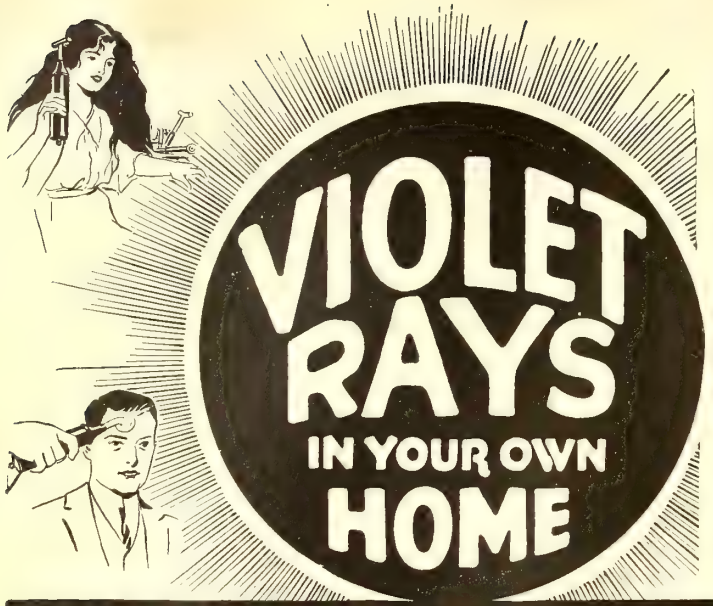
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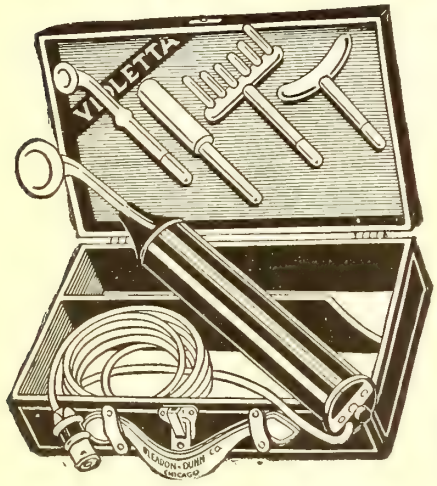
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Dr. Bert H. Rice, of Vinton, Iowa, says: "I have good results with the Violetta High Frequency Instrument in all cases of neuralgia. Almost instant relief in Facial Neuralgia."

K. L. Allen, D. C., 205 Boone National Building, Boone, Iowa, says: I have had very good results with the application of High Frequency Current in cases of Paralysis, Rheumatism and Neuritis and think it a great help in drugless healing."

Dr. Daniels, Lisbon, North Dakota, says: "Have used the VIOLETTA in such cases as Goitre, Bronchitis, Pleurisy, Neuritis, Neuralgia, and Lumbago, and find it very beneficial. In fact, I would not be without it in my office."

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LOCATING ENEMY GUNS BY FLASH AND SOUND

(*Continued from page* 14)

As the name suggests, "sound ranging" is based for its operation on the transmission of sound, either thru the air or thru the earth, whenever a gun is fired. Some of this work is performed in conjunction with the flash spotters, for by observing the flash of a distant gun, and then counting the seconds on a split-second watch until the sound is heard, the distance at which the gun is located may be accurately computed, as the velocity of sound thru air is about 1,100 feet a second. The velocity of light is practically instantaneous, or 186,000 miles per second, and secondly it serves very accurately to consider the flash of the gun as the starting point of the onward journey of the sound wave. The accurate locating of any gun is accomplished by having two observers take telescopic or other sightings on the gun, and noting the distance between the two observers and the angles as measured on their respective instruments. Thus it is a simple matter to solve accurately by triangulation the definite location of the enemy cannon.

This is only one side of "sound ranging" science, however, as applied to modern artillery tactics, and the scientists and engineers connected with the work of the artillery, particularly the locating of enemy gun positions, early in the war worked out a highly sensitive sound detecting apparatus which picked up the sound of enemy guns, even at a great distance, as transmitted thru the earth. For this purpose detectaphones and Audion amplifiers prove highly efficacious. Enemy guns 15 miles distant were accurately located by this means, the same triangulation maneuvers as previously outlined being followed. Two and usually three observation (sound-detecting) points being employed, advantage being taken of the values as given by the velocity of sound when transmitted thru the earth, and also by the difference of time at which these sounds arrive at different sound-detecting stations. Used in conjunction with the regular angular measurements, the locating of enemy guns became as simple to General Pershing's artillerymen as weighing out a pound of butter would be to a groceryman.

EXPERIMENTS IN RADIO-ACTIVITY.

Part III.

(*Continued from page* 35)

radio-activity noticed that radium induced an activity into substances placed in its vicinity. This induced activity was found to consist of an active deposit formed by the disintegrating radium. In the spinthariscope the lens portion was found to assume this induced activity because of its proximity to the active substance. This may be easily shown by use of the electroscope, described in the first article. Using the spinthariscope in the possession of the author, the following results were obtained:—empty, the electroscope discharged in 700 seconds; the lens portion was then removed and introduced into the electroscope. This time it only required 320 seconds. This conclusively shows that radium induces an activity into other objects exposed to its radiations. This induced activity, however, soon decays. Other uses for the spinthariscope will suggest themselves to the reader, but in any case he will certainly never regret purchasing or else making one.



Radiograph Taken by the Author, Using An E. I. Co. Spinthariscope with Lens Removed. The Figure "U" Was Cut from Brass Sheet.

(*To be continued*)

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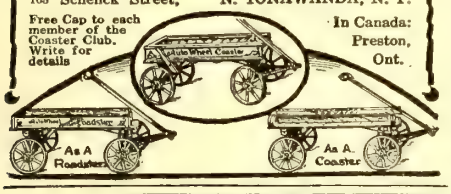
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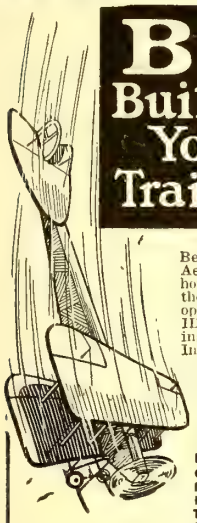
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SCIENCE IN SLANG
THE SPECKS IN SPACE

(*Continued from page 45*)

last is one octillion, five hundred seventy-five septillion. The weight of the Sun is two octillion."

"Then the Sun weighs twenty-three decillion, forty nonillion grains," put in Punk.

"Approximately," returned Stokes, with his quaint smile.

"Do you think that the lines of—er, force, or electricity, that are radiated from the Sun act upon the Earth turning on its diurnal axis and traveling in its course around the Sun in the same manner as the armature of a dynamo?" enquired Bill Dean.

"That is possible, I suppose. At least the radiations from the Sun are, more than likely, responsible for our electrical phenomena and along with it—but we do not know to what extent tho—plant and animal life.

"Some have one theory, some have another, but I would not be surprised at some new stuff that will do to our dope what Galileo did to the old 'Seven Stars' idea. From the thought that our planet was the center (natural to the more or less egotistical Man) of the universe, to the idea that the Sun was IT and then that the Pleiades are the center. Some say they are—we cannot disprove it, as far as I know of the matter. But that is not saying it is final. At present we have no way of peering way out into the infinite space and discerning the outer stellar orbs. With the innovation of the instrument that makes it possible, we will step on a stride further as Galileo did with his telescope, and discover other systems and the orbs that go to make up the system. The more, I believe, we go into the study of the universe and its gloriousness the more aware will we be of its true greatness and vastness.

"Now, as we have inches and feet as linear measurements, we have the distance between the Sun and Earth as the 'Astronomical Unit'—then, when ascertaining the distance of a star way out there in the vast infinite depths that we cannot reach or understand by figures nor even imagination, but can only term Space, by determining its parallax, we are only able to express its distance in 'Light Years'—and when you stop to consider that light travels at the rate of 186,000 miles per second—well buy a tablet and figure it for yourself. To our minds, we cannot conceive of anything without beginning nor end (excluding the circle), and to our minds things must have three dimensions to be understood by us. Now the universe has apparently no beginning nor end as far as we are able to discern.

At this point we drew up at a road house, or Inn. "How about a shot of raspberry juice into the neck to wash that ethereal discourse down," suggested Stokes, in his almost provoking anti-climaxical tone and manner, as we entered the building.



AN OMISSION

We wish to state that credit for the photographs accompanying the article entitled "The City of Splendid Night," by Amos Stote, publisht in the January, 1919, issue, should have been given to the New York Edison Co.

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Some Government War Secrets

—and the reason for the Victory Liberty Loan

"WE HAD promised the Allied war-chiefs that we would have in France by July of last year, 600,000 men. On that date we had a little over 1,900,000. We had behind them nearly 2,000,000 in this country under training who would have been on the front before July, 1919, and we had behind those 4,000,000 men as many more men as were necessary to do the job.

"Four million men in France meant at least 20,000,000 tons dead weight of shipping to take care of them, and we had that program under way and were making our maximum output just about the time the armistice was signed. Twenty million tons of shipping at present cost means just about $4,000,000,000 or a little over.

"Did you know that those 2,000,000 men in France, who did so much to bring the war to an end, had only one small battery of American-made artillery behind them; just one battery of 4.7 and a few big naval rifles! The rest of the artillery used by the American soldiers was made by Frenchmen in France. But, on the way was a great stream of guns and shells that would have blown the German army off the earth. But that stuff had just come into large production in November, 1918. And it is for the deliveries on that big peak production that we have to pay in December and January and will have to continue to pay for in February."

* * *

"Our program for tanks, of which few got into action, was, I have been told, to provide for a tank in 1919 for every 75 feet of the front."

* * *

"Those are some of the things that cost money, and practically none of those great supplies of artillery, of shells or tanks, even of ships, practically none of that stuff was ever used. What an awful waste! We are asked to pay for a dead horse that never drew a load! It is discouraging, paying for something that is no good!

"Well, let's see if it's any good. Do you realize that the German army was never really routed; that except for a little bit of a stretch down in Alsace-Lorraine it was never fighting on German soil? They were brave soldiers, the German soldiers. They still had millions of them on the Western front. And yet they surrendered while they were on foreign soil. They had a fleet which had required years and years and years to build and it flew the white flag without firing a shot."

* * *

"I cannot believe that these great stores of munitions were wasted. In addition to the bravery of the American doughboy that arrived in France and got into action in numbers about the 15th of July and turned the tide and drove the Germans back, in addition to his bravery and his almost reckless spirit of determination, for which the praise cannot be too high, I say in addition to that, I believe there was one other factor that brought this war to an end at least one year before the most optimistic of us had dared to hope for. One other factor, and that was that Germany, her general staff, knew that back of the few hundred thousand Americans that really got into big action, and back of the 2,000,000 in France, was another 2,000,000 ready; and despite the fact that we had practically no artillery of American make on the Western front, that there was a great stream of American-made artillery on the way. And it is my conviction that the German staff knew that if they prolonged the war into 1919, they were inviting, not certain defeat, but certain annihilation."

* * *

"We are asked to pay for things that were never used; we are asked to pay for shells that never were fired; for cannon that never reached the battlefront, but we are asked to pay for those things that helped in a major way to bring this war to an end in 1918 instead of 1919. And the bringing of this war to an end twelve months before we could logically look for it means that *we are asked to pay for saving the lives of 100,000 or 200,000 American boys who would have died on foreign soil had the war continued another year."*

—Extracts from a speech by Hon. Lewis B. Franklin, Director War Loan Organization, U. S. Treasury Department.

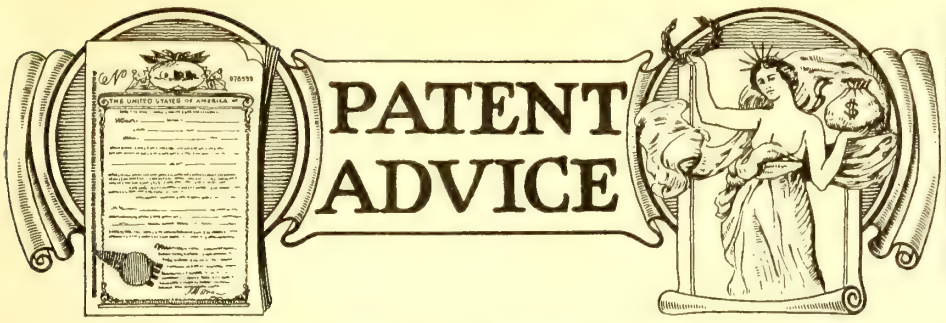
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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

NOTICE TO CORRESPONDENTS

Questions on Patent Advice are answered in this department every month, and naturally each question must take its turn. We have received so many letters during the past months that it is absolutely impossible for us to answer them all in the "Experimenter." Thus, for instance, the answers appearing in this issue are of letters going back as far as Oct., 1918. We would therefore urge our correspondents to bear this in mind, and if an answer is wanted quickly, correspondents should make themselves acquainted with the rules printed above.

Sectional Automobile Radiator

(318) Edwin Schade, Camden, N. J., writes: "I have noted in a recent magazine a photograph of a pile of automobile radiators that have been damaged in the war. It has been my experience in repairing the present type of radiator that it takes anywhere from one-half hour to as high as three days to fix a leak. This is true especially when it happens to be in the interior. My idea is to build a radiator in units. Should one or more units be damaged, they could be replaced by others in a very short time. Kindly advise if such an idea would be of any benefit, and if it could be patented.

A. It is doubtful that a device of this kind would prove satisfactory, for the reason that there would probably be a good deal of trouble to interconnect the various sections, and there would probably be just as much trouble in keeping these connections from leaking as in a well-made radiator. That a device of this kind can be patented is also very doubtful to us.

Telephone Appliance

(319) R. C. Kennan, Indianapolis, Ind., submits a drawing and description of a telephone appliance which is designed primarily to eliminate trouble for the man who talks several feet away from the phone and expects people to hear him on the other end of the line. The arrangement also permits using the phone without holding the receiver in the hand. Our correspondent wishes our advice if this device is patentable and if we think a market exists for such a device.

A. This is one of those devices of which probably five thousand have been patented in various forms in the past. Our correspondent's device has a lever at the end of which the receiver is fastened. The arm and the receiver swing in a half circle, and is then locked. The subscriber can then talk without using his hands. The hook connection is automatically established as soon as the lever is raised.

A. There is nothing new to this and, as we stated, many thousand similar ones have been patented in the past. There does not seem, moreover, to be a market for such an appliance.

Trolley

(320) Frederick E. Barber, Syracuse, N. Y., encloses a sketch and description of a device to keep the pole of a trolley from jumping off the wire. Our advice is asked.

A. We have exprest our views as to trolleys a great many times in these columns. Our advice to trolley inventors is: "don't". Our ideas were fully exprest in a recent answer to one of our correspondents in these columns. We refer to our March issue, page 825, Patent Advice No. 308.

Magazine Mailer

(321) Carlyle Rudolph, Minneapolis, Minn., says: "Is there such a thing as a magazine mailer? A machine that folds, wraps, stamps and gets magazines all ready for mailing. I have an idea which I think is worth something, but don't like to start on it until I know if there is anything similar in use."

A. There are certainly machines to do this. For instance, the ELECTRICAL EXPERIMENTER is folded and wrapt every month on a machine of this kind. While the machine does not automatically stamp the wrappers, this, however, can readily be accomplisht by a simple attachment on the market now. If our correspondent has something fundamentally new, he is advised to get in touch with any of the large printing houses who have such machines and he can hear from them as to what the requirements are.

Safety Elevator Device

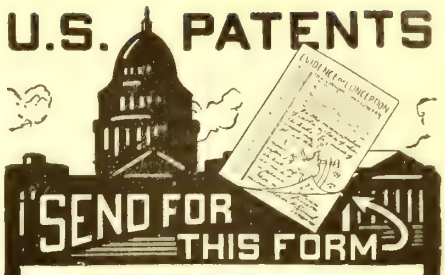
(322) Ralph E. Hast, Elkins, W. Va., explains his invention as follows: "The idea of this invention is to have a device on elevator doors which, when the doors were closed, would close a circuit, allowing the operator to ascend or descend, but when the doors are *not* closed the circuit would be open, thus rendering it impossible to operate the elevator. The device on the doors would be a partly concealed socket which operates easily but forms a constant circuit when closed and cannot be jarred out of place."

A. There is nothing new in our correspondent's idea. Safety devices of this kind have been used for many years, and are in use right now. Take for instance the New York Subway Elevators, particularly the ones at 181st Street and Broadway, operate with this device.

Depth Bomb

(323) George W. Curtis, Detroit, Mich, has invented a depth bomb which works on the sea water-conductivity plan by means of which contacts are closed when the sea water enters the intake of the bomb. Our advice is asked as to the practicability of this device.

A. There is nothing new about this device—many bombs of this kind having been proposed during the war. The regular depth bombs, however, working on the hydro-static principle, are very much simpler and better.



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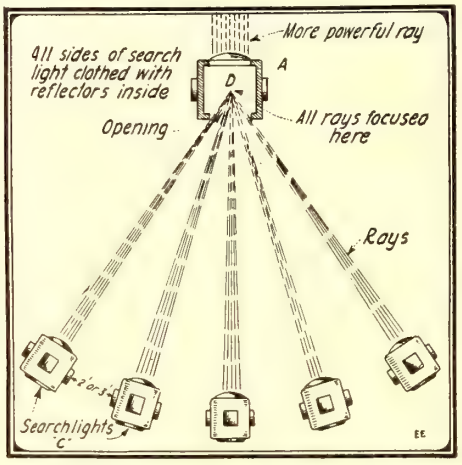
Phonograph Needle

(324) R. W. Napper, B. Guiana, S. America, asks us: "Do you think that a patent of any value could be secured on a double-ended gramaphone needle, i. e., a needle sharpened at both ends? This would tend to save steel, as each needle could be used *twice* instead of only once."

A. We do not think that a needle of this kind would be of great benefit and we believe a needle of this kind was once tried. The reason is that a needle of this sort cannot be held as securely as one with the squared off end; it tends to rattle because the upper end is not supported except by a sharp point.

Searchlight

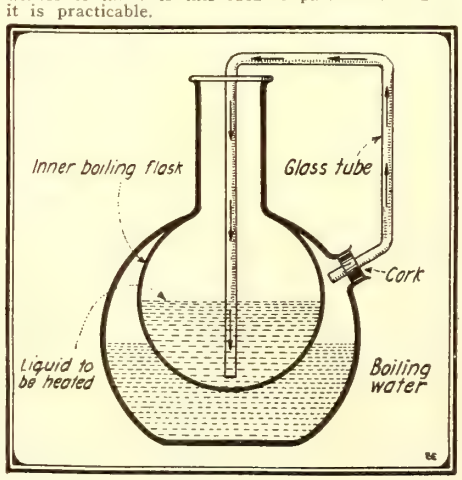
(325) Joel Silver, Newark, N. J., submits the following idea: "I think that if about five searchlights have their rays focused on the inside of another larger searchlight (see illustration) there will be more power; hence a small searchlight, with the aid of others, can be made more powerful. The rear of the main light (A) is cut open (B). All the searchlights (C) have their rays focused upon the center (D) of A. With very good reflectors and a very powerful lens, I am quite sure that a longer distance will be obtained. That is, it will be five times as powerful as one of its size."



A. While the idea is ingenious and no doubt novel, it certainly is not practical, for nothing could be gained either electrically or economically to arrange the searchlights as shown. The reason is that one searchlight can be made to give the same amount of light by using large enough carbons and consuming a corresponding amount of current. Of course, a multiplicity of searchlights are used in a great many cases, but not to concentrate the light on a point. They are usually employed to throw the light over an extended surface.

Chemical Flask

(326) Eug. Lavigne, Montreal, Can., submits diagram and sketch of a combined water bath and boiling flask. It is shown in our illustration. He wishes to know if this idea is patentable and if it is practicable.



A. While no doubt a patent could be obtained on this device, we do not think it would be of much value for the reason that it could be used only in very few cases. As our illustration shows, the evaporating water would flow into the central flask and it is quite certain that more or less water would find its way into the central flask, where surely it is not wanted or needed. This is our main objection to the idea.

In the June issue: "HOW TO FINANCE AND MANUFACTURE A PATENT," by Jay G. Hobson.
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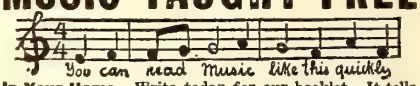
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COLD LIGHT

(*Continued from page 23*)

proper conditions the small light wave may be given off by the electron without affecting the whole molecule in the least. *That is cold light.*

An interesting experiment can be performed with a vacuum tube, which illustrates completely the principle of light production by ionization, and at the same time explains the principle of the Moore light. Few people, other than scientists, realize what a peculiar thing the production of light in a vacuum or Geissler tube is. The light is evidently not the product of heat, but depends on the fact that the electric spark breaks the gas molecules up into charged particles or ions. And this phenomena is most noticeable when a certain degree of exhaustion is reached in the tube.

When air is pumped out of a tube in which there is an electric spark discharge, several different stages, as shown in Fig. 3, are successively reached. At first the discharge in the tube is the ordinary disruptive spark. In the next stage it forms a quiet thread of light thru the tube. Then the thread of light becomes a broad pencil of light, and finally with more exhaustion the whole tube is filled with a soft luminous glow, which is technically known as the *positive column.* This is the point of highest conductivity of the tube, and may be reached with an ordinary air pump. With further exhaustion, by means of a special air pump, the resistance increases, the cold light disappears, and the point is reached where X-ray phenomena and fluorescence appear. The color of the light in the tube depends on the gas used in the tube and is undoubtedly the product of the ions. Just before the war a Frenchman, Claude, devised a means of producing in quantities the rare gas, *neon,* which gives an intense yellow light in a vacuum tube. The carbon dioxid which Moore uses gives a white light. Other gases, possibly rare ones, may be found which are better still, and *helium* has been suggested as a standard by some. However, up until the time the U. S. Government discovered the way of producing it in immense quantities for balloon work, during the war, it was too rare to be practical. The more the conditions in such a light can be improved, and the more nearly the light is a pure ionization or cold light, the higher the luminous efficiency will be. An interesting table is given, showing the progress which has been made up to the present, including the vacuum tube.

Luminous Efficiency of Various Illuminants

Candle	2 per cent
Gas mantle	5 per cent
Carbon lamp	6 per cent
Flaming arc	15 per cent
Vacuum tube	40 per cent

REVOLUTION COUNTER FOR DYNAMOMETER

(*Continued from page 39*)

duration of thirty seconds. The time element may be changed at will by the use of saws of any desired number of teeth.

To start the apparatus, the starter button is brought into action until both brushes bear on the metal drum. This completes the circuit and engages the clutch thru the electro-magnet and spring thus starting the counter. At every swing of the pendulum, the circuit thru the solenoid is made and broken, thus drawing the saw—as illustrated—thru a circumferential distance equal to one tooth. After thirty swings of the pendulum one brush is again bearing on the insulated section of the drum and the counter clutch is disengaged. A reading of the counter gives accurately the number of revolutions of the dynamometer in thirty seconds. This counter may also be used in connection with a fuel weighing apparatus.

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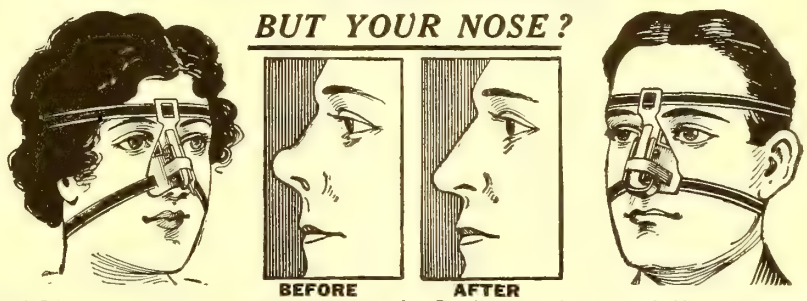
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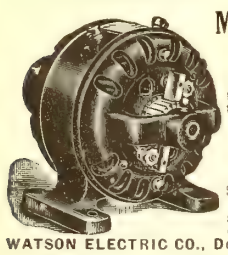
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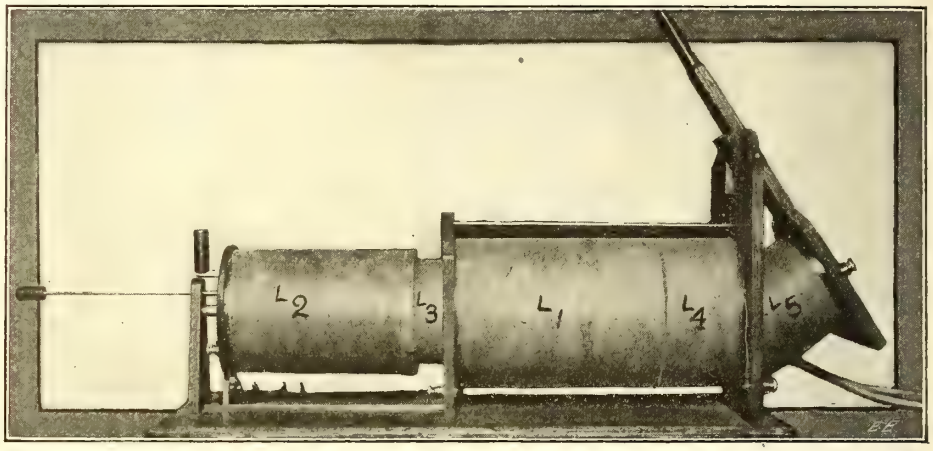
Continued

New Regenerative Vacuum Tube Circuits

(*Continued from page* 33)

these wave lengths, the proper size inductances are always to be utilized. It is advisable to use this circuit whenever large amplifications are desired at extremely low wave lengths. Tests have been made with this circuit in comparison with other low wave length regenerative circuits, and it was found that the above circuit gave better and more efficient results and that it was possible to produce regeneration in the plate circuit with much greater ease than that obtainable with the usual type of circuit.

A similar but a more complicated circuit is shown in Fig. 5. The radio frequency bridging condensers C_3 and C_4, are used to permit radio frequency currents to pass freely to the plate.



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Fig. 6 outlines a circuit similar to Fig. 5 in which the plate of the first vacuum tube is coupled magnetically thru coils L_4 and L_5. The purpose of another vacuum tube circuit is to amplify the audio frequency currents of the first vacuum tube. This audio amplification is accomplisht thru coils L_6 and L_7, which are mutually coupled with this arrangement, and it is possible to amplify the signals to 1000 or more times their original value. It was possible, in tests, to amplify signals received from a distance of 5000 miles to such a value as to cause the incoming signals to be heard twenty feet away from the telephone receiver. The telephone receiver was equipt with the proper megaphone.

In Fig. 7 is delineated a radio telephone circuit using a vacuum tube for the generation of sustained oscillations. The grid and plate are coupled magnetically thru inductance L_2, which also energizes the antenna circuit thru inductance L_1. Condenser C is used to tune the oscillatory circuit CL_2. The plate voltage in this work is considerably higher than the plate voltage used in receiving sets and it usually ranges from 300 to 1500 volts. This is usually accomplisht by the use of the generator G. The inductance L_3 which is a choke coil is used to prevent high frequency currents from the plate circuit entering the generator. Modulation is accomplisht by shunting a telephone transmitter T, thru a resistance R and battery B across the grid and filament of the tube, as indicated.

Another successful circuit is shown in Fig. 8 and voice modulation in this circuit is accomplisht by coupling the telephone transmitter thru an induction coil I, comprising coils L_3 and L_4. The primary L_4 is connected to the transmitter and battery B, as shown. The modulated wave is imprest upon the grid in the vacuum tube, which wave is superimposed upon the main radio frequency oscillations.

(*Continued on page* 76)

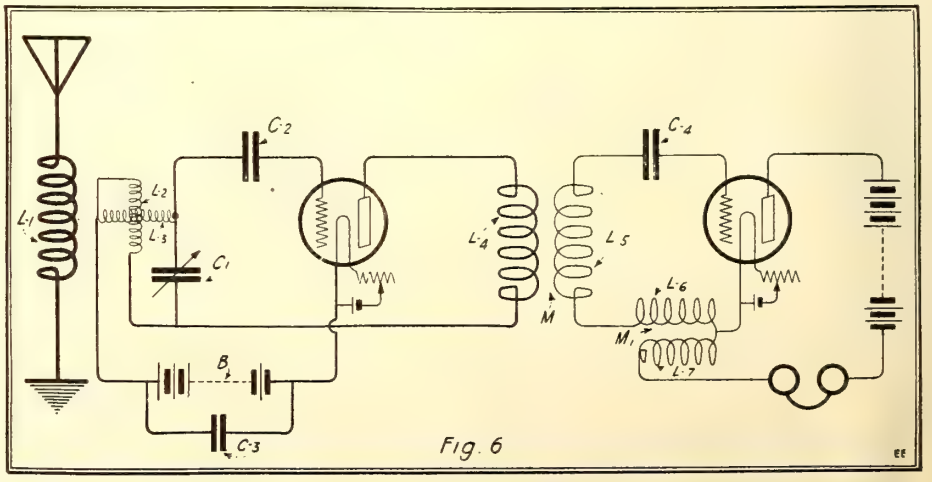
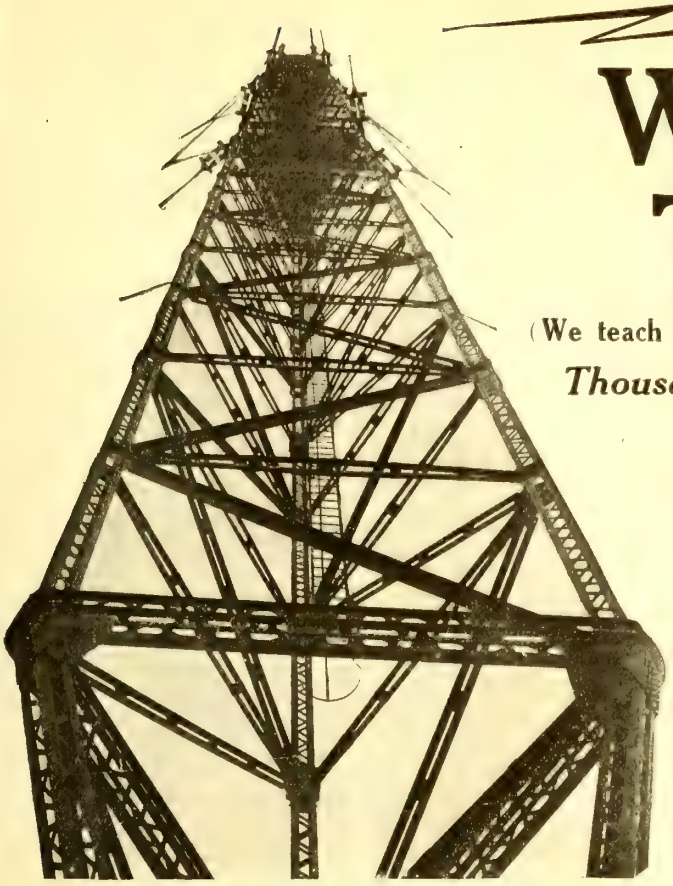


Fig. 6

Two Stage Audion Amplifier, the Circuit of the Second Audion Being Magnetically Coupled to the First Audion Circuit. Amplifying Power 1,000 Times and Better.



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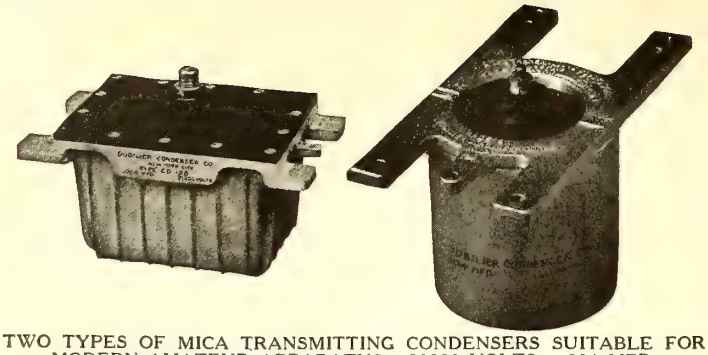
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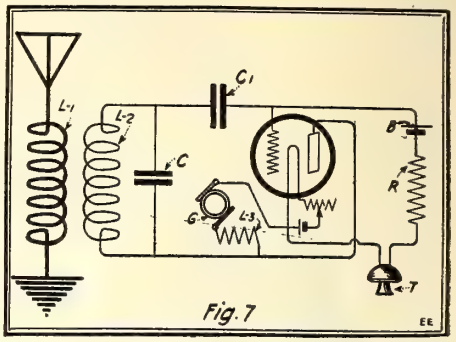
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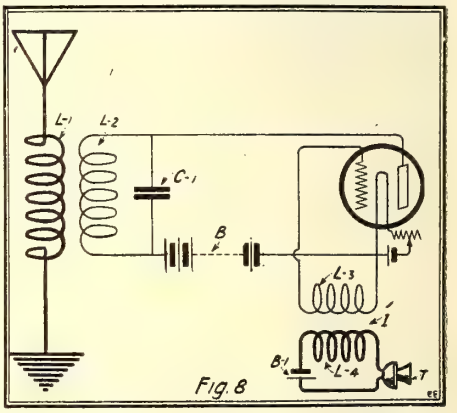
(*Continued from page 74*)

Another circuit to accomplish the same result as above, is indicated in Fig. 9, in which case the oscillations are started thru the coupling coil M and the voice modulation imprest upon the grid circuit is ac-



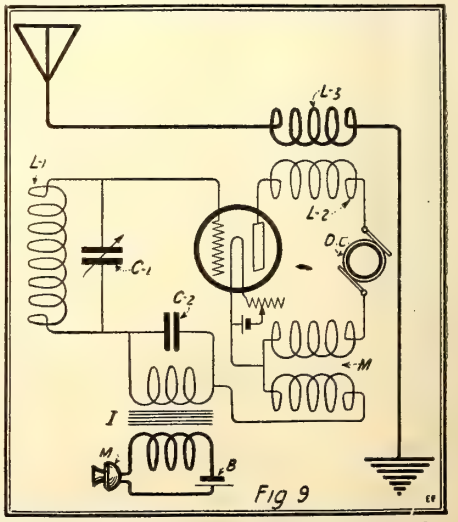
First Form of Radiotelephone Transmitting Circuit, Utilizing an Audion, of Interest to Amateurs.

complished thru the telephone induction coil whose secondary is connected thru the grid and one leg of the coupling coil M, and the other to the main oscillatory coil inductance L_1. The primary of the induction coil is connected with the microphone and battery as indicated. Tuning is accomplished with condenser C_1, which is in the oscillatory circuit C_1L_1. Energy trans-



Second form of Audion Radiotelephone Transmitter with Magnetically Coupled Modulating Circuit.

ferred to the antenna circuit is accomplished thru the plate inductance L_2, inductively coupled to the antenna inductance L_3. To reduce the impedance of the grid circuit due to the high inductance of the secondary of the telephone induction coil, it is necessary to shunt a capacity C_2 of considerable magnitude to overcome this excess impedance.



Third Form of Audion Transmitter for Radiotelephony.

PUTTING IT OVER ON FRITZ.

(*Continued from page 22*)

see the sector thus marked out—by triangulation the position of every wireless sender could be ascertained—abandoned. This prediction came true every time, and tho the secret was guarded jealously during the war, it now can be let out, as Germany is harmless, and every other nation knows just how the prophecy was made.

It was not often that the Germans kept Allied brains working overtime on a puzzle. In a single instance, however, the Huns thought up a devilishly clever plan for getting secret information into Germany. This was called for weeks and weeks the "Nauen-Madrid Buzz."

Nauen, of course, was the official German Government wireless station, while in Madrid, Spain, was situated a station capable of sending messages to any part of the German empire in Europe. During all the months of the war in which direct communication between Germany and the outside world was practically severed official war bulletins and "inspired" news came out from Nauen thru Madrid. The latter station sent back neutral news and views of the war.

In the spring of 1917, however, came a queer development. Every now and then Nauen would seem to be badly bothered by "static" or by some imperfection in the sending apparatus. The station would emit an unintelligible buzz, like unto no message known to operators. This was regarded with grave suspicion by the Allied intelligence departments, and when Madrid started the same thing a whole corps of military wireless detectives were assigned to the problem. No one doubted that this was some new form of communication, but what on earth could anyone make out of that continuous buzz?

Weeks past with no light on the question. The two stations had grown bolder and were using the buzz constantly. Valuable information leaked to the enemy, and it was made practically certain that the "buzz" was responsible.

The mystery was solved by the help of a lucky accident. The technique of studying every code wireless message of the enemy had been to take down the sounds of the spark on a cylinder phonograph record; this gave the intelligence officer an accurate reproduction at any time he desired. On the occasion mentioned an officer had been trying to establish some basis of similarity between several of the records without success, when his machine ran down. As the needle grated to a stop on the cylinder the officer sat up suddenly. He thought he detected something that sounded just a little like a message!

He wound the phonograph and turned its speed indicator down so that the record revolved only a few times a minute. Then he applied the needle again. Aha! *There was something there!*

Tho this arrangement gave him insufficient to enable him to solve a code, he had the idea. Next the phonograph cylinder was attached to a motor, revolving at three hundred revolutions a minute, and several records taken at high speed of the peculiar buzz. When these records were re-run at moderate speed it was simple; the messages were decoded in an hour and were found to be questions and answers on topics the Germans were not even supposed to know existed!

The method used by the Germans and by the Madrid operator had been simply to punch in the message on a perforated paper roll. Then running this thru the sending equipment at high speed the message had gone into the ether waves at too rapid a rate to be caught by ordinary methods. At the other end the receiving station used the phonograph equipment to catch and record the message.



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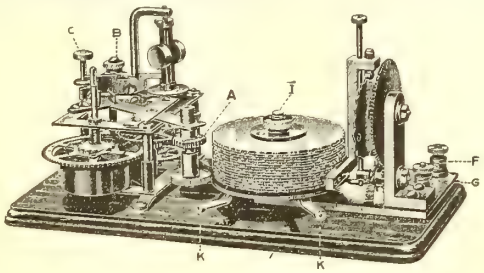
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The Omnigraph Automatic Transmitter will teach you the Continental and the Morse Codes, **at home, in half the usual time** and at the least possible expense.
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205 New Jersey Ave.,
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Feb. 17th, 1919.

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39 Cortlandt St., New York City
Dear Sirs:—Received my Omnigraph No. 2 with a set of Morse and an extra set of Continental Dials and wish to thank you for your prompt shipment.
Five minutes after I had received the box, I had it unpacked and working. I cannot praise it too much and a friend of mine as soon as he heard it, said: "Why, man, that sends PERFECT Morse and Wireless." I will give you all the praise that I can. I myself doubted that the machine would do all you stated but it does all you state AND THEN SOME.
Hoping to be of help to you and wishing you the best of success in your business, I remain
Very truly yours,
(Signed) Thomas W. Braidwood,
Pres. Cape May County Radio Asso.

205 New Jersey Ave.,
Anglesea, New Jersey,
Feb. 20th, 1919.

The Omnigraph Mfg. Co.,
39 Cortlandt St., New York City.
Dear Sirs:—In reply to your letter of 19th inst., I am GLAD to give you permission to use my previous letter in any way you see fit.
Two weeks ago I could not receive enough Morse to understand what a person was saying but today I can receive about ten words per minute on my Typewriter when the OMNIGRAPH is sending.
I have a First Grade Commercial Radio Operator's License and am using the OMNIGRAPH to better my receiving and to fit me for land telegraphy.
Wishing you the best of success for the future, I remain,
Very truly yours,
(Signed) Thomas W. Braidwood, Radio 3 U Z,
Pres. Cape May County Radio Asso.

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How did you learn to talk? By listening.
JUST LISTEN,—THE OMNIGRAPH WILL DO THE TEACHING



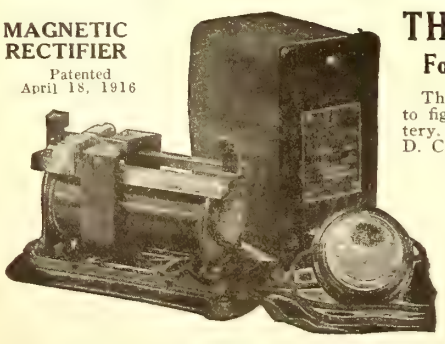
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Cleveland, Ohio

Advertising Talks
NUMBER 2

IF you have ever stopped to figure out the terrific cost involved in publishing a magazine, and the small amount of money that you pay for your issue each month, you probably wonder how a publisher can afford to give you as much as he does. If it were not for the advertising carried, he could not do it. Your 20c would not buy a magazine one-half the size, or quality, of the "Experimenter" unless that magazine were supported by the advertisers who use its columns every month.

The *Electrical Experimenter*, especially, costs a vast sum of money every month to produce. The magnificent wash drawings and expensive cuts that you see in every issue and which have made the "Experimenter" famous are only one of the many items that makes the publishing of your magazine a severe and heavy strain. The price you pay for your copy helps to meet part of this expense, but the advertisers foot the most of the bills. Don't let that fool you, however. They are not doing it for any love of the "Experimenter"—it is a business proposition with them. Each and every one have something that they feel is of interest to you. Perhaps it is a piece of merchandise that they want to sell; a new wireless outfit, a correspondence course that they know will improve your mind and equip you to earn more money; maybe it is a book or a novelty that you would enjoy having; but, whatever it is, they are willing to pay their good money to support the magazine in order that the magazine can print their advertisements.

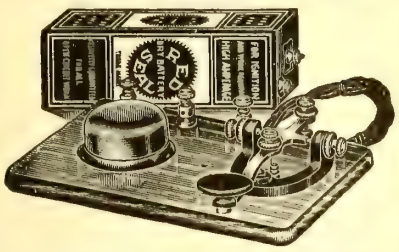
The more advertisers we have, the more income there is each month, and the publishers of the *Electrical Experimenter* have committed themselves to putting back into the magazine, in enlarging its size, and improving its articles, and its drawings, every penny that comes in through the circulation or advertising. **You will notice that with this issue eight more pages of *pure text* have been added, making this number the biggest ever published. This was made possible by the big increase in advertising during the past few months.** You can help the work along and make the magazine still larger and better, if you will purchase what you need and the things you require in your work or for your pleasure, from the advertisers who are helping you. Read what they have to say in every issue, and when you want anything, no matter what it is, look it up in the advertising columns of the "E.E." and send your orders to those firms who are helping give you a magazine that you would not want to do without.

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Advertising Manager.

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For Learning Telegraph Codes



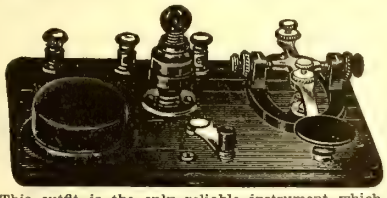
The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

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PRACTICAL CHEMICAL EXPERIMENTS

(*Continued from page 34*)

clean cut, due to the shears. Since new wool is distinctly elastic, there is a certain amount of *give* to the fibers when subjected to tension. In the case of wool that has been scoured and dyed, the elasticity has somewhat decreased, the fibers becoming considerably firmer. If subjected to tension and rupture, the break has the appearance of a fracture, like a bone.

Referring to Figs. 9 to 18, inclusive, Fig. 9 shows shoddy made from new, fine, blue worsted clips. Notice the great variety of broken ends of fibers, and also the tendency of the fibers to split or tear lengthwise. The fibers showing the side breaks are evidently due to a tearing action of the shoddy machine.

Fig. 10 is a shoddy made from new, fine, black worsted clips. Here again may be noticed their peculiar terminal fractures, where the fiber has been pulled asunder. One of the fibers has a number of *spines* projecting from it. These so-called *spines* are really the fiber cells, which, no doubt, were loosened by the tension on the fibers in the machine. Note that both Figs. 9 and 10 represent new wool that has been simply mechanically reduced to shoddy, and at no time carbonized.

Fig. 11 is shoddy made from carbonized brown serge. Here it may be seen what indicates the brittle character of the fiber, devoid of elasticity. The breaks of the fibers are seen to be quite abrupt.

Fig. 12 is a shoddy made from brown serge that has been carbonized and subsequently stript. The abrupt character of the breaks is plainly noticeable, while at the same time the fibrils comprising the body of the wool fiber are very distinct. Their presence may be attributed to the chemical action of the stripping.

Fig. 13 shows fibers made from blue serge that had been first carbonized, then stript, and afterwards dyed green. Here again we notice the tendency to break longitudinally, and where a terminal break occurs, the fibrils appear distinctly.

Fig. 14 is shoddy from the same batch as that shown in Fig. 12, except that it has been dyed a full red. Here we notice that one of the fibers has been split longitudinally, while the other three fiber terminals show break characteristics that indicate the brittleness of the stock.

Fig. 15 was originally a brown serge that had been carbonized, then stript, afterwards dyed a deep orange, and finally garneted. A great majority of the breaks of fibers in this sample are extremely abrupt. There appears to be no longitudinal ruptures, and this seems to indicate little or no elasticity. Even the fibrils do not show plainly.

Fig. 16 is a shoddy made from brown serge that has been carbonized, stript and dyed an olive shade. Here again we see the abrupt fractures of the fiber and a tendency to longitudinal splitting. The fibrils are entirely wanting.

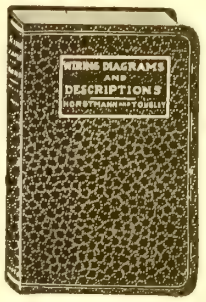
Fig. 17 is a shoddy made from various knit goods of different colors that were first carbonized, then stript, and afterwards dyed blue, producing finished colors of varied hues. The fibers show a rather curious side abrasion; a form of mutilation that appears to be quite common in this lot of shoddy.

Fig. 18 is a shoddy made from serges that were carbonized, stript and dyed a deep maroon. It will be seen that the tendency of some of the fibers is to split longitudinally. The terminal shown is characteristic of a fiber pulled apart lengthwise, when the fibrils have a tendency to separate, forming a brush-like head.

The various characteristics above re-

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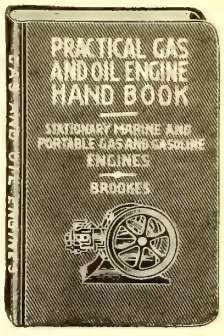


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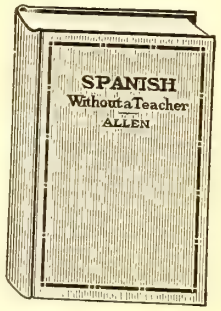
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ferred to, and illustrated, will serve to draw attention to what one must look for in an examination of cloth that is believed to contain shoddy. In masses of shoddy such as are usually taken for microscopic examination, there will always be found many short fibers due to mechanical breaking of long fibers, but to separate them is an operation of great delicacy, tho yielding results of no value.

THE "BURNING" TEST

Vegetable fibers may be readily distinguished from animal fibers by burning. Animal fibers, such as Wool and Silk give off the smell of burnt horn. They do not fire like vegetable fibers, but cease to burn when removed from the flame, and the burnt portion curls up, forming a hard cinder at the end of the thread. Vegetable fibers, on the other hand, give off a slight smell of burnt wood when ignited. They burn away very rapidly with a flash, leaving no hard cinder, but a white or gray ash only. The above tests broadly distinguish vegetable from animal fibers, but further chemical examination is necessary to distinguish mixtures of any of them when woven into cloth. (See Fig. 19.)

Referring again to Figs. 1 (Cotton) and 4 (Linen) we can readily distinguish the difference by means of the microscope as shown. If the fabric is without starch, **oil makes linen translucent and cotton opaque.** The finish must be washed out of highly finished materials before this test can be used.

A test to distinguish between linen and cotton, which only an expert, or at least a person having quite some experience, can perform, consists of what is known as the *"tearing"* test. The linen weaves in general are more difficult to tear than cotton. The torn ends of the linen threads appear uneven in length and the individual fibers are **twisted in every direction. The sound of tearing linen is shrill, and that of cotton dull or muffled.**

An easy way to distinguish between the highly-sized and calendered *Cotton Damask* and true *Linen Damask* is to boil a sample. After being dried and ironed, if it is *cotton it will have a dull and somewhat fuzzy appearance,* while the *luster and smoothness of real linen will not be affected* by this treatment. *Mercerized Cotton Damask* keeps more luster than untreated cotton, but less than linen.

Since the price of pure, new wool is relatively high, it is the practise of manufacturers to mix other materials with it, the most common of which is *"Shoddy."* Such goods have many uses, being a full-bodied, but flimsy fabric, it is made chiefly into cheap cloth, table covers, etc. Manufacturers state that the best grade of worsted shoddy—that having long fibers—is superior to a low grade, short staple, new or virgin wool; also that it is impossible to get the texture and finish required for some of the best grade goods *without* the use of some shoddy. Owing to the fact that shoddy is made from wool fibers, as stated under the heading "Shoddy," it is very difficult to determine its presence by chemical means, owing to the fact that it will respond to the same tests as applied for wool. The microscope is the most accurate means available for determining the presence of shoddy in woolen cloth. It is true that the rough feel and cheap appearance of the fabric gives some idea of the presence of a *large percentage of shoddy,* but the famous "feeling test" for cotton or shoddy in moderate quantities must give way today to a more scientific analysis, as herein given.

Shoddy is not alone as an adulterant of woolens. Cotton is employed quite extensively. It is a simple matter to detect the presence of cotton, *as wool is dissolved in alkalies* and *not affected by acids* while on the other hand *cotton is dissolved by acids* and *not affected by alkalies.* Fig. 20 shows

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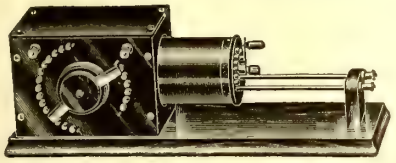
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a convenient method of testing for cotton and wool. One glass contains a solution of Caustic Potash or Caustic Soda into which is immersed a sample of the wool to be tested. A precipitat indicates the relative amount of cotton and other substances present. Likewise when cotton is immersed in an acid, the precipitat will show the relative amount of adulterants. See Fig. 7.

It is easy to determine heavily-weighted silk material by burning a small sample. Pure silk burns rapidly, smells like wool, and produces a small amount of brittle, curled-up ash. Material which is heavily-weighted will have an ash which is stiff and which often holds the shape of the sample. Cotton is frequently mixt with silk. It is easy to detect cotton in silk by the microscope, as the fibers of silk are round and smooth, while the cotton fibers are ribbon-like and fuzzy. See Fig. 8. Cheap but heavy silks are usually loaded with lead in granular form. A chemical test for lead will readily reveal its presence.

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Fig. 21. Removing Iodin Stains from Light or Other Colored Cloths By Application of Ammonia. The Ammonia May Be Applied With a Glass Rod or Sponge, and Should Be Immediately Washed Out as Soon as the Iodin Stain is Removed.

For unstarched stains, sponging with Ammonia, or alcohol, the latter being frequently used on materials which water would injure. See Fig. 21.

Starch, such as prepared for laundry purposes may be used for washable materials. Immerse the stained parts in the starch and boil. It first turns blue and then disappears. Flour may be used in the same manner as the starch.

For starched materials, the stains may be immersed in a dilute solution of Sodium thiosulfate (known photographically as "Hypo") and then rinsed thoroly. Sodium sulfite (not sulfate) may be used in the same manner as the thiosulfate. Another method is to soak the stains in dilute ammonia (sp. gr. 0.95) until they disappear.

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HOW THE FRENCH LOCATED SUBMARINES.

(*Continued from page 9*)

major problems, if not indeed the predominant one, to be met with in working out a more selective and accurate form of submarine listening device was that, whatever its form, it should be susceptible of operating and functioning on any vessel while it was under full headway, and further, that the indications given by the instrument of the direction of such sounds should be sufficiently accurate to permit the commander of the vessel on which it was installed to set a straight course for the indicated spot where the submarine lay in wait for its prey. Contrary to general opinion, many authentic instances are on record where submarines were surprised in this way during the war and sent to the bottom, sometimes by armed merchantmen or converted yachts, and again by fast destroyers or submarines. The English in particular seem to have obtained very gratifying results in fighting the U-Boats with their own submarines.

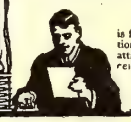
Lieut. Walser designed his apparatus after first carefully studying a well known, yet heretofore overlooked, principle of physics, viz: that sound, identical to light, upon passing thru one medium into another, is *refracted*. The orthodox theory concerning the complex light beam or ray from a given object states that they comprise a number of component waves, which may be considered as parallel when their source is situated a sufficient distance, and which parallelism is upset only when an obstruction is placed in their path, when they are thus caused to enter a new medium having a density of a different value from that in which they were propagated. Lieut. Walser had the forethought to perceive that sound waves must follow the same theory. To prove his theory, he interposed in the path of sound waves a device which would respond to various vibrations, and which formed what we might term an *acoustic lens*. As has been found in explaining the theory of light transmission, a similar effect takes place in sound transmission thru the air or water and other mediums, and the result of thus interposing such an acoustic lens or vibrating member causes the individual waves composing the complex wave propagated from a given source to come to a focus. This has the two-fold effect of intensifying the individual waves and also of isolating them precisely from other sounds emanating from the sources foreign to the one being localized. Naturally, the different sources of sound will create a corresponding number of foci, of which the geometric focus can be ascertained by mathematical computation. In a similar manner from the position of the sound focus which corresponds to any individual source of sound, the definite direction of that source can be readily estimated.

The accompanying illustrations show the "Walser submarine detector" gear as installed on French vessels, and the detail view shows how the sound detecting lenses, which are fitted into large steel bulges or "blisters", secured to the hull of the vessel, are connected to two trumpets, which may be traversed in a circle above them, so as to accurately localize the various sounds heard from different vibrating diaframs comprising the lenses. One trumpet picks up and localizes the sounds from the *port* lens, and the other the sounds picked up and intensified by the *starboard* lens. The spherical segments supporting the multiplicity of lenses is indicated by *A* in the detail figure. This segment is provided with a circular series of openings, *B*, each of which contains a sensitive vibrating diafram, *C*. The general effect of this arrangement is to focus all of the sounds picked up, the focal points all lying on a circle, *I*. As aforementioned, the vessel fitted with this apparatus has two of these lenses, one to *port*

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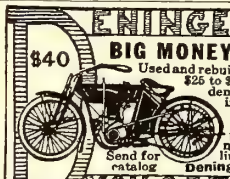
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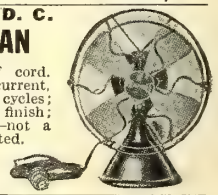
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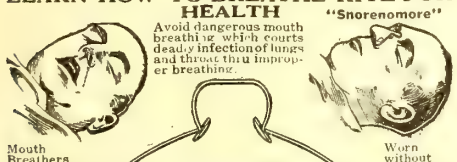
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and one to *starboard* of the keel. Just over these two lenses, there is built a specially solid sound-proof room or cabin, in which the operator of the submarine detector is located. The arrangement of the apparatus is such that the operator can sit in the center of the cabin with the listening helmet on his head, and by means of two ear trumpets, *D*, in the diagram, any sounds passing thru the lenses can be quickly picked up and localized for direction. One trumpet takes care of the sounds from the port lens and the other the starboard lens.

By means of the large rotating drum, which appears just to the right of the operator, the edge of said drum being calibrated, so that as the handle of the drum is turned the trumpets over the lenses are rotated about the respective focal circles of any sounds received. The control drum, which is manipulated by the operator, revolves the trumpets, *D*, which are pivoted on a fork, *E*, thru the movement, *H*. *J* represents the counterweight, which by means of cord, *K*, maintains the trumpet in such a position that its axis is always pointed toward the center of the spherical lenses. The function of the counterweight, *L*, is to maintain the balance of the movable arm on which the trumpet is supported, while the weights, *M*, M^1, cause this arm to oscillate about the pivots, *N*, N^1, in such a way that the rolling of the vessel is counterbalanced, thus tending to keep the mouth of the trumpet in the same horizontal plane at all times. The complete apparatus is carried by the metal frame marked *O*.

With the apparatus in use, the operator hears the sound with the greatest intensity and sharpness when the trumpet axis is in line with the focus of that particular sound. He can also hear a certain sound when the trumpet is anywhere in the vicinity of the focal point. The operator proceeds in any event to explore the various foci by manipulating the central control drum, which revolves the trumpets around the focal circles. This centralized control drum having been calibrated beforehand, it becomes a simple matter for the observer to accurately locate the direction of a certain sound, or more strictly speaking,—its origin, as soon as he has manipulated the trumpet to the proper focal setting, so as to hear the received sound with the greatest intensity and clarity. By a quick calculation based upon the value of the minimum intensity of the sound received, the range of the submarine can be approximately calculated. It is then a comparatively simple matter to steer a straight course for this spot, and if the object of the search turns out to be a submarine, then the destroyer will pass over it and discharge depth bombs upon it.

Of course the wiseacre will say, it is all very well to locate a submarine and then steering a course so indicated for the object of dropping several carloads of "ash cans" (depth bombs, in navy vernacular) upon it, but what about the movements of the U-Boat, which may have paddled off a mile or so from the spot so dear to the heart of the naval officer. This problem would seem to be solved by the fact that contrary to the usual apparatus utilized for such purposes heretofore, the operator may keep right on taking the soundings of the submarine, while the vessel is under full headway and moving toward it. The sensations experienced by the submarine detection officer located in his steel-bound cubbyhole down near the keel of the on-rushing vessel, as the sound of the submarine's engines and propellers pound louder and louder in his ear trumpets, probably can be better imagined than described, for the submarine commander may have a "card up his sleeve" and be just about scrappy and clever enough to lay for the on-coming destroyer or war vessel and discharge a torpedo at it or open up with a broadside from some nifty "seven inchers."



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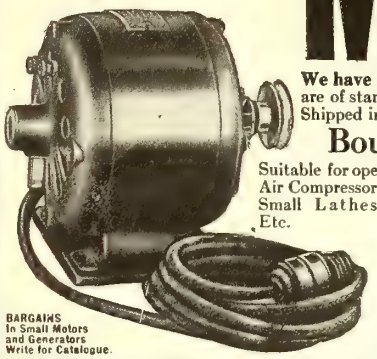
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THE THOUGHT RECORDER

(*Continued from page* 12)

ent upon wave motion, it should not be surprising therefore that thoughts or active thinking should give rise to wave motion as well.

This theory is greatly strengthened by the fact that it has been proven beyond doubt that active thinking necessitates an expenditure of energy. If you sit perfectly quiet in a chair without expending any visible muscular energy, and if you concentrate very hard upon a certain problem, it is not infrequent that perspiration appears on your forehead from the simple effort of thinking. Of course, this is rather a complex phenomenon, as the perspiration is not produced directly, but rather indirectly by the nerve centers working upon the human organs, principally the heart. Nevertheless, we know that thinking, proper calls for an expenditure of energy in the brain itself. That this energy is considerable can also be shown experimentally.

It therefore cannot come as a surprise that the act of thinking should give rise to a direct wave motion, sending out from the brain certain waves in an analogous manner, to the spoken word which produces sound waves of a certain wave length. It is quite probable, however, that thought waves are simply another form of ether waves, the same as radio waves or light waves. Just as light rays traverse thru a thick glass pane without suffering any appreciable loss, just so will thought waves probably pass readily thru the human skull. If once we admit this theory it follows that it should be possible to detect such waves, and the only thing we need to know about them are the wave length and other important characteristics. We may take it for granted that the human brain, sensitive as it is, probably is not at all sensitive to these waves, and that by suitable apparatus it should become possible to detect such waves.

Just what apparatus are necessary to detect thought waves, or the effects therefrom, the writer does not venture to predict, but there is no doubt that the apparatus will be eventually found. Very little is known about the emission of the thought waves, and as a matter of fact the entire mechanism which produces thoughts is practically an unknown quantity, but every effect can be translated and recorded if once we understand its fundamentals.

Thus, fifty years ago the recording of the voice would have appeared just as fantastic as the recording of thought appears today. People then rightly said, how could it be possible to hold the spoken word; it goes into the air and vanishes instantly. But once acoustics were better understood, it became a simple matter for the inventor of the phonograph to record the voice. Similarly, the day will come when thoughts will be recorded in an analogous manner. All that is necessary, as stated above, is suitable apparatus, and this should be easy to find.

The writer, in suggesting the audion as a thought-wave detector, does not do so because he thinks that it is suitable in all respects, or even feasible. His main idea is to set the stone rolling, and get other people to think about the problem, when sooner or later something surely will emerge. The writer has suggested the audion because it is known as one of the most sensitive electrical detecting apparatus for wave motion which we have today. If thoughts give rise to electrical waves, then by winding a few turns of wire on a headband and slipping it over the head, it should be possible to detect the presence of thought waves in the audion. On the other hand, too, the audion is enormously sensitive to capacity effects,

as is well known. Thus, for instance, an oscillating audion is so sensitive that when the human hand is approached to it at a distance of even two feet, the presence of the hand will be heard plainly in the telephone receiver. If this is the case, the disturbance created in the mind should certainly make its presence felt in the audion, for thinking being first of a chemical nature, the act certainly must give rise to capacity effects. But let us assume that active thinking does not give rise to waves, electrical or otherwise, then the mere chemical action (and resulting capacity effects) should produce a disturbing influence upon the audion. These variations, if ever so slight, could then be amplified by the use of an audion or other amplifier, and the resultant effect be sent into an Einthoven string galvanometer. The small mirror attached to the string of the galvanometer will send its luminous pencil upon a light-sensitive paper tape which moves at a certain rate of speed in front of the mirror. The result will be a wavy line traced upon the paper tape in the well-known manner. The paper tape traveling on will pass thru its fixing tank, and from there will emerge from the outside of the machine after it has past thru a small drying chamber heated by electrical coils.

From this, it will be understood that a man sitting in front of his Thought Recorder will be able to actually see on a tape his recorded thoughts, the same as the telegrapher working on a trans-Atlantic cable watches his tape and its wavy line produced by the Syphon recorder, emerging from the latter. Of course, it will be necesary for everyone to learn the "thought alphabet" just as the stenographer today must learn the various characters, or as the child is taught how to read and write, and as the cable operator must learn how to read the Syphon recorder "alphabet." All this, however, is simple, and is only an educational feature once the apparatus has been invented.

The objection naturally comes to the mind immediately that even if we have a machine to record the thoughts, all we will get on the tape will be a jumble of confused thoughts, and we might get a lot of things on the tape that were not meant for recording or registering at all. Such criticism, of course, is beyond controversy for the simple reason that when you write a letter by hand or on the typewriter, you have also at first a lot of confused thoughts, but you do not record such thoughts even by hand or by machine. It often happens after you have written down certain thoughts that you must change them. The same is true of the thought recorder, of course.

Here the man who is doing the recording has a push button in his hand, shown at A in our illustration; if he does not press the button nothing is recorded. Once he wishes to record his thoughts in an orderly manner, he pushes the button and the tape begins moving simultaneously—he will begin thinking in an orderly and slow manner the subject he wishes to record. He will think just as hard and just the same as if he were to pen down his thoughts by hand. The machine will then do the rest. If he thinks the wrong thoughts, naturally the wrong thoughts will be recorded, exactly the same as if he had written them by hand. There is no difference. In our illustration, our artist has endeavored to show what will happen in the future business office when the thought recorder comes into universal use. The business man of tomorrow will dictate his correspondence on the thought recorder, while his stenographer, who is perfectly familiar with his "thought writing," will type out the correspondence from the tape, which is kept moving by electric motors, in front of her eyes. A foot pedal stops or starts the motor, and there is also a reversing attachment so the tape will run backwards should she wish to re-read a certain portion of the tape.



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The True Wireless

By Nikola Tesla

(Continued from page 63)

greatly from the intensity of the received impulses because the electric niveau between the mountains is raised, as I have explained in connection with my lightning protector in the EXPERIMENTER of February.



Fig. 17. Illustrating Influence of Obstacle in the Path of Transmission as Evidence Against the Hertz-wave Theory.

Again in Fig. 19 two transmitting circuits, one grounded directly and the other thru an air gap, are shown. It is a common observation that the former is far

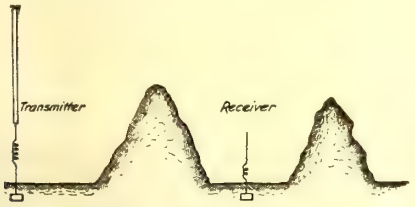


Fig. 18. Showing Effect of Two Hills as Further Proof Against the Hertz-wave Theory.

more effective, which could not be the case in a transmission with Hertz radiations. In like manner if two grounded circuits are

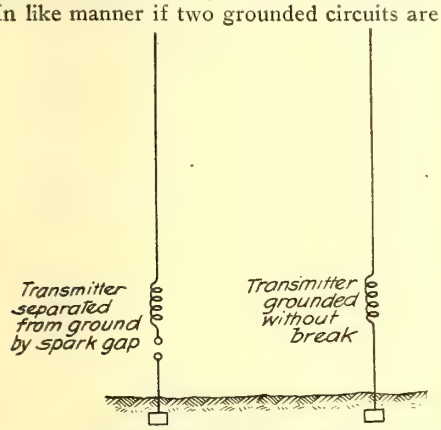


Fig. 19. Comparing the Actions of Two Forms of Transmitter as Bearing Out the Fallacy of the Hertz-wave Theory.

observed from day to day the effect is found to increase greatly with the dampness of the ground, and for the same reason also the transmission thru sea-water is more efficient.

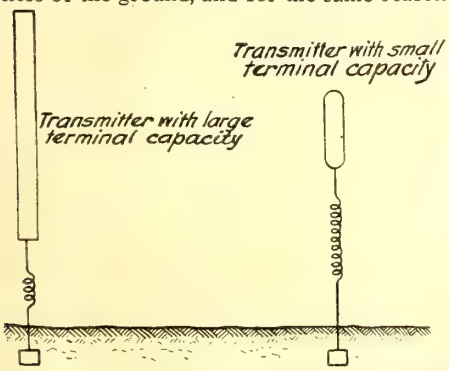


Fig. 20. Disproving the Hertz-wave Theory by Two Transmitters, One of Great and the Other of Small Energy.

An illuminating experiment is indicated in Fig. 20 in which two grounded transmitters are shown, one with a large and the other with a small terminal capacity. Suppose that the latter be 1/10 of the former but that it is charged to 10 times the potential and let the frequency of the two circuits and therefore the currents in both antennas be exactly the same. The circuit with the smaller capacity will then have 10 times the energy of the other but the effects on the receiver will be in no wise proportionate.

The same conclusions will be reached by transmitting and receiving circuits with wires buried underground. In each case the actions carefully investigated will be found to be due to *earth currents*. Numerous other proofs might be cited which can be easily verified. So for example *oscillations of low frequency* are ever so much more effective in the transmission which is inconsistent with the prevailing idea. My observations in 1900 and the recent transmissions of signals to very great distances are another emphatic disproval.

The Hertz wave theory of wireless transmission may be kept up for a while, but I do not hesitate to say that in a short time it will be recognized as one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history.

TO ALL RADIO AMATEURS

We have received many thousands of communications from radio amateurs for the past few months asking us about the status of their radio stations, and when they will be allowed to operate them again.

Inasmuch as there has been no official information as to the reopening of amateur stations, during the armistice, we can only say that in all likelihood, amateurs will not be allowed to operate until actual peace has been signed. In his executive order of April the 6th, 1917, President Wilson closed all radio stations in the United States by an act approved in the Radio Law of August 13, 1912.

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EDITOR.

WRINKLES, RECIPES & FORMULAS.

(Continued from page 42)

If carbon dioxid is to be generated, fill tube A with marble chips and tube B with dilute hydrochloric acid.

It is evident that the parts of the generator can be easily cleaned and new chemicals put in. The completed apparatus is shown in Fig. 3.

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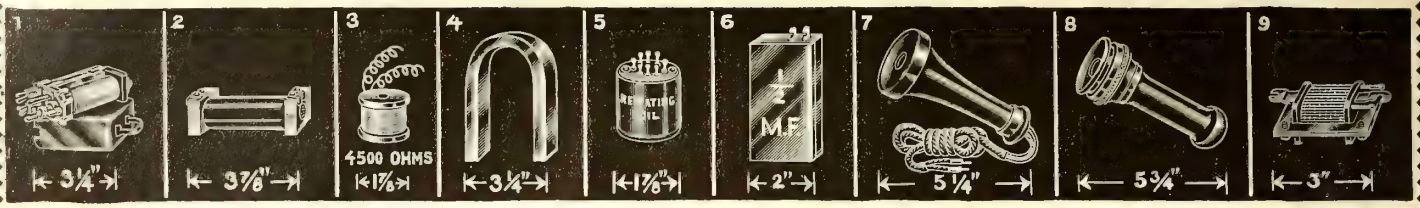
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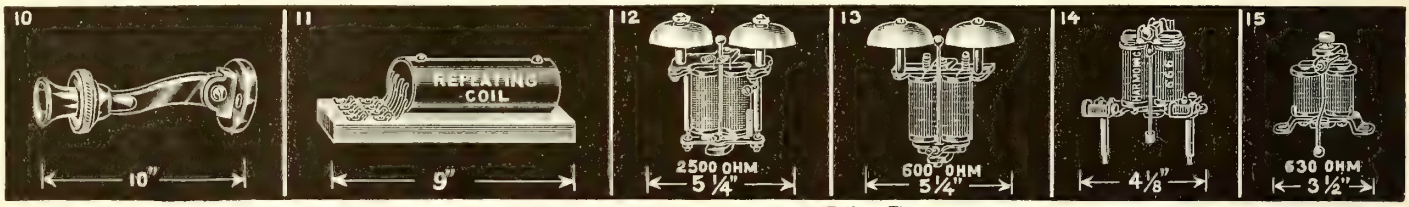
NO. 5 REPEATING COIL (Transformer). This is a standard small repeating coil and is used by all telephone companies. It has 4 different windings and eight contacts. Entirely enclosed in iron. The resistance being respectively 72 and 120 ohms, and 90 and 100 ohms. Diagram is furnished. Can be used for wireless, for boosting signals, etc.
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NO. 6 ½ M.F. CONDENSER. This is a standard telephone condenser and has ½ microfarads. Condenser comes in neat metal casing. This condenser is used in connection with spark coils to absorb the vibrator spark. Invaluable for test buzzers to absorb spark and make the sound of buzzer more steady. Is also used by every experimenter in connection with wireless where a fixed capacity is needed. Several of these condensers should be in every experimenter's laboratory.
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NO. 7 DOUBLE POLE BELL TELEPHONE RECEIVER—hard rubber casing with 4 ft. cord and tips. Standard 75 ohms—very powerful magnets. This receiver can be used in connection with any ordinary telephone work, and you will even find it sensitive enough for short distance wireless work.
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NO. 10 MICROPHONE AND BRACKET. An A-1 sensitive microphone of the carbon grain type. Has hard rubber mouthpiece and enamel steel bracket, the instrument being 10 inches long. This microphone, in connection with our No. 7 or 8 Receiver and No. 16 Ringer Box, will constitute a complete telephone outfit, good to speak 50 miles or more, at a remarkably low price.
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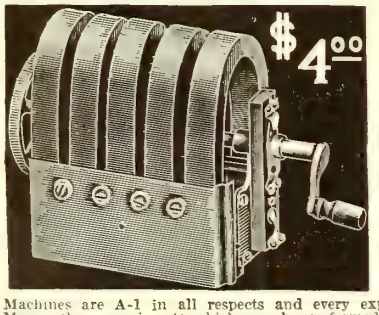
NO. 11 REPEATING COIL (Transformer). A standard repeating coil used for telephonic work. The coil windings are encased in an iron tube 2¼ inches in diameter. There are eight terminals for the four windings to connect to and the instrument is invaluable in connection with radio work to boost up signals, audion work, etc. Many interesting uses will be found for this coil. Resistances are: 100, 120, 145, 175 ohms.
No. 11 Repeating Coil—shipping weight, 8 lbs. Price..... **$2.00**

NO. 12 POLARIZED RINGER with Bells. The resistance of the two coils is 1250 ohms each. The armature is perfectly adjustable. Bell will work on any magneto. We also furnish blue print with ringer showing how *a first class polarized relay* can be made by anyone using only a few pieces of metal and screws.
No. 12 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.50**

NO. 13 POLARIZED RINGER with Bells. This is the same kind of ringer as the No. 12, except that it is not adjustable and that the resistance is less. First class in all respects. Blue print furnished with this to *make polarized relay* same as with No. 12. Solenoids on this ringer are worth more than the price we ask for the entire ringer, and do not forget a powerful magnet that goes with it.
No. 13 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.00**

NO. 14 HARMONIC RINGER. This ringer is also polarized and has a powerful magnet. It works on 66.6 cycles and any magneto will operate it if run at a certain speed. A very finely built instrument. Resistance of each coil being 200 ohms. Can be converted into a polarized relay by substituting a very fine leaf spring inside the heavy one furnished. A most interesting instrument with which to experiment.
No. 14 Harmonic Ringer — shipping weight, 4 lbs. Price..... **$1.60**

NO. 15 RINGER without Bells—630 ohms. This also is a polarized ringer and has an adjustable armature. The adjustment is done by means of the top screw. A beautiful little instrument. With this instrument, too, we furnish a blue print showing how a *polarized relay can be built.* You should have several of these beautiful little instruments. They are worth their weight in gold; the powerful magnet alone being worth more than the price we ask for the entire instrument.
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No. 55 5-bar magneto, 110 Volt A. C. Generator

This is one of the most powerful magnetos ever built, when manufacturers could afford to put good stuff into them; equipt with transmission, make and break, etc. Transmission wheels are all brass, crank handle furnished. This magneto, as well as the other ones listed below, will light a 110-volt lamp merely by turning the crank handle slowly. While this magneto gives alternating current only, it can be rewound so it will light up a number of four, six and 10-volt lamps, all depending upon the thickness of the wire you wind on the armature. As we furnish these magnetos, they will give a powerful alternating current and you will not be able to stand the current when grasping hold of the terminals. This makes an ideal shocking machine. All our generators can be transformed into a direct current machine by equipping it with a home-made commutator. Machines are A-1 in all respects and every experimenter should have one of them in his shop. Many other experiments which can be performed with this machine will readily suggest themselves to any experimenter. The magnets furnished with these generators are very powerful, each one being able to lift one pound easily.

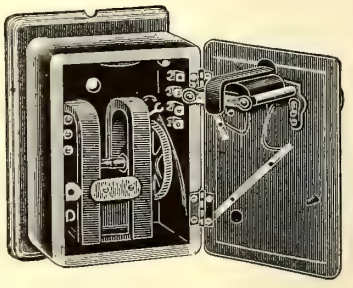
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NO. 33 3-BAR GENERATOR, same as described above except that it has only 3 bars, and is somewhat smaller.
No. 33 3-bar Generator—shipping weight, 10 lbs. Price..... **$2.00**

NO. 44 4-BAR GENERATOR, same as No. 55 except that it has 4 bars, and is somewhat smaller.
No. 44 4-bar Generator—shipping weight, 15 lbs. Price..... **$3.00**

NO. 66 6-BAR GENERATOR, same as No. 55 except that it has one more magnet and the armature is somewhat larger and more powerful. This is the biggest type made and is extremely powerful.
No. 66 6-bar Generator—shipping weight, 30 lbs. Price..... **$4.50**

No. 16 Western Electric Ringer Box



complete with 2500 ohm polarized ringer, bells in front of cabinet. The magneto furnished is of the two-bar type, brass gear transmission to drive it, and crank on the outside of the cabinet. The cabinet is of polished oak, piano finish and if you mount our No. 10 microphone and bracket in front of the cabinet and use our No. 7 or 8 receiver, and then use a switch to break the current you have a first-class telephone outfit at a ridiculously low price. This ringer box is one of the greatest bargains that has ever been put out. Even if you do not need it for telephonic work, you should have it as the instruments themselves are worth much more money than we ask for the entire outfit.

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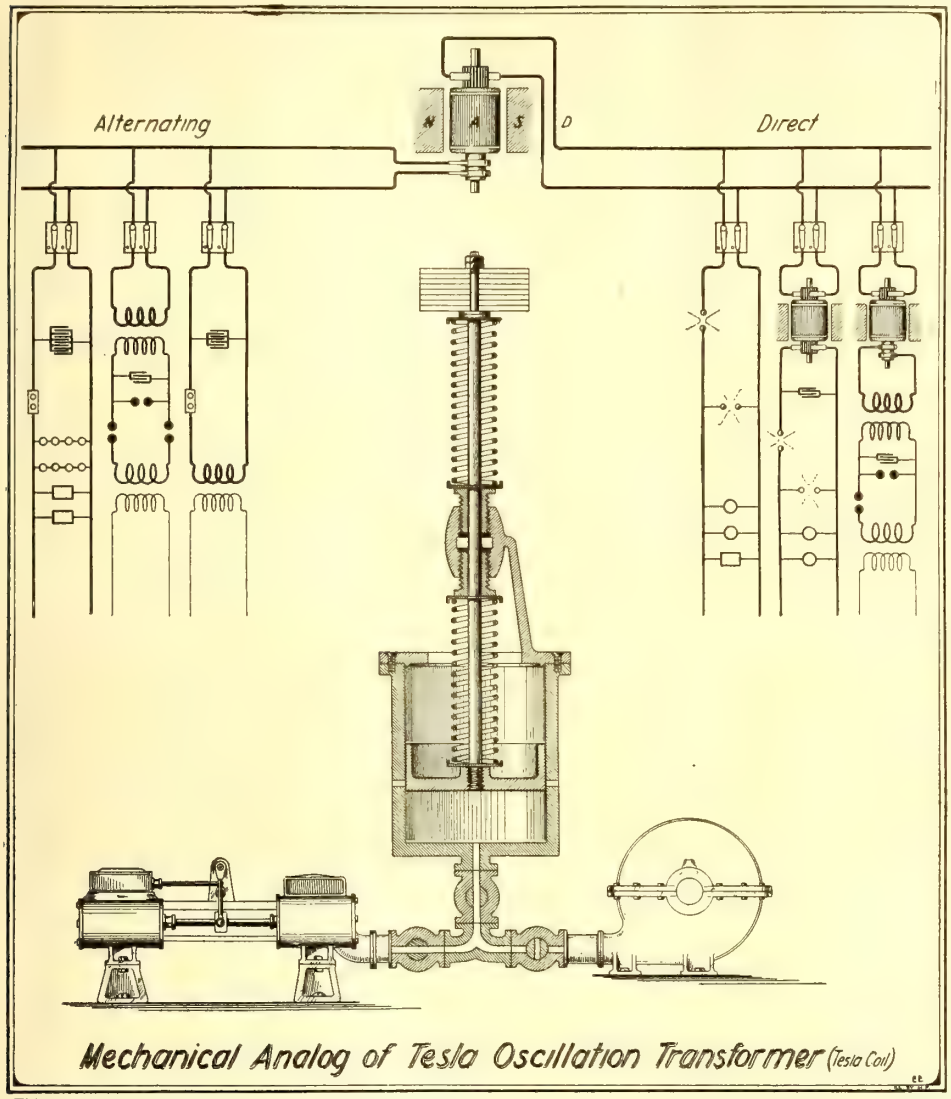
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My Inventions

(*Continued from page 65*)

engineers of a defect involved in the transformation by the new method, namely, the loss in the spark gap. Subsequent investigation showed that no matter what medium is employed, be it air, hydrogen, mercury vapor, oil or a stream of electrons, the efficiency is the same. It is a law very much like that governing the conversion of mechanical energy. We may drop a weight from a certain height vertically down or carry it to the lower level along any devious path, it is immaterial insofar as the amount of work is concerned. Fortunately however, this drawback is not fatal as by proper proportioning of the resonant circuits an *efficiency of* 85 *per cent* is attainable. Since my early announcement of the invention it has come into universal use and wrought a revolution in many departments. But a still greater future awaits it. When in 1900 I obtained powerful discharges of 100 feet and flashed a current around the globe, I was reminded of the first tiny spark I observed in my Grand Street laboratory and was thrilled by sensations akin to those I felt when I discovered the *rotating magnetic field*.



Mechanical Analog of Tesla Oscillation Transformer (Tesla Coil)

This revolutionary improvement was exhibited and explained by Tesla for the first time in his lecture before the American Institute of Electrical Engineers May 20, 1891. It has made possible to generate automatically damped or undamped oscillations of any desired frequency and, what is equally important, of perfectly constant period. It has been instrumental in many great achievements and its use has become universal. The underlying principle may be briefly stated as follows: A source of electricity is made to charge a condenser and when the difference of potential at the terminals of the latter has reached a predetermined value, an air-gap is bridged, permitting the accumulated energy to be discharged through a circuit under resonant conditions, this resulting in a long series of isochronous impulses. These are either directly used or converted to any desired volume or pressure by means of a second circuit inductively linked with the first and tuned to the same. The above diagram is taken from Tesla's lecture before the Franklin Institute and National Electric Light Association in 1893 and shows more elaborate arrangements of circuits, now quite familiar, for the conversion of ordinary direct or alternating currents into high frequency oscillations by this general method. In the mechanical apparatus illustrated, an attempt is made to convey an idea of the electrical operations as closely as practicable. The reciprocating and centrifugal pumps, respectively, represent an alternating and a direct current generator. The water takes the place of the electric fluid. The cylinder with its elastically restrained piston represents the condenser. The inertia of the moving parts corresponds to the self-induction of the electric circuit and the wide ports around the cylinder, through which the fluid can escape, perform the function of the air-gap. The operation of this apparatus will now be readily understood. Suppose first that the water is admitted to the cylinder from the centrifugal pump, this corresponding to the action of a continuous current generator. As the fluid is forced into the cylinder, the piston moves upward until the ports are uncovered, when a great quantity of the fluid rushes out, suddenly reducing the pressure so that the force of the compressed spring asserts itself and sends the piston down, closing the ports, whereupon these opecations are repeated in as rapid succession as it may be desired. Each time the system, comprising the piston, rod, weights and adjustable spring, receives a blow, it quivers at its own rate which is determined by the inertia of the moving parts and the pliability of the spring exactly as in the electrical system the period of the circuit is determined by the self-induction and capacity. Under the best conditions the natural period of the elastic system will be the same as that of the primarily impressed oscillations, and then the energy of the movement will be greatest. If, instead of the centrifugal, the reciprocating pump is employed, the operation is the same in principle except that the periodic impulses of the pump impose certain limitations. The best results are again obtained when synchronism is maintained between these and the natural oscillations of the system.

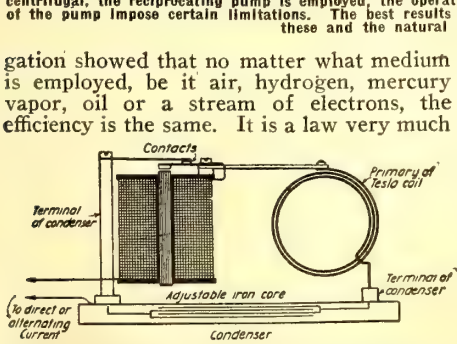


Fig. 3—Scheme of Circuit Connections In Tesla's Oscillation Transformer Shown in Fig. 1. The Secondary Circuit Which Slips Into the Primary Is Omitted.

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SKINDERVIKEN TRANSMITTER BUTTON

Transmitting Violin Music

Fig. 1 shows how the music of a violin can be transmitted by means of the Skinderviken button. The button may be attached to any part of the violin and if it is not desired to drill a hole into the violin which may be valuable, there are numerous places where the button can be attached by means of a small nut, or if this is not desired a small lump of sealing wax into which the thread part of the button is quickly prest before it cools, will do nicely. Music can thus be transmitted from one room to another.

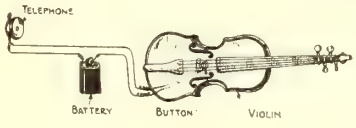


Fig. 1

Transmitting Piano Music

Fig. 2 shows how to transmit piano music at a distance. The button is attached to the front sounding board by drilling a very fine hole into the panel, or should this not be desired, it can be attached by sealing wax as described under Fig. 1. The wire can, of course, be concealed as desired. An interesting stunt can be performed by interposing a battery into the line, and the receiver shown in our diagram can then be the ordinary house telephone receiver. Piano music can then be transmitted to your friend who may be hundreds of miles distant, and the music will be absolutely clear. The same stunt can also be performed, of course, with the violin as shown in Fig. 1.

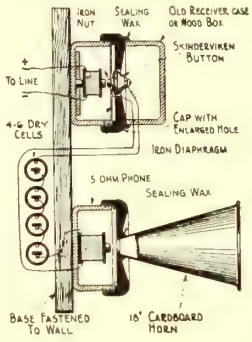


Fig. 3

A Loud Talker

Fig. 3 shows how an ordinary telephone receiver can be made into a loud talker. Very often it is desired to have a telephone conversation come in so loud that every one in the room can hear it clearly. Our illustration shows how this can be done. The telephone receiver connected to the incoming line is attached to the top of the base board as shown. The only alterations will be as follows: The cap is unscrewed and its hole is enlarged somewhat to take the Skinderviken button as shown. A thin iron nut is then attached, necessary on account of the pull exerted upon it by the telephone receiver. If the telephone receiver is a single pole type, the arrangement as shown in diagram is O. K. If a double pole receiver is used, a small iron plate instead of the nut must be used, as otherwise the pulling effect will not be so good, altho still appreciable. It is important that the nut does not touch the telephone pole piece, as otherwise the transmission will not take place. It will be necessary to underlay the diafram with a few paper washers in order to raise it sufficiently. After the Skinderviken button has been attached, it is necessary to enclose it in a sort of sound-proof box as shown in illustration. This box may be a turned wooden box, but an old telephone receiver shell will do nicely. It should be attached by means of sealing wax as shown, making it entirely sound-proof. The two transmitter wires are then connected to a loud talking receiver which may be an ordinary pony telephone receiver (single pole), which must be wound to *five ohms* or otherwise the results will not be satisfactory. By winding the receiver spool full *and evenly* with No. 26 enamel wire, you will get about five ohms. The battery between the standard receiver and the 5 ohm receiver must be ascertained by experiment, usually from four to six volts and sometimes as high as ten volts are required. It should be noted that the Skinderviken button does not easily burn out and can stand about one ampere continuously. The more battery current put on, the louder the voice. The important part now to consider is the transmitter horn, which must be made of white bristol board, the same as used on visiting cards. Buy it at any stationery store. The horn may be from 14 to 30 inches long, and the opening at the small end should be about ½ inch. It can be attached by means of sealing wax to the receiver cap. On the loud talker, the ordinary receiver diafram will do, altho one a trifle heavier works better. No magnet is used in this receiver as the pull on the diafram is electro-magnetic as well as the transmission of the voice. This device talks very loud.

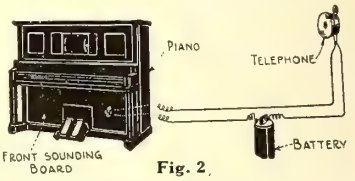


Fig. 2

How to Make a Telephone Extension

Fig. 4 shows how you can make a telephone extension to an existing telephone system. Suppose you are a telephone subscriber and you wish to have another extra phone somewhere in the building for someone else to listen in: all you need is a Skinderviken button mounted on a cigar box as shown. When the receiver is taken off the hook, it is placed on top of the cigar box directly over the transmitter button and from there the usual line runs thru a battery to the receiver. The distant party can then hear what is being said. If it is desired to have him reply also, in that case it will be necessary for him to talk into a Skinderviken transmitter and an extra line with a telephone receiver near the house phone. The party who makes the connection would then naturally have to take the receiver and place it over the mouthpiece so that the party at the other end of the wire could hear what is said. This arrangement is not shown in the diagram, but it is self-evident.

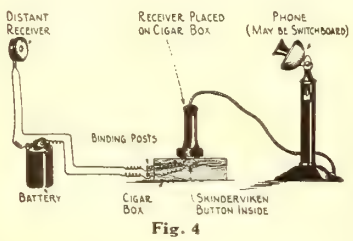


Fig. 4

"Howler," and Telegraph Practice Set

Fig. 5 shows an interesting instrument called "Howler". It is used in connection with telegraph practice instruments. It gives a loud clear musical tone every time the telegraph key is depresst. From two to three dry cells are used. The construction is somewhat similar as explained in No. 4 and the illustration is self-explanatory. The underlying idea is that the single pole telephone receiver works the Skinderviken transmitter which in turn again operates the telephone receiver, giving rise to a clear note; the same as if you take an ordinary telephone receiver of your house phone and place it over the transmitter mouthpiece, only you will find that the tone of the device described above is much better and clearer. This instrument probably constitutes one of the best and simplest learner's outfits. It can, of course, also be used as a radio test buzzer, simply by connecting one of the transmitter wires to the detector. It works very well indeed.

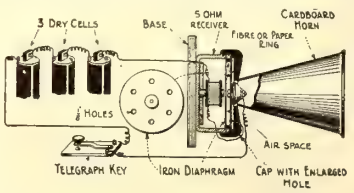


Fig. 5

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YOU can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *Our outfit was used by secret service operatives during the War. It is being used on the stage.* So much for its commercial adaptations! *You* can procure apparatus of the same type.

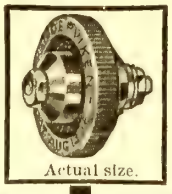

Actual size.



Fig. 3



Fig. 6

One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. In figures 3, 4 and 5 are shown some unusual and practical methods. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons cannot be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.

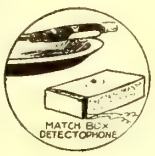


Fig. 4

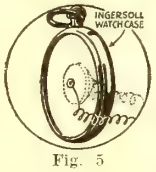


Fig. 5

Full directions for connecting up the button for use as a detectophone are given in booklet No. 4 which is sent with each button. Figures 1 and 2 of this advertisement, two of the many illustrations in booklet No. 4, show the circuit connections of the detectophone.

The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.

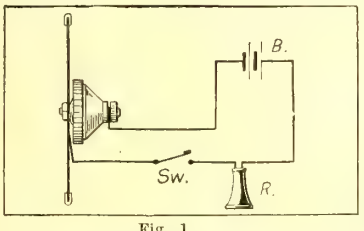


Fig. 1
Transmitter Button mounted on Diaphram. Simplest circuit.

BARGAINS

These prices are very low

All equipment is GUARANTEED. The apparatus is the same as sold by us to large telephone companies. 110 volt telephone generators.

3 bar	$1.75	Weight 6½	lbs.
4 bar	2.25	" 8	lbs.
5 bar	2.75	" 10	lbs.
Ringers 80 ohm	.35	" 1	lb.
" 1000 ohm	.75	" 1	lb.
Silk cords, 6 ft. 3 cond.	.20	" 3	oz.
" " 6 ft. 4 cond.	.20	" 3	oz.
" " 3 ft. 2 cond.	.10	" 1	oz.
Transmitters complete with Steco transmitter button	$1.50	12	oz.
Induction coils	.35	6	oz.

AMONG electrical experimenters the button has created a sensation. It is not uncommon to receive unsolicited letters like these: "I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

$1.00 ppd.

"I have been using one of your transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimentary." "I have been using one of your transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"

Mr. H. Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In writer's opinion, obtained by actual elaborate tests, your Transmitter Button is probably most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."



Fig. 7

Figures 6, 7 and 8 suggest some very interesting experiments. That of reproducing music at a point far removed from the phonograph is very popular with experimenters. The Skinderviken Transmitter Button is mounted in a very small hole in the under side of the sound arm. (Note: This hole will not injure the quality of the music.) When the phonograph is being played, the sounds produced are transformed by the Skinderviken Transmitter Button into a varying electrical current. The receiver, which is located in another room, reproduces the music at that point.

Figures 7 and 8 illustrate the methods of transmitting sound by means of the vibrations in a body while speaking. Speech will be reproduced by the receiver just the same as if the experimenter had spoken into a transmitter. In these experiments the Skinderviken Transmitter Button is mounted on a small iron disc.



Fig. 8

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

We have the utmost faith in our transmitter button. We guarantee satisfactory service or we will refund the purchase price. Boys — Young and old—send in a dollar bill RIGHT NOW! You can't lose. If you're not satisfied, you receive your dollar back. Isn't that fair?

Send a 3c stamp for a copy of Booklet No. 4.

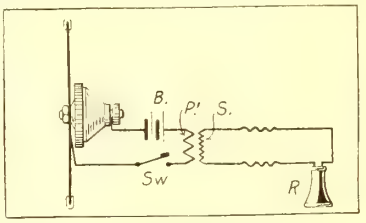


Fig. 2
Transmitter Button mounted the same but with Induction Coil.

USE THIS COUPON

STECO, 2134 North Clark St., Chicago, Illinois, or New York City, N. Y. (Use Pencil) E. E. 5-19

Gentlemen:—Please enter an order for Enclose sufficient postage for mailing.

[ ]	Skinderviken transmitter buttons	@ $1.00	prepaid	Ship to
[ ]	110 volt generators bars	@	Wt. lbs.	
[ ]	Ringers ohms	@	Wt. lbs.	
[ ]	Cords conductor ft.	@	Wt. lbs.	
[ ]	Induction coils	@ .35	Wt. lbs.	
[ ]	Transmitters with T. Button	@ 1.50	Wt. lbs.	
[ ]	Telegraph Keys	@ 1.25	prepaid	Send Booklet No. 4. [ ]

Opportunity Ad-lets

YOU will find many remarkable opportunities and real bargains in these columns. It will pay you to read and investigate the offerings made every month by reliable firms, dealers and amateurs from all over the country. No matter what you may be seeking, whether supplies, automobile accessories, the opportunity to make money, or anything else, you will find listed here the best and most attractive specials of the month.

Advertisements in this section seven cents a word for each insertion. No advertisement for less than 50c accepted. Name and address must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency.

Ten per cent discount for 6 issues, 20 per cent discount for 12 issues. Objectionable or misleading advertisements not accepted. Advertisements for the June issue must reach us not later than April 22.

The Circulation of the Experimenter is over 100,000 and climbing every month

EXPERIMENTER PUBLISHING CO., INC., 233 Fulton Street, New York, N. Y.

Automobile Accessories.

Liquid Silk Automobile Polish, finish lasts as long as new car, or money back. Sample 25c. prepaid. Liquid Silk Mfg. Co., Delanson, N. Y.

Ford power Mechanical Products greatly increase ability Ford Cars, Sedans, Trucks, Tractors, Racers, "4 Speed Forward Auxiliary Transmission"; Double Power, High, Low; Reverse; Powerful Motor Brake descending hills; "Absolute Neutral." Easy winter cranking. "Full-power" "16-Valve Cylinder Head," 20%-64% Power increase, government test. Other Ford Power Devices coming. Opportunity agent, dealer, owner. Send for trial plan K. Victor-Ford Trans. Mfrs., 246-248 W. 54th, New York.

Fords run 34 miles per gallon with our 1919 carburetors. Use cheapest gasoline or half kerosene. Start easy any weather. Increased power. Styles for all motors. Runs slow high gear. Attach yourself. Big profits for agents. Money back guarantee, 30 days trial. Air-Friction Carburetor Co., 270 Madison St., Dayton, Ohio.

Aeronautics.

Flies 2,000 Feet—Manhattan Racer, 26" wing spread, made finest materials, strictly a speed and distance aeroplane for amateurs. Great for spring and summer outdoor sport. Complete materials, knockdown, carved propellers, assembling and flying instructions, $3.50 Postpaid in U. S. Blueprint only, 35c. Postpaid. Blueprint Bleriot racer, guaranteed 600 foot flyer, 35c. Postpaid. Hec Aeroplane Co., 6 West 48th Street, New York City, N. Y.

Motorcycles.

Motorcycles from $25 up—New and second-hand. Easy terms, large list to choose from, all makes. Send 4c. stamp for Bulletin "A." Peerless Motorcycle Co., Watertown, Mass.

Telegraphy.

Telegraphy (both Morse and wireless) and Railway Accounting taught thoroughly and quickly. Big salaries now paid. Great opportunities. Oldest and Largest School—est. 45 years. Catalog free. Dodges Institute, 7th St., Valparaiso, Ind.

Stamps and Coins.

100 Different Stamps 10c., 200, 25c. Michaels, 5600 Prairie, Chicago.

Free—Packet Valuable Stamps to Applicants 50% Approval. Benj. Forbes, 160 Devilliers, Pittsburgh, Pa.

300 Different Stamps, 35c; 100 different U. S. 21c. C. Reitter, Box 1054, Detroit, Mich.

78 Different Stamps to approval applicants. Enclose 5c. Harland Burgett, 419 Spring St., Lima, Ohio.

For Sale—Twenty large American cents, all different dates, for only $1.55. Old coins bought up to 1916. Catalogue, 10c. Savage, 436 Melville St., Rochester, N. Y.

Stamps—61 all different free. Postage, 3c Mention paper. Quaker Stamp Co., Toledo, Ohio.

Stamps—Send 25c. for our collection. Some fine ones. Facastenhz, 425 LaGrave, Grand Rapids, Mich.

California Gold, Quarter size, 27c.; Half-dollar size, 53c.; Dollar size, $1.10; Large cent, 1820, and catalogue, 10c. Norman Shultz, Kings City, Mo.

500 Finely Mixed United States or Foreign Stamps, 12c. Philatelic Star, Madison, N. Y.

Old Money Wanted.

We Buy and Sell Old Coins. $2 to $500 each paid. Keep All Old Money; you may have valuable coins. Send 10c. for New Illustrated Coin Value Book, 4 x 6. Guaranteed prices. Get posted. Clarke Coin Co., Box 110, Le Roy, N. Y.

Tricks, Puzzles and Games.

Magic—Card Tricks—Sensational Escapes—Jokes—Novelties. Everything in the amusement line. Large illustrated catalog of a thousand tricks free. Write today. Largest amusement goods manufacturers in the world. Heaney Magic Co., Desk 200, Berlin, Wisconsin.

Leading Magical Magazine! All magicians like it! You will, too! Why? The value is there. Sample, 10c.; three months, 25c.; year, $1.00. Eagle Magician, Dept. E, Minneapolis, Minn.

Black Art Hindoo Experiments, 1919 Edition, 25c. Invisible Ink. Free Trick. Catalogue each order. Linhorst Magic X Shop, St. Louis.

1000 Stage Tricks with 500 illustrations. Catalogue 10c.; small catalogue free. Hornmann Magic Co., Sta. 6, 170 Eighth Avenue, New York.

Tricks, Puzzles, Jokes, Toys, Games, Novelties, Doll and Cane Racks, Plays, Wigs, Stage Supplies, Escapes and Illusions. Large 1917 catalog free. Oakes Magical Co., Dept. 549, Oshkosh, Wis.

100 Kinds Wire and Steel Puzzles. Catalog and leader, 10c.; postpaid. Western Puzzle Works, St. Paul, Minn.

77 S. Spencer Street,
Aurora, Ill.
Feb. 6, 1919.

Editor E. E.

Dear Sir:—The small ad I had in the February issue is surely bringing some great results, about six letters each day from all over the United States and Canada.

I would like to know the price of one insertion of the one-inch ad I am inclosing also cost of six insertions.

Please answer quickly.

Yours truly,

HOWELL RANG.

Exchange Ads.

For Sale—Single barrel shotgun, 110 v. Portable electric heater, Hawkins' Guides, Zeno chewing gum vending machine, and other articles. For description and prices, send three-cent stamp. Earl Brown, 514 Virginia Ave., Martinsburg, W. Va.

Wanted—Small motion picture machine for home, price about $10. Donald Porter, Frazee, Minnesota.

Sell—Motorcycle engine; telescope; chemicals; electric motor. Shank, 521 Jefferson St., Dayton, Ohio.

For Sale—1 K.W. Packard transformer, round detector and amplifier bulbs. Will buy old type General Electric Induction Fan Motor. Harry Weber, 1113 Walnut St., Dover, Ohio.

Wanted—Rifle telescope sight and Kraig rifle or carbine. A. L. Chamberlin, Box 132, Davenport, Iowa.

Bargains—Cyclopedia Applied Electricity, $15.00; Popular Science Library, $10.00; Excellent condition. First money order takes same prepaid. T. H. Blacknall, Box 107, Raleigh, North Carolina.

Sale—Regenerative Receiver, Storage Battery, other apparatus. Write for description. Thompson, 36 John St., Worcester, Mass.

For Sale—Twin Motorcycle, or engine, New Sayville Rotary spark gap, $7.00. Two Portable Wireless Sets, spark coils, wireless and electrical instruments. H. Gary, 600 Main St., Aurora, Ill.

Wanted—Smith motor wheels. Johnston, 9 Rutherford, Binghamton, N. Y.

Wanted—Small Graflex camera. A. Hofman, P. O. Box 809, City Hall Sta., N. Y.

For Sale—Wireless instruments. Vincent Natalish, 68 West 56th St., New York City.

Head Set—New Brandes distance phone—3,000 Ohm, $13.50, sell $8.00. Send stamp, large list Receiving Electrical apparatus. Dare, 94 Clinton Ave., Brooklyn, N. Y.

For Sale—Omnigraph five dials clock driven wireless code, quenched gap, polarized relay 5 ohms, stepup transformer. Will accept no less than $25 for outfit. Pastime Theatre, Union Hill, N. J.

Exchange Ads.—Continued.

Sell—Variety of articles, apparatus, etc. Write wants. Send stamped envelope. Vernon Palen, Sparta, Wisconsin.

"Multi-Audi-Fone", brand new, $15. Try this with your Audion or any detector. C. Francis, Box 1504, Providence, R. I.

Wanted—Quick! Volumes 1, 2, and 3 "Electrical Experimenter" either bound separate or any odd copies purchased. Good prices offered. Write for particulars and price to Box 70, Care Electrical Experimenter.

For Sale—Receiving set $10.85; consists of 15 and 7 inch double slider coupler, cat-whisker, detector, 14 point loading coil 17 and 3 inch. Have other wireless things. Send for list quick. George Faunce, 5 Green Street, Millville, N. J.

Cheap—Cyclopedia Applied Electricity. Stamps, Coins, junk. Howorth, University, Miss.

Exchange—Cycle-car for Smith Motor Wheel or bicycle engine or $50. Send stamp for particulars. Carl Mayo, Orleans, Mass.

Wanted—Whimshurst Static Machine. All letters answered. J. Picucci, 670 57th St., Brooklyn, N. Y.

For Sale—Shaw Motor attachment, $20. Harold Lambert, Haverstraw, N. Y.

Typewriter—Like new—For sale or exchange. John Galbreath, Rogers, Ohio.

For Sale—25 Watt Dynamo parts, $10. ½ K.W. Transformer Coil, $5. Electro Oscillation Transformer, $5. Loose Coupler, $2. Navy Receiving Transformer, $15. Blitzen Variable Condenser, $3. Murdock Variable Condenser, $3. Variable Condenser, $2. Ground Switch, $1.50. 2000 ohm phones, $2.50. Home Medical Apparatus, $3.50. Post Card Projector, $3.50. Bell Ringing Transformer, $1.50. $30 Mecanno, $20. All in good order. First draft or money order takes them. Burrows Rogers, Cainsville, Mo.

Sell or Exchange—Ford Gray & Davis Starting and Lighting system; Shaw bicycle motor attachment. Want Dynamo ½ K.W. or larger, 24 to 60 volts direct current, or screw cutting lathe 8" swing or larger. Frank Pantel, Muscatine, Iowa.

For Sale—Blueprints of motor windings, see ad under Blueprints, etc., this issue. Charles L. Chittenden, 811 West 181 St., Kansas City, Mo.

I have wireless apparatus and other things for sale. Write for list now. George Sharp, 73 Everett Ave., Providence, R. I.

Sale—Send stamp for list of wireless instruments, all bargains. Geo. Sprouls, 5624 Palethorpe St., Philadelphia, Pa.

Sell—New $50 Phonograph, $25. C. Gillespie, 72 Woodward, Buffalo, N. Y.

Sell—Motorcycle engine, $10.00; Magneto, $3.00; Spark coils, $1.50; Generator, $1.25; Motor, 75c. Harley-Davidson Motorcycle, $30.00. Ruben Hilborn, Brown City, Michigan.

Wanted—½ K.W. transformer, Packard or Thorderson. Clyde Stream, 2537 Elmwood, Kansas City, Mo.

Boys! Big mechanical Engineering Set. Contains three motors. All for $75.00, cost a lot more. Send cash in registered letter. Russell McQuilkin, Millport, Col. Co., Ohio.

Pocket Tester for electricians, trouble-shooters and maintenance men. For use in place of lamps on 90 to 500 volt lines for locating shorts, grounds, opens and blown fuses. Size 2½" x 5", in neat leather case with leads for testing. $1.50 postpaid. Falls Electric Shop, Cuyahoga Falls, Ohio.

Sell—White Cross Vibrator. Almost new, half price. Write Wm. Waldrip, Attico, Ind.

Sale—Swop. Whole Laboratory! Electrical Bargains. Write for list. All answered. Chas. Derrick, Grampian, Pa.

For Sale—$60.00 Regina Vacuum Cleaner with attachments, $25.00. P. Crawford, 13 Ten Broeck St., Albany, N. Y.

Sell—5 H.P. 2 cylinder gasoline engine, $46. Will exchange for screw cutting lathe. Herbert Sicklesteel, 802 12th St., Detroit, Mich.

Scenery for Hire.

Collapsible Scenery for all Plays. Amelia Grain, Philadelphia, Pennsylvania.

Agents Wanted.

Easy, Pleasant Work for mechanics, shop men, clerks, during spare hours, will add many dollars to their salaries. Also want persons who can give full time. Big wages assured. Novelty Cutlery Co., 308 Bar St., Canton, Ohio.

Insyde Tyres, inner armor for automobile tires, double mileage and prevent punctures and blowouts. Quickly applied. Costs little. Demand tremendous. Profits unlimited. Details free. American Automobile Accessories Co., Dept. 54, Cincinnati, O.

Mechanical Novelty for Old and Young. Barrel of Laughs—Amusement and Fun. Everybody possible customer. Samples with particulars, 25c. Rullet Co., Hartford, Conn.

Klean-Rite Marvelous Washing Compound. Whirlwind seller. Great Repeater. Big Profits. Shipments prepaid. Special offer and samples free. Bestever Products Co., 2426-L5 Polk St., Chicago, Ill.

$10 Daily refinishing chandeliers, brass beds, automobiles by new method, without capital or experience. Free particulars and proofs. Write today. Gunmetal Co., Ave. D, Decatur, Ill.

Miracle Motor-Gas amazes motorists. 3c. worth equals gallon gasoline. Eliminates carbon. 300% profit. Isom, Idaho, wires: "Ship 500 packages. Made $70 yesterday." Samples free. Chas. A. Butler, Sec'y, Dept. 70, Toledo, Ohio.

"History of the World War," by Francis A. March, brother of General March. Authentic, complete—750 pages—illustrated—official photographs. Freight paid—credit given. Agents making fortunes. Free Outfit. Victory Publishing Company, 649 Manhattan Bldg., Chicago, Illinois.

Install Farm Lighting Plants. Big Profits. Get our Agency Plans at once. Wolkee Co., Louisville, Ky.

Cameras, Supplies—Photo Developing.

Kodakers: How would you like to get a 9 x 11 enlargement of your best negatives free? Drop us a card right now asking about it. Films developed at 10c. per roll, prints 3c., 4c. and 5c. each. Satisfaction guaranteed. Ford's Foto Studio, Ellensburg, Washington.

Mail Us 15c with any size Film for development and 6 velvet prints. Or send 6 negatives any size and 15c. for 6 prints, 8 x 10" mounted enlargements 35c. Prompt, perfect service. Roanoke Photo Finishing Co., 255 Bell Ave., Roanoke, Va.

Frane's Brownatone 25c. Tones 250 pictures beautiful brown; easy as washing prints. Frane, Eureka, Ill.

Special Trial Offer. Your next Kodak film developed, 5c. Prints 2c. each. Moser & Son, 1919 St. James Ave., Cincinnati, O.

Clean, Neat, Perfect Kodak Finishing at the lowest prices. Work returned the same day received. Send film for sample print and copy of Catalog on Developing, Printing, Enlarging and Hand Coloring, also copy of Photo Craft Magazine, which will help you make better pictures. Photo Craft Co., Box 69, Ann Arbor, Mich.

Make real mystic photos without camera or plates by using Star Photo Papers. No experience necessary. Complete outfit for making 15 pictures, 25c. Abrams Co., 1305 Peoria St., Chicago.

Any six or eight exposure film up to Post Card size developed and printed, 10c, or enlargement, 8 x 10, your favorite negative, 20c. Special Introductory offer to show high quality work. Associated Photo Co., Dept. 12, Cincinnati, Sta. A.

Chemicals.

Chemicals and Laboratory Apparatus for analysis and experimenting. April list 5c. Frane, Eureka, Ill.

Chemicals or Chemical apparatus—We have just what you need. Our lists are without end. State your requirements. We also make up experimental sets of any value. The particulars of our standard sets will be furnished upon request. Zeigler Experimental Laboratory, Rochester, N. Y.

Stammering.

Stammering permanently eradicated at home. Cure positively guaranteed. Particulars free. Cheshire Training System, Keene, N. H.

For Advertisers.

Unheard-of Trial Offer! Inch display or 30-word classified advertisement ten weeks, $1.00. Record Advertiser, Box 2E, Houston, Va.

"Quick-Action Advertising—How it is Building Business for the Progressive Advertisers of America"; A little story of results told by the advertisers themselves—not the publisher. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 West 39th St., New York.

Business Opportunities.

Make Die-Castings. Sketch, Sample, Booklet, and Proposition, 12c. Byrd & Blair, Box 227E, Erie, Pa.

Why Sell Perfumes and Toilet Goods for others? Make your own; get all the profits. Particulars, Laboratory Box 1316—X— Memphis, Tenn.

Manufacturer desires electrical specialties. Devices or supplies having possibilities of large sales wanted. What have you? North Phila., Pa., P. O. Box 5861.

Earn Money at Home. "The Reliable Plan" tells how. Ten cents. Edw. C. Maher, Dover, New Jersey.

Victory—Mechanical Toy Soldier window attraction. 30 inches high. Salutes, turns head, points with finger, etc., as set. Well made, nicely dressed officers, privates, Uncle Sam, etc. Electrically operated. Does some stunt every half minute or oftener as set and will salute soldier and pay no attention to other if desired. Representative wanted in each city and town. Write for prices. The John M. Biggs Co., Box 324, Chattanooga, Tenn.

Dollars Yearly in Your Back Yard. No ginseng, mushroom dope. New ideas. Investigate. Particulars free. Metz, 313 East 89, New York.

Enter a new business. Earn $3,000 to $6,000 yearly in professional fees making and fitting a foot specialty, openings everywhere with all the trade you can attend to; easily learned by anyone at home in a few weeks at small expense; no further capital required; no goods to buy; job hunting, soliciting or agency. Address Stephenson Laboratory, 18 Back Bay, Boston, Mass.

Build Up an Income in Oil—Others are doing it—Why not you? Today is the opportunity. Join our easy monthly payment plan now—it may mean hundreds in profits. Write for information. National Oil Drilling Co., Dept. K, Houston, Texas.

$30.00 a week evenings. I made it with a small mail order business; continued my regular job daytime. Free Booklet tells how, 2 cents postage. Albert W. Scott, Cohoes, N. Y.

Patents for sale. To buy or sell patents address Patent News-H, Washington, D. C., only inventors' newspaper published.

Install Farm Lighting Plants. Big Profits Get our Agency Plans at once. Wolkee Co., Louisville, Ky.

"Quick-Action Advertising—How it is Building Business for the Progressive Advertisers of America"; A little story of results, told by the advertisers themselves—not the publisher. You will be interested in reading this little booklet, which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 West 39th Street, New York.

Are you in search of a formula to produce a certain preparation? If so, perhaps we can help you. We are ever on the alert and closely following the development of the industrial arts in all its branches. Our standard price for each formula or process issued is Thirty-five cents. Let us hear from you. Industrial Methods Bureau, 320 Fifth Ave., New York City.

Iceless Refrigerators. Particulars for stamp. Bachman, Box 57, Fullerton, Penn.

Hurry: Our First Issue. Plans and specifications for building National Advertising Weather Service. Sales talk picture of finished machine, etc. Profit $150.00 for manufacturer. Protected territory. Descriptive literature, terms and picture 25 cents. None free. National Sales Co., Box 421, Lima, Ohio.

Start a profitable business manufacturing "Puffed Crisp". Delicious confection. Whirlwind money-maker. Machine, Instructions complete $6.50. Samples 10c. Bestever Products Co., 2426-E5 Polk St., Chicago.

Want to make $30 a week in spare time? Particulars, 20c. Walker, Box 465, Dayton, Ohio.

Opportunity—I have a comprehensive, electrical idea; available for development, that should revolutionize a certain industry. Interesting research is here afforded experimenters and inventors in something new, useful and worthwhile for amateur and experienced electrical people. Postpaid three dollars. Roy Y. Hughes, Electrician, Mitchell, South Dakota.

Big possibilities in new profession. Easy to learn in comparatively short time. Field of practice unlimited. Many so engaged earning $2,500.00 to $10,000.00 a year. Exceptional opportunities for women. Write to Howard College, 527 S. Ashland Blvd., Chicago, Illinois.

Collections.

How to Collect Accounts; also Exposure of Membership and Contract Collection Agencies. Booklet 25c. Smith Mercantile Agency, Jefferson, Ohio.

For Men.

Razor Blades sharpened right. Single edge 2½ cents, double edge 3½ cents. Keenedge Shop, 7 South 10th, Philadelphia, Pa.

Help Wanted.

30 Men-Women, 18 or over, wanted immediately. U. S. Government positions. Commence $92 month. Vacations. Common education sufficient. Hundreds Permanent Peace Positions. Write immediately for list. Franklin Institute, Dept. E 26, Rochester, N. Y.

Wanted—Ambitious Workers to start Collection Bureaus. Be independent—make big income yearly. We train and refer business to you. "Scientific Facts" free. National Collection Bureau, Dept. 20, 65 Maynard, Columbus, O.

Dollars Saved—Used correspondence courses, bought and sold. MacMichael Educational Bureau, Victor, N. Y.

Be a Detective. Good income. Excellent opportunities to travel. Particulars free. Write American School of Criminology, Dept. E, Detroit, Mich.

Make Die-castings. Sketch, Sample, Booklet and Proposition, 12c. Byrd & Blair, Box 227F, Erie, Pa.

Books.

Books for Real Live People. Lists free. J. E. Sheridan, 417 E. 151st St., New York.

Dear Reader—If Occult, New-Thought and Scientific books appeal to you, send for my catalog, it's free. I have books on Personal Magnetism, Concentration, Spiritualism, Clairvoyance, Seership, Will, Mind, Hypnotism, Mesmerism, Character Reading, Healing, Mysticism, Success, Salesmanship, Mechanics, Entertainment, etc. A. W. Martens, J-49, Burlington, Iowa.

24 Money-Making Formulas, 25c. $15 course in candy making—6 complete lessons for 50c. Both books 60c. Alton Studio, Alton, Iowa.

Where to Buy Right; How to Advertise; no expense 2—25c. Box 115, San Francisco, Calif.

Invisible Inks—30 formulas, 15c. Horton P. Jones, Perry, Ia.

"Nature Book" facts every married and engaged person should know, 35c. Central Company, 599 Ninth Avenue, New York.

World-Romic System, Masterkey to All Languages. Six Textbooks, $1.44. French Chart, 37c; Spanish, 37c; Aviation Dictionary, $1.50. French-English Aviation Dictionary, 61c. Languages, 143 West 47th, New York.

To Get Better Pictures: Read the Amateur Photographers' Weekly; illustrated; weekly prize competitions; print criticisms; many unique features; $1.50 per year; three months' trial subscription 25c. Abel Publishing Company, 401 Caxton Bldg., Cleveland, Ohio.

Old E. E. Back Numbers: We have some valuable old E. E. back numbers on hand as follows: 1915—Jan., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec., price each 35c. 1916—Jan., Feb., March, May, June, Sept., Dec., price each 35c. 1917—Jan., April, May, Aug., Nov., Dec., each 35c. 1918—Jan., Mar., May, 35c; 1918—June, July, Aug., Sept., Oct., Nov., Dec., each 20c. 1919—Jan., Feb., Mar., Apr., 20c. We can fill orders at once upon receipt of your remittance, and if you have not these numbers already, now is your chance to get them, as they probably will be snapped up very quickly. Experimenter Publishing Co., 233 Fulton St., New York City.

Health.

Tobacco or Snuff Habit Cured or no pay; $1.00 if cured. Remedy sent on trial. Superba Co., SA, Baltimore, Md.

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Continued on page 94

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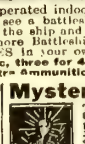
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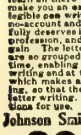
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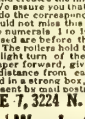
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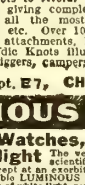
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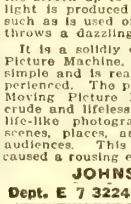
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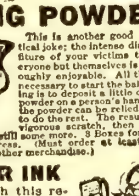
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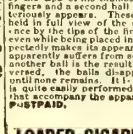
This trick is so effective and surprising The performer hands around the ball for examination, and immediately it is returned to him he seizes it by the tips of his thumb and forefingers and a second ball mysteriously appears. These are held in full view of the audience by the tips of the fingers of the left hand, and even while the fingers perform the dexterous manipulations necessary to produce its appearance. Finally the magician apparently suffers from some kind of spasm and yet another ball is the result. The feat can then be reversed, the balls disappearing one after another until none remains. It is a very interesting trick that is quite easily performed by following the directions that accompany the apparatus. **PRICE 25 CENTS, POSTPAID.** JOHNSON SMITH & CO.

GOOD LUCK RING



Quaint and Novel Design A VERY unique and uncommon ring, made of gunmetal. Skull and crossbone design, in two brilliant flash red eyes sparkling out of the center. A novel talking object of interest, hence the name **Good Luck Ring,** a id whilst we will not positively guarantee that, it is certainly a very unique ring that you will take a pride in wearing. They were made to sell at 50 cents, but as a special bargain we will supply them to customers mentioning this paper, at **Not. PRICE 25 CENTS, POSTPAID. JOHNSON SMITH & CO.**

LOADED CIGARETTES



Just Like Ordinary Cigarettes, But Such Real Startlers!

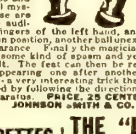
A box containing ten apparently genuine **Cigarettes.** They contain a cap which explodes with a loud report when one is smoked.

The cigarettes are real, and afford as good a smoke (while they last) that the victim is taken entirely by surprise. A great laugh producer and entirely harmless. **Price, box of ten, 25 cents, postage.**

Johnson Smith & Co., Dept. E-7

THE "LITTLE GIANT" TYPEWRITER

A First Class Writing Machine For $1.25



A per ect little typewriter for $1.25. There are thousands of persons who would like to use a typewriter but whose needs and business do not warrant the expense at ached to the purchase and use of a fifty or seventy-five dollar machine. To such persons we confidently recommend our Little Giant. It is strongly made, but simple in construction, so that any one can quickly learn to operate it, and write as rapidly as they would with pen and ink. The letters of the alphabet are conveniently arranged so as to enable one to write rapidly, the numerals 1 to 10, and the punctuation marks being together. With this machine you can send your best girl expert love letters, address-ed envelopes, bills, and do almost any kind of work not requiring a large expensive machine With each typewriter we send a book of full printed instructions for using the machine. Price complete **$1.25** by mail postpaid.

SERPENT'S EGGS



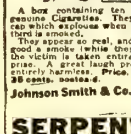
Each box contains 12 Eggs, which are no larger than a grain of oats. When lit with a match, however, each one gradually hatches itself into a Snake several feet long, which curls and twists about in a most lifelike manner. **Price per box 10c, postpaid. Johnson Smith & Co.**

MYSTIC SKELETON



A jointed figure of a skeleton 14 inches in height, which dances to music and perform various gymnastic movements while the operator may be at a distance from it. The figure may be controlled by the spectators. When handed back to the operator it is simply placed on a chair or table, when it will seemingly become endowed with life, and begin to move. At the command of the operator it will sit down, stand up, dance, etc. We send full direction with each Skeleton, by the use of which anyone can readily make it perform. **10c postpaid.**

CIGARETTE ROLLER

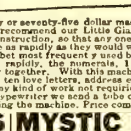


Very neat and handy. Weighs no more than a quarter of an ounce. It makes better cigarettes than you can buy and makes them easily and quickly. You can use just the tobacco you prefer and have a nicer "smokes" than ready made, and more of them besides saving about half of your money. Just the size and make of cigarettes just to your own liking. **Price only 10c or 3 for 25c postpaid,** with full instructions for use. **JOHNSON SMITH & CO.**

MIDGET ILLUSTRATED BIBLE

A Great Curiosity

The Smallest Bible in the World

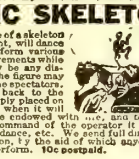


The Midget Bible is a perfect gem, and a work of art. It is about the size of a postage stamp and contains TWO HUNDRED AND FIFTY PAGES of the NEW TESTAMENT, profusely illustrated. This little Bible is a wonder. It is said to bring good luck to its owner. Must be seen to be appreciated. **Price, only 12 cents, three Bibles for 30 cents; one dozen Bibles for $1.00 or 100 for $6.00. Good money can be made selling these Midget Bibles amongst friends, church acquaintances, Sunday schools, bazaars, etc.** Send for a few and try it.

The CONJURER'S CASKET

Apparatus and Directions for a Number of Mysterious Tricks Enough for an Entire Evening's Entertainment 50c

ANYONE CAN DO THEM



It is great fun mystifying your friends. Get this Conjurer's Cabinet, and you will be the cleverest fellow in your district. It contains the apparatus for seven first-rate tricks, including The Disappearing Coin Box, by which, when you open your coat, vanishes from sight at will; the Magic Vase and Ball Trick (a Wooden Ball is placed inside, and upon replacing the lid has disappeared and is found in someone else's pocket); The Magic Nail with which you can apparently cut your finger almost in two; the Mysterious Card Trick (a card is placed in an envelope, and when opened an entirely different card altogether is found); The Disappearing Coin Box (a coin is placed in the little wooden barrel, and when opened again, is found to have vanished entirely, or can be made to change into a coin of another denomination); The Famous Mesmerized Penny that defies the law of gravitation (suspends from the palm of the hand, nose, cheek, wall, clothing, etc.); The Glass Goblet and Vanishing Coin Trick (a coin is dropped into a glass of water, and when the water is poured out the coin has vanished). With the seven tricks described above we send full printed instructions for performing each trick, so that anyone can readily perform all the tricks to the great amusement of their friends or the public. Any boy of ordinary intelligence with this Cabinet of Tricks in his possession, can give a parlor entertainment not inferior to some regular magicians. Besides the tricks contained in the Cabinet, there are twenty-five other feats and illusions fully explained with full printed instructions, for which you can easily make or procure the necessary apparatus Among them are The Mouse in a Pack of Cards, The Drawn Card, The Hat Trick, To Knock a Tumbler Through a Table, One Card Rubbed into Two, To Find the Number Thought of, Mysterious Wedding Ring etc. We also send the secret of performing three wonderful stage tricks, as follows: The Act of Cremation a Woman, Walking on the Ceiling of a Room, and the Disappearing Lady, together with an article of legerdemain and valuable hints to amateur conjurers. **PRICE COMPLETE ONLY 50 CENTS.**

JOHNSON SMITH & CO., Dept. E 7, 3224 N. Halsted Street, CHICAGO

The Newest Novelty Aerial Balloon



Flies gracefully in or outdoors. This is the VERY LATEST SENSATION IN BALLOONS. A brightly colored balloon that measures sixteen inches long is blown up in the usual way, and, when released, the air pressure sends the balloon SOARING UPWARD, the 24-inch propeller SPINNING AROUND AT A LIVELY RATE. The effect is startling. It is a graceful flier that makes the youngsters WILD WITH JOY. May be used repeatedly indoors or outdoors. An immensely interesting toy. **Price 10c each, 3 for 25c pd.**

JOHNSON SMITH & CO., Dept. E 7, 3224 N. Halsted Street, CHICAGO

"The Baby" Double Action Hammerless Revolver

A HANDSOME AND MOST EFFECTIVE WEAPON

$5.50 Measures but 4¼ inches long



Takes regular .22 calibre cartridges

The new **Baby Double Action Hammerless Revolver** has been produced to meet the ever increasing demand for a revolver that would combine small size and light weight with the essential features of **Efficiency and Practicability.** It is small in size, yet is just as effective and serviceable as the most expensive weapon you can buy. Every lady should have a revolver and should know how to use it, and there is no safer or better one made than the **Baby.** A great feature is the safety action that guards against accidental discharge, making it quite safe for young men and ladies. The illustration gives an idea of the appearance, but it should be seen and used to be thoroughly appreciated. The ammunition used is the standard .22-calibre (short) cartridge obtainable anywhere, or you may obtain the cartridges from us (cartridges can be shipped only by express). The revolver fires six shots in one loading. The operation of the charging mechanism is extremely rapid and absolutely reliable; six well-aimed shots can be fired in as many seconds. The revolver is very well constructed, with finest nickel plated finish barrel of cylinder, and it weighs only 4¾ ounces. **The Price of this Perfect Revolver is only $5.50, sent by mail postpaid to any address. JOHNSON SMITH & CO.**

THE EXPO WATCH CAMERA

The most wonderful and ingenious Camera made



It is but little larger than a watch, which it closely resembles. You can carry the Expo in your pocket and take pictures without any one being the wiser.

One Cent a Picture

The Expo loads in daylight with 25 Exposure Films, costing 25c, thus the picture taking part of a whole day's outing need not have had a greater sum of 25c—One cent a picture. 10 Exposure Films also obtainable. It is simplicity itself to operate. Takes pictures through the stem, where the **Rapid Fire Lens** is located. The photos (6/8 x 7/8) may be enlarged to any size.

Price $2.50

QUICK AS A FLASH

Time and instantaneous shutters; weighs but 8 ounces; nickel plated. Endorsed by amateurs and professionals the world over. Thoroughly practical—printing and developing of films just the same as ordinary cameras—is daily use by the police, newspaper reporters, detectives, and the general public. Important boats have been secured with the Watch Camera for enterprising reporters. Equal to a clear, sharp negatives indoors or outdoors equal to any camera on the market, size or price notwithstanding.

Expo Watch Camera $2.50 FILMS, 10 Exposures 15c, 25 Exposures, 25c
Postage 10c Anywhere Leather Pocket Carrying Case, 35c

Johnson Smith & Co., Dept. E 7, 3224 N. Halsted St., Chicago

Trim Your Own Hair With the Utility Safety Hair Cutter

Cuts the Hair Any Length, Short or Long—Saves its Cost First Time Used.



Agents Wanted

Price Only 35c Extra Blades 5c each

If you can COMB your hair you can TRIM your own hair with this marvelous invention. The UTILITY TRIMMER will cut hair any length you desire, short or long, finish the job as nicely as any barber and in one-fourth the time before your own mirror. The ladies can cut the children's hair at home to a nicety. It can be used as an ordinary razor to shave the neck and finish around the temples and neck. Sharpened like any razor, can be carried in the vest pocket ready for instant use, and will last a lifetime.

To use it, stand in front of a mirror, if necessary, and use the UTILITY TRIMMER like you would a comb. Push it through the hair, downward, in the direction the hair grows. **Never forward.**

To cut long hair, first moisten the hair and comb it, so it will lie close to the head, then start cutting at the back of the head as high as you desire, evenly all around the head. Finish around the ears and temples with a square cut, like a barber.

It is impossible to leave any "cut steps" in your hair with this device, as the handle guard guides the cutter blade evenly over the scalp.

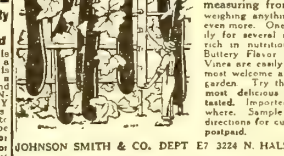
To cut very close, push the blade until the cutting edge is even with the guard teeth.

To shave the face or neck it can be used as an ordinary razor by reversing the blade in the holder, the cutting edge being to the back of the holder, exposing the entire blade, as in each case.

To hone, place the blade in the holder, with the cutting edge to the back, moving the blade out until the cutting edge is clear of the back of the holder. Then hone in the usual manner; finish on a strop as with an ordinary razor.

JOHNSON SMITH & CO., Dept. E 7 3224 N. Halsted St., Chic.

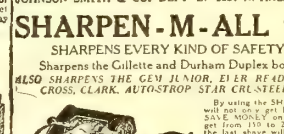
New Vamping Card



No Teacher Needed Surprisingly Simple System

Persons having neglected their Musical Education need not despair, for with the aid of our new VAMPING CARD placing them on the right track to playing by ear you can at once Vamp away to thousands of Songs, Ballads, Waltzes, Rag Time, etc., etc., equal to a Professional Musician. No knowledge of music is required. After using it a few times, you will be able to dispense with the aid of the Vamping Card entirely. **Only 15 cts. p. pd. Johnson Smith & Co., Dept E 7**

Gigantic New Games Butter Bean



The New Edible Vegetable Wonder

Grows to an astonishing size, the Bean measuring from 3 to 6 feet long and weighing anything from 10 to 16 lbs. and even more. One Bean is sufficient for a family for several meals. Very palatable and rich in nutritious materials. The delicate Buttery Flavor is much appreciated. The Vines are easily grown, very prolific, and a most valuable addition to any kind of garden. Try them; you will find them the most delicious vegetable you have ever tasted. Cannot be obtained elsewhere. Sample package of Seeds with full directions for cultivating and cooking **25c,** postpaid.

JOHNSON SMITH & CO. DEPT E7 3224 N. HALSTED STREET CHICAGO

SHARPEN-M-ALL SAFETY RAZOR STROPPER

SHARPENS EVERY KIND OF SAFETY RAZOR BLADE

Sharpens the Gillette and Durham Duplex both edges at one time

ALSO SHARPENS THE GEM JUNIOR, EVER READY KEEN-KUTTER, MARK CROSS, CLARK, AUTOSTROP STAR CRUSTEEL, AND ALL OTHERS



By using the SHARPEN-M-ALL STROPPER you will obtain a PERFECT SHAVE. You will SAVE MONEY on blades as you will be able to get from 100 to 200 shaves out of a blade of the kind above will be as good as the first. The construction is simple and will last a lifetime. There are no springs to get out of order. Any novice can use it just as well as the most expert barber. It is operated by simply raising the lever or handle as shown in the illustration. It has two spiral rollers which travel from heel to point as they are revolved, giving the CORRECT DIAGONAL STROKE. There are no screws, adjustments or any kind of tinkering necessary to operate the machine. The rollers are made of a special material that STROP AND HONE the blade at the same time. The rollers turn only one way, so there is no fear of cutting the blade on the stropper. The SHARPEN-M-ALL is packed in a handsome case 4x2¼x1¾ in. with three blades and full instructions. The weight of the complete machine is but eight ounces.

Price, only $1.00, postpaid.

JOHNSON SMITH & CO., DEPT E7, 3224 N. HALSTED STREET CHICAGO

Potmend *Stops a leak in a minute*



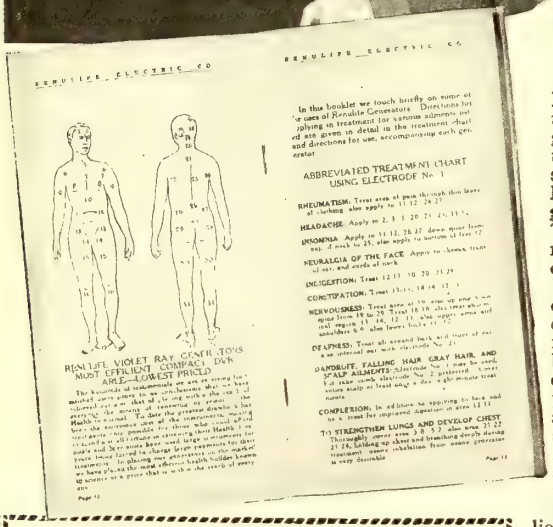
The finest repairer for Ironware, Agateware, Enamelware, etc. Good for kettles, pots, pans, boilers, and every kind of ironware, also for tin, copper, aluminum, ice boxes, hot pipes, cracks in stoves, broken china, porcelain, bric-a-brac, bisque, crockery woodenware, marble, etc. Will not chip, fly, burn, bake or boil out. **THE MEND IS THE STRONGEST SPOT IN THE POT.** Could not be simpler: just mix the powder with water. HARDENS LIKE IRON. Fire-proof, Water-proof. You can fill a big hole or a small crack. Mended place stronger than new. Replaces chipped enamel. Anyone can do it: FAILURE IS IMPOSSIBLE. Better and easier than solder. Three sizes, 10 cents, 25 cents and 50 cents.

Johnson Smith & Co., Dept. E 7 3224 N. Halsted St., Chicago

Now made simple and perfectly safe

TREAT YOURSELF With The Wonderful *Health Restorer* VIOLET RAY




RENULIFE ELECTRIC CO

In this booklet we touch briefly on some of the uses of Renulife Generators. Directions for applying in treatment for various ailments are fully and clearly given in detail in the treatment chart and directions for use, accompanying each generator

ABBREVIATED TREATMENT CHART USING ELECTRODE No. 1

RHEUMATISM: Treat areas of pain through thin layer of clothing, also apply to 17 12 24 25

HEADACHE: Apply to 2, 1, 3, 20, 21, 24, 11, 5.

INSOMNIA: Apply to 11, 12, 26, 27, down spine from nape of neck to 25, also apply to bottom of feet 32

NEURALGIA OF THE FACE: Apply to cheeks, front of ears, and cords of neck

INDIGESTION: Treat 12, 11, 10, 20, 21, 24

CONSTIPATION: Treat 13, 14, 14, 15, 1

NERVOUSNESS: Treat area on 19, also up spine from 19 to 29. Treat 18, 18, also treat abdominal region 13, 14, 12, 11, also upper arms and shoulders 6, 6, also lower backs 31

DEAFNESS: Treat all around back and front of ear as indicated on our work electrode No. 27

DANDRUFF, FALLING HAIR, GRAY HAIR, AND SCALP AILMENTS: Electrode No. 1 may be used, but take comb electrode No. 2 preferred. Cover entire scalp at least once a day, eight minute treatments

COMPLEXION: In addition to applying to face and neck treat for constipation, also areas 12 11

TO STRENGTHEN LUNGS AND DEVELOP CHEST: Thoroughly clean area 3 8 9 7, also area 31 32. Thoroughly clean area 3 8 9 7, also area 31 32. Treat for constipation, also areas 12 11. Lifting up chest and breathing deeply during treatment, assists inhalation from ozone generator, is very desirable

RENULIFE ELECTRIC CO

RENULIFE VIOLET RAY GENERATORS MOST EFFICIENT COMPACT DEPENDABLE—LOWEST PRICED

The thousands of testimonials we are receiving from satisfied users are in themselves ideal evidence that we have solved every problem in connection with the construction of a generator for violet ray treatments. To date the greatest drawback has been the excessive cost of the instruments, making them impossible for those who could afford the benefits they provide in relieving their ailments. Realizing this condition we have now brought out a generator that will produce the same results as all others at one-fifth the price. Many have been asking us for payments for their Renulife, but we have found it impossible to do business on this basis. However, in placing our generators on the market at the present low price, we have placed the means of health within the reach of every one, as a price that is within the reach of every one.

Page 11

You Can Have Bodily Vigor, Success-Attaining Energy, Attractive, Healthful Beauty

All at practically no cost—The great benefits of the ***Violet Ray treatments*** heretofore only procurable at big expense from physicians and beauty specialists are now available in your own home. Look over list of treatments below. Send for particulars.

How Violet Ray Benefits

Electricity from your light socket is transformed into health and beauty-giving Violet Ray—powerfully effective, yet gentle, soothing, perfectly safe. Voltage is raised from ordinary lighting current to *thousands of volts*, giving tremendous penetrative force. The irresistible, revitalizing powers of *Renulife Violet Ray* are carried at once to every nerve cell, fibre and part of body. Blood is enriched and purified by a flood of oxygen, giving added vitality and strength. Assimilation and digestion improved—functions restored to normal—extra supply of fresh blood quickly brought to area treated, removing congestion and supplying nourishment. While relieving pains and aches, the manifest results of disorders, it removes the deep-seated cause; combines the benefits of electricity, vibration, exercise, stimulation and oxidation.

Painless Electricity

Science has modified electricity that the weakest may stand its force without fear or pain. Every tissue and fibre is saturated, patient experiencing only a sensation of relief, as if standing in a ray of sunshine. *Violet Ray high frequency* has no comparison with old, crude, electrical batteries and shocking current. Every jar and shock is removed. The effects are marvelously rapid. Relief can be given in one or more treatments. Often cures are accomplished in that time. It is positive and certain in action. If you value your health, and want to keep or restore your good looks and gain vitality, throw away medicine bottles—take this sensible, scientific means. *Violet Rays* work with nature. Every day's delay makes relief more difficult.

Send for Booklet, "Health via Violet Ray."

Renulife Violet Ray
HIGH FREQUENCY GENERATORS

Offered on a Most Liberal
TRIAL PLAN
Learn the Wonderful Benefits by Actual Use

COUPON FOR BOOK and Special Information

RENULIFE ELECTRIC CO.,
636 Marquette Bldg., Detroit, Mich.

Please send without obligation, your book "Health," explaining Violet Ray treatments with Renulife Generators; also give full particulars as to its application for ailments checked below

TREATS SUCCESSFULLY

..Abscesses	..Facial Neuralgia	..Obesity
..Anemia	..Falling Hair	..Pain in Abdomen and Chest
..Asthma	..Female Complaints	..Paralysis
..Arteriosclerosis	..Goitre	..Piles
..Baldness	..Gout	..Pimples
..Blackheads	..Haemorrhoids	..Pyorrhea
..Brain Fag	..Hay Fever	..Rheumatism
..Bronchitis	..Infantile Paralysis	..Scars
..Bunions	..Insomnia	..Sciatica
..Bruises	..Lameness	..Skin Diseases
..Catarrh	..Locomotor Ataxia	..Sore Throat and Throat Diseases
..Colds	..Lumbago	..Sprains
..Chilblains	..Nervous Affections	..Toothache
..Dandruff	..Neuralgia	..Weak Eyes
..Deafness and Ear Diseases	..Neuritis	..Wrinkles
..Eczema		..Warts and Moles
..Enlarged Prostate		

Name.....

Address.....

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RENULIFE ELECTRIC CO., 636 Marquette Bldg., Detroit, Mich.

CANADIAN RENULIFE ELECTRIC CO.
236 Netting Bldg., Windsor, Ont.

SALES REPRESENTATIVES WANTED

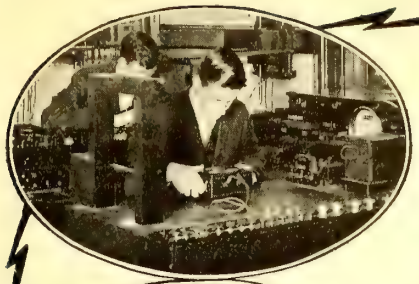

Unequaled for scalp and hair

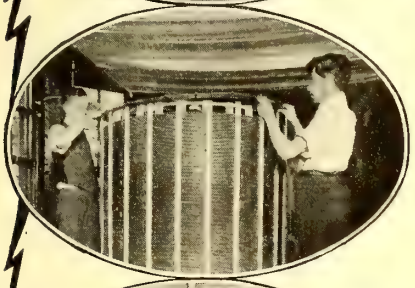

Brings beauty parlor to your home

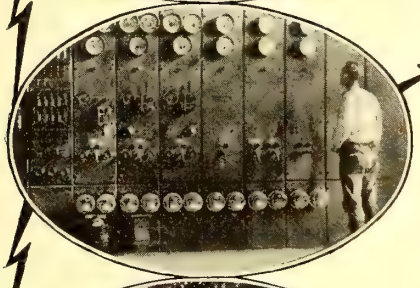
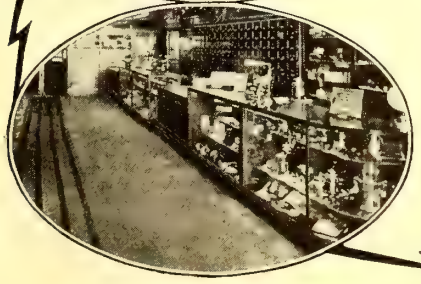

Inhaling ozone. For Catarrh, throat and lungs. Marvelous local results with general tonic effect


Treatment for general debility, nervousness, etc.

Learn ELECTRICITY as in practice



Electricity as experts know it—

RIGHT before you there is pictured a compact set of books which contains all the information you require to advance to the highest positions in the world of electricity. No instruction, no consultation by correspondence is necessary. The entire subject is before you, clearly written and clearly illustrated.

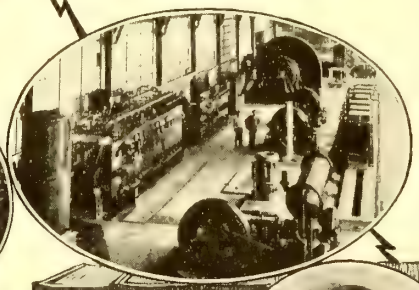
Whether you have spent years with electricity, or are a mere beginner, CROFT'S LIBRARY OF PRACTICAL ELECTRICITY will enable you to master modern practice, and fit you quickly for one of the thousands of responsible positions now open to those who are properly trained in electricity.

NOT ONE CENT IN ADVANCE

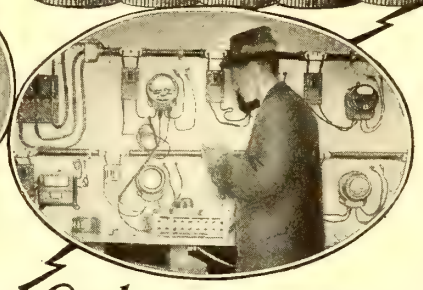
In twenty years' practice Terrell Croft has learned many things about electricity. As apprentice, as lineman, as draftsman, and finally as electrical engineer with the Westinghouse Company, he has learned the practical man's wants.

With his own practical experience, and with the co-operation of a score of other authorities, he has completed what is considered the most valuable study and reference course ever attempted.

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Gentlemen: The CROFT LIBRARY OF ELECTRICITY reached me March 3 and more than came up to my expectations. I have been in the electrical business for fifteen years, and know the general run of electrical books. Terrell Croft's Library is the best I have ever had the pleasure of examining.

Yours truly,
EDWARD T. HOFF,
713-3rd Avenue,
Asbury Park, N. J.

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Occupation Ex-6-19

Electrical Experimenter

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EDITORIAL

Tree Wireless

IN 1904, during Army maneuvers in California, General, then Major, George O. Squier, of the U. S. Signal Corps, made the important discovery that it was possible to receive radio messages, using live trees as an aërial. He found that by merely driving a metallic spike into the tree trunk, a few feet above the ground, and by connecting the wire from his radio receiving instruments to the spike, messages would come in astonishingly well over this new "aërial".

The invention, while important, received but scant notice, even in the scientific press of that day. Indeed, the majority of radio people knew very little about the invention, and those who did know considered the tree aërial as a freak, along with the bed-spring aërial and others of a similar nature.

During the war, however, the discoverer of the system, who had now become Major General Squier, Chief Signal Officer of the Army, made many new experiments with trees and radio. Recently, before the Physical Society, General Squier delivered a highly interesting lecture on the subject, and from what transpired, it is certain we have merely scratched the surface of an important invention.

General Squier, for instance, has been in constant communication with Europe for months, receiving messages from all of the large radio stations located in England, France, Italy and Germany, using nothing but trees for his aërials. But that was not all. He demonstrated that it was just as easy to *send* radio messages over a tree as it was to receive them. Indeed this holds true not only for telegraph messages, but radio telephone communication has been actually carried on between trees over a distance of *three miles!* So far no attempt has been made to increase this distance, altho it is obvious that any distance, depending only upon the power of the sending instruments, can be bridged in this manner.

That this system proved of immense value during the war can be readily imagined. Our signal corps men for that reason never were troubled with the communication lines in their rear, as long as there was a live tree about. No conspicuous wire aërial was needed for their radio work; code messages flew back and forth from the most extended points of our lines, right under the Germans' noses, who never suspected innocent-looking trees as being the carriers of priceless information.

General Squier thinks that the tree aërial will soon supplant the wire antenna entirely; even the big commercial stations, he thinks, can make excellent use of his discovery. The radio amateur particularly, will find the trees about his house a new and welcome source for his experiments. Many parents and landlords object to unsightly aërials on or about the house. An innocent-looking tree—if there is one near at hand—now solves the problem for the ambitious amateur. And the higher the tree, the better the results.

The new botanical antenna, on the other hand, brings us many new and interesting problems. One—and a curious one at that—is: How to figure the *wave length* of such an aërial! No doubt General Squier has, or will work out a standard formula for us. Undoubtedly, too, the wave length will vary from year to year—due to the growth of the tree. Then, too, in Spring, before the leaves are on the tree, the wave-length should be slightly less than in the summer time, due to the smaller area and resultant capacity. Also it would seem that in the winter time, the wave-length of the tree would be much less than in the Spring, due to the conducting sap receding from the branches.

Suppose you were to "spike up" every tree in a small wood—say, a thousand trees! The enormous area exposed to the ether, would theoretically give us a wonderfully effective antenna. We say theoretically, because we do not know how the immense added capacity would affect our instruments.

H. GERNSBACK.

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The Master Key tells of these wonderful Natural Laws and therefore substitutes definite principles for uncertain and hazy methods. An understanding of this scientific truth is the imperative condition, the underlying verity, the necessary precedent to every truly successful business or social relation.

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The Master Key avoids theory, speculation and abstractions of all kinds. It confines itself to the operation of natural laws. These laws are clear, concise, definite and positive and can be demonstrated by any one.

The Master Key is not interested in conditions or effects, but in the cause by which the effects are produced; it is therefore limitless and has rewards hardly to be expressed in words.

All conditions are the result of the operation of this law, but unfortunately, the law will operate to our disadvantage just as readily as for our benefit and for this reason many are unconsciously creating discordant, destructive, inharmonious, poverty stricken conditions instead of conditions of health, abundance, elegance, beauty, refinement and wealth. It is simply a question of understanding; a question of knowing how to take advantage of natural laws.

If you have any objective in life, which you have not as yet succeeded in taking, or if you wish to change any condition, physical, mental, financial or environmental, or if you wish to add an asset of inestimable value to your present resources, the Master Key has a message for you.

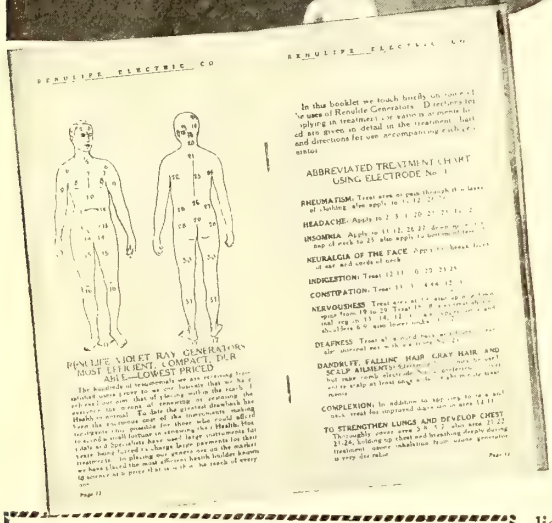
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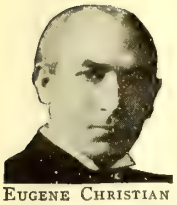
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New Stomachs for Old In 48 Hours

By R. S. Thompson


EUGENE CHRISTIAN

THOUSANDS of people who suffered for years with all sorts of stomach trouble are walking around today with entirely re-made stomachs—stomachs which have been re-made in from 48 to 72 hours! They enjoy their meals and never have a thought of indigestion, constipation or any of the serious illnesses with which they formerly suffered and which are directly traceable to the stomach.

And these surprising results have been produced not by drugs or medicines of any kind, not by foregoing substantial foods, not by eating specially prepared or patented foods of any kind, but by eating the plainest, simplest foods *correctly combined!*

These facts were forcibly brought to my mind by Eugene Christian, the eminent Food Scientist, who is said to have successfully treated over 23,000 people with foods alone!

As Christian says, man is what he *eats*. What we take into our stomachs today, we are tomorrow. Food is the source of all power, yet not one person in a hundred knows the chemistry of foods as related to the chemistry of the body. The result is we are a nation of "stomach sufferers."

Christian has proved that to eat good, simple, nourishing food is not necessarily to eat correctly. In the first place, many of the foods which we have come to regard as good are in reality about the worst things we can eat, while others that we regard as harmful have the most food value.

But perhaps the greatest harm which comes from eating blindly is the fact that very often two perfectly good foods when eaten at the same meal form a chemical reaction in the stomach and literally explode, liberating dangerous toxic poisons which are absorbed by the blood and circulate throughout the system, forming the root of all or nearly all sickness, the first indications of which are acidity, fermentation, gas, constipation and many other sympathetic ills leading to most serious consequences.

And yet just as wrong food selections and combinations will destroy our health and efficiency, so will the right foods quickly create and maintain bodily vigor and mental energy. In my talk with Eugene Christian, he told me of some of his experiences in the treatment of disease through food—just a few instances out of the more than 23,000 cases he has on record.

One case which interested me greatly was that of a young business man whose efficiency had been practically wrecked through stomach acidity, fermentation and constipation, resulting in physical sluggishness which was naturally reflected in his ability to use his mind. He was twenty pounds underweight when he first went to see Christian and was so nervous he couldn't sleep. Stomach and intestinal gases were so severe that they caused irregular heart action and often fits of great mental depression. As Christian describes it, he was not 50 per cent efficient either mentally or physically. Yet in 24 hours, by following Christian's suggestions as to food, his constipation was relieved, although he had formerly been in the habit of taking large daily doses of a strong cathartic. In five weeks every abnormal symptom had disappeared—his weight having increased 6 lbs. In addition to this, he acquired a store of physical and mental energy so great in comparison with his former self as to almost belie the fact that it was the same man.

Another instance of what proper food combinations can do almost overnight was that of a man one hundred pounds overweight whose only other discomfort was rheumatism. This man's greatest pleasure in life was eating. Though convinced of the necessity, he hesitated for months to go under treatment, believing he would be deprived of the pleasures of the table. He finally, however, decided to try it out. Not only did he begin losing weight within a few hours, regaining his normal figure in a matter of weeks, but all signs of rheumatism disappearing, and he found the new diet far more delicious to the taste and afforded a much keener quality of enjoyment than his old method of eating, and wrote Christian a letter to that effect.

But perhaps the most interesting case that Christian told me of was that of a multi-millionaire—a man 70 years old, who had been traveling with his doctor for several years in a search for health. He was extremely emaciated, had chronic constipation, lumbago, and rheumatism. For over twenty years he had suffered with stomach and intestinal trouble which in reality was superaciduous secretions in the stomach. The first menus given him were designed to remove the causes of acidity, which was accomplished almost overnight. And after this was done he seemed to undergo a complete rejuvenation. His eyesight, hearing, taste, and all of his mental faculties became keener and more alert. He had had no organic trouble—but he was starving to death from malnutrition and decomposition—all caused by the wrong selection and combination of foods. Almost immediately after following Christian's advice this man could see results, and after six months he was as well and strong as he had ever been in his life.

These instances of the efficacy of right eating I have simply chosen at random from perhaps a dozen Eugene Christian told me of, every one of which was fully as interesting, and they applied to as many different ailments. Surely this man Christian is doing a great work.

I know of several instances where rich men and women have been so pleased with what he has done for them that they have sent him a check for $500 or $1,000 in addition to the amount of the bill when paying him.

There have been so many inquiries from all parts of the United States from people seeking the benefit of Eugene Christian's advice and whose cases he is unable to handle personally that he has written a little course of lessons which tells you exactly what to eat for health, strength and efficiency. This course is published by The Corrective Eating Society of New York.

These lessons, there are 24 of them, contain actual menus for breakfast, luncheon, and dinner, covering every condition of health and sickness from infancy to old age and for all occupations, climates, and seasons.

Reasons are given for every recommendation based upon actual results secured in the author's many years of practice although technical terms have been avoided. Every point is explained so clearly that there can be no possible misunderstanding.

With these lessons at hand it is just as though you were in personal contact with the great food specialist, because every possible point is so thoroughly covered that you can scarcely think of a question which isn't answered. You can start eating the very things that will produce the increased physical and mental energy you are seeking the day you receive the lessons, and you will find that you secure results with the first meal. This of course, does not mean that complicated illnesses can be removed at one meal, but it does mean that real results can nearly always be seen in 48 hours or less.

If you would like to examine these 24 little Lessons in Corrective Eating, simply write The Corrective Eating Society, Department 1646, 443 Fourth Avenue, New York City. It is not necessary to enclose any money with your request. Merely ask them to send the lessons on five days' trial, with the understanding that you will either return them within that time or remit $3.00, the small fee asked.

The reasons that the Society is willing to send the lessons on free examination without money in advance is because they want to remove every obstacle to putting this knowledge in the hands of the many interested people as soon as possible, knowing full well that a test of some of the menus in the lessons themselves is more convincing than anything that can possibly be said about them.

Please clip out and mail the following form instead of writing a letter, as this is a copy of the blank adopted by the Society, and will be honored at once

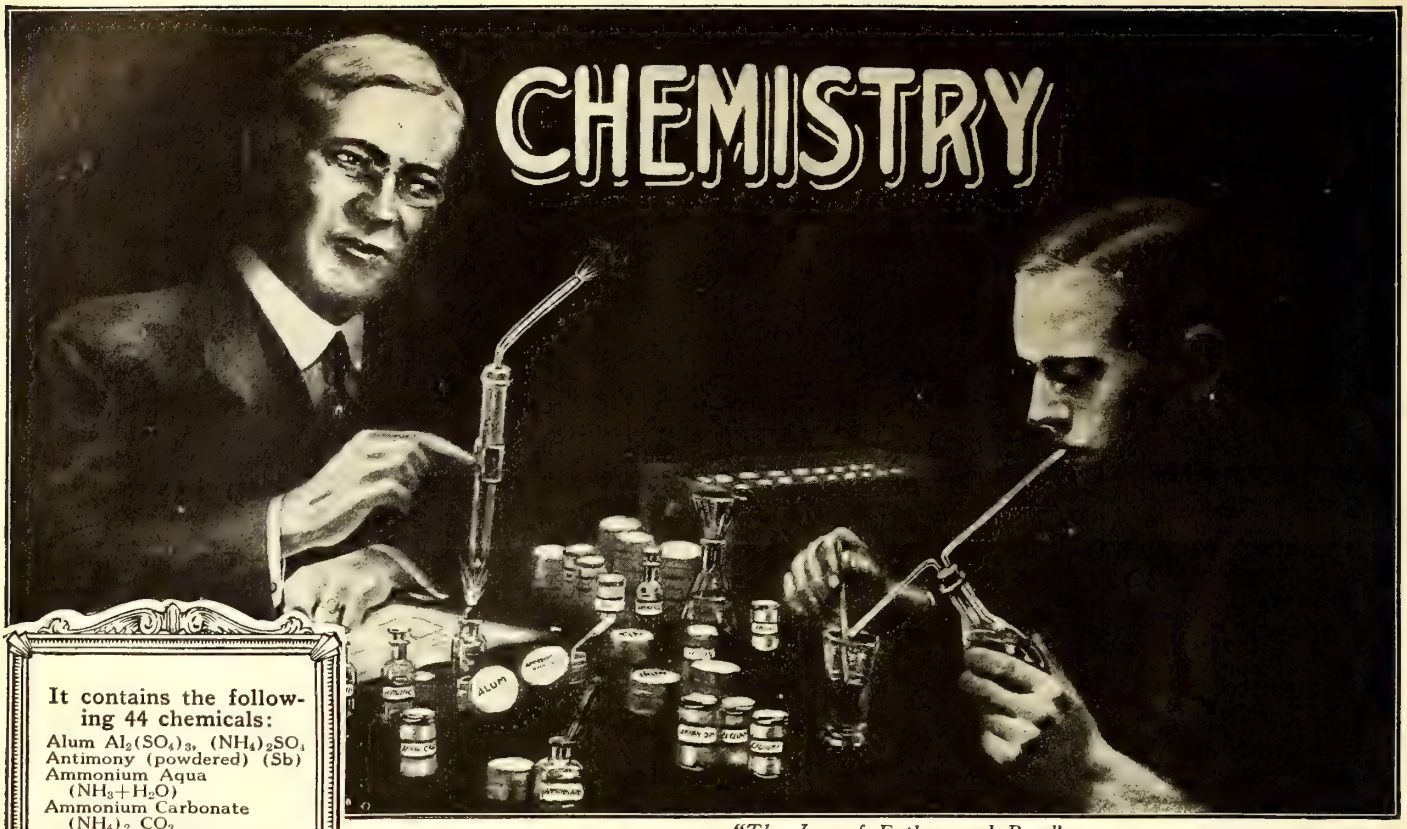
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Brimstone (Sulphur) (S)
Calcium Chloride $(CaCl_2)$
Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_4 2H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
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Magnesium Carbonate $(MgCO_3)$
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Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
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The apparata furnished are all of the best obtainable make and of standard laboratory size and shape. A list of the 17 pieces of apparata furnished with this outfit is printed also herewith.

The Instruction book is a real **Chemistry Course for the Beginner.** Some of the Contents are: **Division of Matter:** This is a Treatise on Elementary Chemistry and deals with the theory of the Elements, Molecules and Atoms, etc. **Chemical Nomenclature.** This explains in simple language the derivation of the chemical names of the Elements and their compounds. There is a chapter on **Laboratory Operations; Glass Working; First Aid; Fire Extinguishers; Experimenters' Aphorisms,** etc.

A good part of the book is devoted to Weights and Measures. The Metric System, the English system and the U. S. System are fully explained.

The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

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See our full page Ad, on page 182 for Free Cyclopedia

How I Stopped Forgetting In One Evening

How in One Evening I Discovered the Secret of a Good Memory and in Six Months Increased My Business One Hundred Thousand Dollars

By William Gerard

WHO would ever have thought that a $100,000 increase in my business would come from a simple secret learned in one evening. And yet, that is just what happened. I look back on it today, and can hardly believe that it is only six short months since I learned from David M. Roth, the famous memory expert, how to make my memory do wonderful things that I never before dreamed possible.

I consider the evening I met Mr. Roth one of the most momentous in my life. It was at a dinner of the Seattle Rotary Club. Mr. Roth was present and started his exhibition by asking sixty of those present to introduce themselves to him by name. Then he requested a gentleman at the blackboard to write down names of firms, sentences and mottos on numbered squares, meanwhile sitting with his back to the writer. After this, he was asked by various Rotarians to tell what was written down in the specific squares. Mr. Roth gave the entire list without a mistake. After finishing with this, Mr. Roth singled out and called by name the sixty men to whom he had been introduced earlier, and who in the meantime had changed seats and mixed with others present.

After the meeting, I was introduced to Mr. Roth by a mutual friend, and congratulated him upon his marvelous feats of memory. To my surprise, Mr. Roth said, "Why, Mr. Gerard, such things are nothing at which to marvel. Anyone can do these things and even greater things with his memory. A good memory is not a gift. Any person of average intelligence can easily develop his memory. I, myself, am an example of this fact. As a young man my memory was so poor I could hardly remember a man's face or name 20 seconds. I soon realized that this bad memory would scare away any chance I had for success. Right then and there I determined to improve my memory. And now, after 20 years of attention to the subject, I feel that I can do as much for other people's memories as I have done for my own. I have recently finished work on a simple and practical course through which anyone can improve his memory until it becomes a veritable sponge for absorbing facts, faces, names and all the information one wants to remember. This course contains all of my secrets and principles. If you will write to my publishers in New York, the Independent Corporation, you can make arrangements for examining the course without charge."

Needless to say I wrote the Independent Corporation, asking to examine the course. In a few days I received the seven lessons together with a little booklet of letters from many men telling what they had already done through the aid of the course. It was very encouraging for me to read the letter from C. Louis Allen, who at the age of thirty-two became president of the million dollar Pyrene Manufacturing Company, and is now the president of the Sales Company bearing his name.

"Now (says Mr. Allen) that the Roth Memory Course is finished I want to tell you how much I have enjoyed the study of this most fascinating subject. Usually these courses involve a great deal of drudgery, but this has been nothing but pure pleasure all the way through. I have derived much benefit from taking the course of instruction and feel that I shall continue to strengthen my memory. That is the best part of it. I shall be glad of an opportunity to recommend your work to my friends."

You may be sure that after reading the balance of the letters telling of *real results,* I went right at the course that very evening. I expected to find the lessons "brain breakers", but to my surprise, the Roth Course was as easy and fascinating as a game. I hated to put it by that evening and surprised my wife by repeating backwards, forwards and all ways fifty words of all sorts. My wife could not understand how a person with a memory so poor as mine could do such a thing after only about one hour's study. But the course gives the secret of a good memory *right at the start.* I played the memory improving game for a few minutes each evening for a month. And the further I got the more fascinating the game became. Long before a month was up I had amazed my family and my friends on a number of occasions by various memory feats, and to them the astounding difference in my memory was nothing short of a miracle.

And now, my memory behaves so efficiently that my business has felt the impetus of my increased mind power and has responded in a joyously lucrative fashion. Within the last six months my sales have jumped up $100,000*—with no "war-baby" or external force to boost my business.*

The reason I know that my business expansion is due to my own increased power is that I seem to have a new grip upon affairs. I employ old facts and experiences, give them a new twist and have thereby revitalized my business methods. I now remember and apply all that I have heard other people have learned. Nothing slips my mind that can be used to some business advantage. I find and store in my new, iron-bound memory real nuggets of facts and experiences that other people casually let drop. When a condition arises, I just seem to open a certain drawer of my mind, then take out and marshal together all facts and precedents that I have learned. My memory has become an ally that never fails to help me push my business ahead "on high."

I now seize many golden opportunities that before would have slipped by and been out of reach by the time I woke up.

You see the Roth Course has done vastly more for me than merely teach me how to remember names and faces, telephone numbers, etc. It has done more than make me a more interesting talker. It has done more than give me confidence in myself.

Mr. Roth's Course has endowed me with new business perspective. It has made me a keener observer. It has given me a new sense of proportion and values. It has given me visualization—which after all is the true basis of business success.

I feel that I owe the Roth Memory Course a great debt—in fact, a $100,000 debt. I feel that telling my story to the readers of The Electrical Experimenter Magazine is only a small payment for what the course has done for me. Any power that can increase a man's business $100,000 and increase his mind power 90% deserves that man's sincere and truthful endorsement. I *know* that this is what the Roth Memory Course has done for me and for my business. Not alone am I happy to be able to tell my story as it happened, but I am gratified to know that anyone can do the same thing. A mere glance over the first lesson will show that there is a course, not for "high brows" who love to bathe in theory, but practical and easy instructions for every man, woman or child, who knows the enormous value of a good substantial memory. This same hand of mine that gave out $5 for the Roth Course took in $100,000 as a result, and in telling my experience, I feel that in a small way, I am repaying the great debt that I owe to the David M. Roth Memory Course.

WILLIAM GERARD.

AMAZING MEMORY FEATS

Any man, woman or child of average intelligence can easily and quickly acquire a sure and exact memory.

When David M. Roth, the famous expert, first determined to cultivate his memory he did it because he had a poor memory. He actually could not remember a man's name twenty seconds. He forgot so many things, that he knew he could not succeed unless he did learn how to remember.

Today there are over ten thousand people in the United States whom Mr. Roth has met at different times—most of them only once—whom he can name instantly on sight. Mr. Roth can, and has, hundreds of times at dinners and lectures, asked from fifty to one hundred people to tell him their names and telephone numbers, and business connections, and then, after turning his back while they changed seats, has picked each one out by name and told him his telephone number and business.

These are only a few of the scores of other equally "impossible" things that Mr. Roth does—and yet a few years ago he could not remember a man's name twenty seconds. You too can do these wonderful things.

SEND NO MONEY

So confident is the Independent Corporation, the publishers of the Roth Memory Course, that once you have an opportunity to see in your own home how easy it is to double, yes triple your memory power in a few short hours, that they are willing to send the course on free examination.

Don't send any money. Merely mail the coupon or write a letter and the complete course will be sent, all charges prepaid, at once. If you are not entirely satisfied send it back any time within five days after you receive it and you will owe nothing. On the other hand, if you are as pleased as are the thousands of other men and women who have used the course, send only $5 in full payment. You take no risk and you have everything to gain, so mail the coupon or a letter now before this remarkable offer is withdrawn.

Independent Corporation

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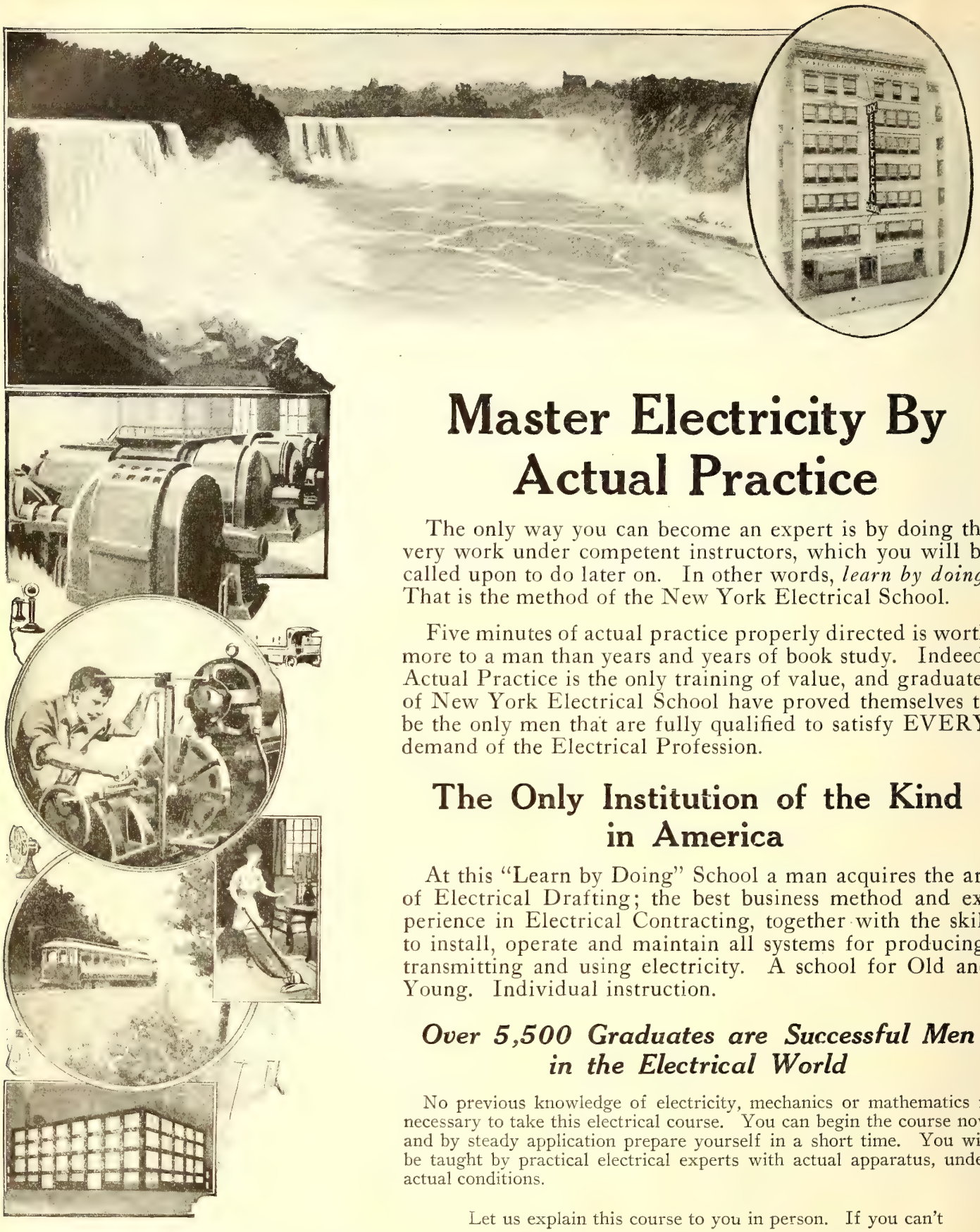
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Please send me the Roth Memory Course of seven lessons. I will either remail the course to you within five days after its receipt or send you $5 in full payment of the course.

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Vol. VII. Whole No. 74 JUNE, 1919 No. 2

Listening to Theater Critics

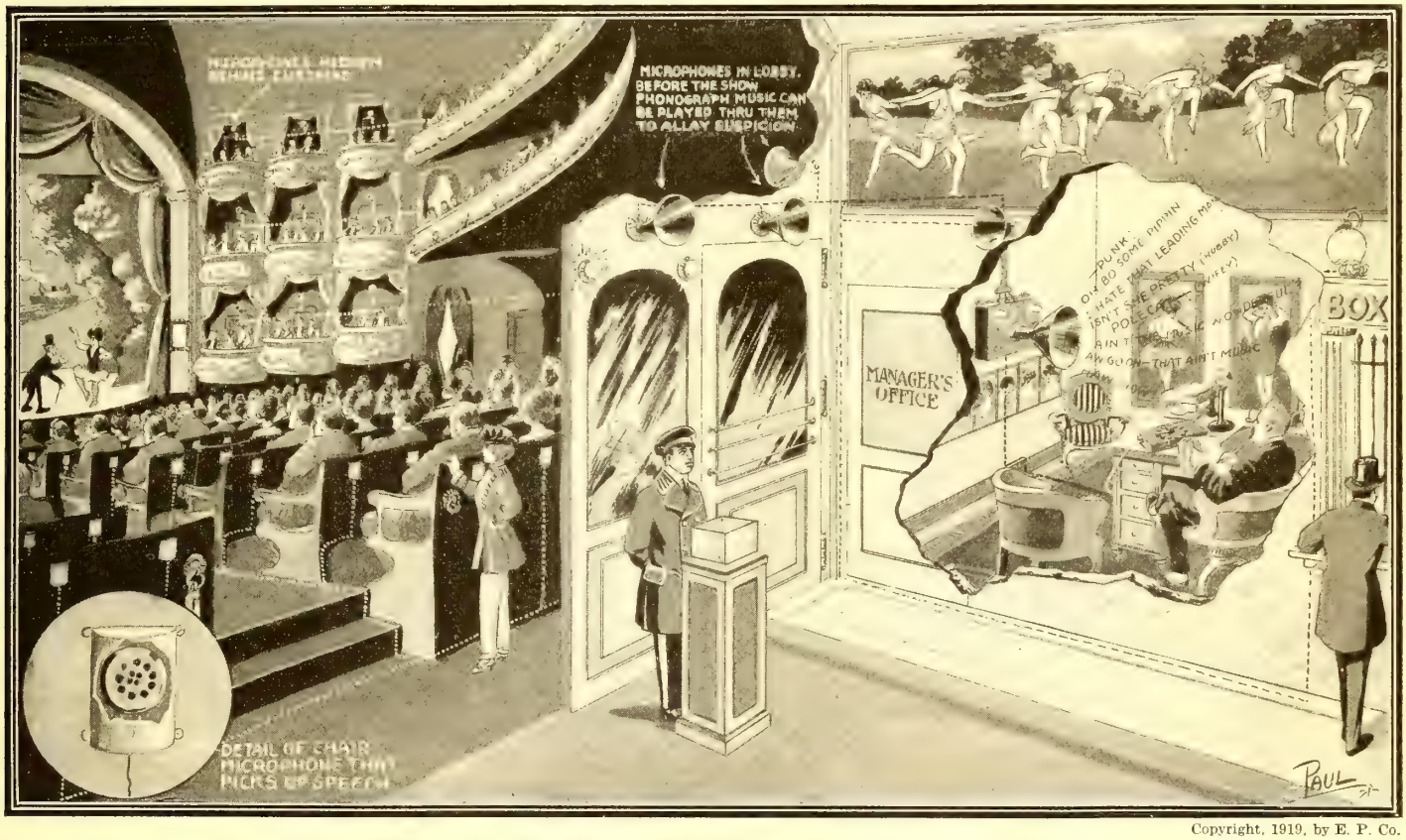
WE of the present generation have seen the dictograph or supersensitive telephone, applied to almost every purpose imaginable, from listening to the whispered machinations and plottings of criminals to the honeyed words of the philanderous husband making love to a chorus girl.

But now comes the very latest application of the dictograph, for the purpose of overhearing the criticisms of theater audiences, and it took Chicago to show us the way. In that city there is a large motion-picture theater completely equipt with dictograph transmitters or microphones, liberally sprinkled thruout the auditorium, so that the manager, by means of a small switchboard installed in his private office, may overhear the conversations, caustic or otherwise, regarding Bessy Tinkletoes and the merits and demerits of the corseted leading man, not to mention the "villiun" and the dashing, smashing "soubrette."

The *microphones* or sound-detecting apparatus, camouflaged so as to be invisible, are secured on the backs of the various chairs in the orchestra or balcony, and are connected up with separate wires leading to a switchboard in the manager's office, so that as the switch is turned, the respective microphones are switched into circuit alternately. The current modulations set up by even a whisper several feet away from one of these microphones act on a loud-speaking telephone at the manager's desk. It is also possible to connect up such apparatus with a set of head receivers strapt to the ears, the same as in the regular dictaphone sets used by crime investigators, after the fashion made famous by Detective Burns and other defenders of the common law.

Not only is it possible with such an arrangement to place microphones or sound detectors on the backs of seats in the auditorium, but they may be placed in the boxes behind portieres, and in many other advantageous and inconspicuous positions. It is rather difficult to conceal them in the foyer, but by a little clever subterfuge and ingenuity exercised by the engineers having charge of the installation, this problem is quite easily solved. For instance, an old trick of the showman may be put into play, namely, that to allay suspicion on any trick, you must convince the public that everything is apparently as it seems; and bearing in mind P. T. Barnum's famous lines—"The public likes to be fooled," and "There's one born every minute," we proceed in the present case to do a little fooling of the public ourselves, and thusly do we do it; by placing the microphones in a series of small ornamental horns about the lobby, in the bases of which there are also arranged loud-speaking telephone devices. Before the performance and during intermissions, when the foyer and lobby

(*Continued on page* 162)



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A New Idea Tried Out in a Chicago Theater—Eavesdropping on the Critics in the Audience. The Remarks of These Self-appointed Dramatic Critics Prove Very Valuable to the Enterprising Theater Manager, As a Failing Show May Be Revised and Strengthened So As to Make a Real "Hit." The Super-sensitive Microphone or "Dictograph" Solves the Problem—the Instruments, Distributed Thruout the Auditorium, Can Be Switched Onto a "Loud-talking Reproducer" in the Manager's Office, in Any Order Desired.

Electric Drive on U. S. S. "New Mexico"

By CHARLES M. RIPLEY

THE battleship *New Mexico* is the pride of the United States Navy, and her electric drive is the pride of the *New Mexico*. How the electrical machinery looks, how it works, why the electric drive is preferable to other forms of propulsion, how she looks inside and outside, is here related by one of the men who recently was a passenger on Uncle Sam's latest superdreadnaught, riding between the Brooklyn Navy Yard and Rockland, Maine.

This latest leviathan weighs 32,000 tons and requires 32,000 horsepower or *one horsepower per ton*. Her weight is equivalent to a bar of iron weighing one pound to the foot and forming a band of iron from the North to the South Pole with enough in addition to reach from Maine almost to the borders of Florida. She is so huge that it requires ten tugs to push her from her pier in Brooklyn Navy Yard out into the East River. From the platform called the "crow's nest" at the top of the mast down to the level of the water is 120 feet, or equal in height to a ten-story building.

The battleship can generate enough electricity to run the giant General Electric Works and the Schenectady Railway Company.

Motors Drive Propellers.

Like everything else that is electrical, the *New Mexico* is the cleanest institution of her kind. There are no engines or turbines connected with the propeller shafts—only electric motors. There are no grates under the boilers—merely oil burners. There is not a coal or ash shovel on the ship; nor are there any cinders, smoke, dust, or soot.

The *New Mexico* "coals" thru a 6-in. hose, that is because she burns only oil for her power. The total oil capacity of the dozen or more compartments is 3,400 tons or 6,800,000 lbs., or nearly a million gallons. If the *New Mexico* were an automobile with a mileage of 20 miles per gallon, this amount of oil would drive her close to 20 million miles or a distance equal to 80 times to the moon. But a 32,000-ton battleship does not equal the mileage of a flivver, for it weighs as much as 60,000 of those vehicles, and must plow thru the water displacing her own weight of water each time she runs her own length, 624 feet. The cost of fuel is more important on ship board than on land, and this is emphasized by the fact that on the 2,000-mile trial trip alone she will displace over 620,000,000 tons of water.

From Oil to Electricity.

Following the energy of the oil fuel thru the different processes until this energy drives the propellers electrically is an entertaining and instructive trip. Escorted by courteous officers, you start for one of the three boiler rooms. You must open and close several steel bulkheads in the watertight compartment and descend steel ladders and steel steps apparently equivalent to those in a five-story building. On the way down you must pass thru an "air lock" similar to those which give the excavators access to the caissons used in building the foundations of the skyscrapers 90 feet under Broadway, or in constructing the piers under big bridges in the middle of the river. The officer who escorts you is very careful to close the steel door behind you before he opens the one in front of you.

High Air Pressure.

No sooner are the bolts loosened than you feel the increased air pressure swish into your ears. This is because the air in the fire-room is maintained at a higher pressure than the outside air. All the air which the firemen breathe is pumped air. There is more oxygen in a cubic foot of this air than there is in ordinary air. This increased pressure and increased oxygen are both useful in providing the proper combustion in the boiler.

How Smoke Screens Are Made.

If the *New Mexico* wishes to throw a smoke screen, the men in the fireroom merely turn a few tiny hand valves in a ¼-in. pipe and, presto! inky blackness will vomit from the single smoke stack and blacken vast sea areas. This is a very nice study of how different mechanical mixtures of oil and air will bring about different chemical combinations between oil and oxygen. One of these combinations eliminates smoke by effecting almost perfect combustion; while the other creates a heavy black smoke which will practically blindfold the enemy. And three little ¼-in. pipes in each boiler are all that is needed to do this.

THE day of the all-electric superdreadnaught, not to mention electrically driven war vessels and merchant ships of smaller size, has arrived. In the present article Mr. Ripley gives us an interesting authoritative description of his trip on Uncle Sam's latest superdreadnaught, the "New Mexico", with her 32,000 horse-power electric propelling plant. Like everything else that is electric, the "New Mexico" is the cleanest institution of her kind. There are no engines or turbines directly connected with the propelling shafts—only powerful electric motors. There are no grates under the boilers—merely oil burners. Electrical propulsion not only does away with reversing turbines, but also does away with reduction gears, with their accompanying mechanical loss. The battleship "New Mexico" can travel a distance of 7,500 knots at 12 knot speed before it will be necessary to take on more fuel. The electric equipment totals nearly 100,000 horsepower, including over 100 loud speaking telephones, nearly 200 electric fans, electric gyroscopic compasses, and in fact "Electricity" rules the day everywhere about this modern naval wonder.

Size of Boilers.

It is said that no other 32,000-ton battleship has as few as nine boilers. There are three boiler rooms, each in a separate compartment, and each room contains three large boilers. Each of these nine boilers can deliver over 4,000 horsepower and contains three miles of 2-in. seamless pipes. Put end to end the pipes in all nine boilers would make a seamless tube 27 miles long. The Pennsylvania has 12 boilers and the Oklahoma has 12, altho its tonnage is only 27,500.

The history of the steam engine shows that its inventor, James Watt, thruout his entire life opposed any steam pressure higher than 5 to 10 lbs. per square inch. The *New Mexico's* boilers supply *steam at 250 lbs. per square inch!*

Superheated Steam.

After the steam is generated, and has past thru the big pipe away from the water in the boiler, it is again brought in contact with the flames of the furnace and is superheated to a still higher temperature. In fact, as the steam leaves the boiler it is about 450° F., or hot enough to melt solder and tin.

Superheated steam gives super-results. This is because the steam turbine is clast among engineers as a "heat engine" and the more heat that is supplied in this steam the more energy is available for power.

Two Power Plants.

For propulsion there are two electric power plants in separate compartments. They are way down low in the *New Mexico* close to the boilers. Each of these power plants alone is able to drive the battleship at a speed of 18 knots. (A nautical mile, or knot, is 6,080 feet, as against 5,280 feet in a land mile.)

Turbine Electric Plant.

In two separate steel compartments 15 by 45 ft. are located the two turbine generator sets, each not over 27 ft. long. The turbine itself is little larger than a hogshead of molasses laid over on its side. It seems almost incredible that this small machine can generate 16,000 horsepower from steam.

The engine rooms of most ships of the past have been a tangle of bending and curving pipes, and in order to move about the men had to stoop down to go under them or climb over them or squeeze between them. When one of these pipes burst it practically meant the death of every man in the engine room. One of the advantages of these power plant rooms in the *New Mexico* is the fact that there is only one steam pipe in the room, and that is only 16 ft. long.

Steam Turbine.

In each of these two power plants the steam turbines make electricity for driving the battleship. From the outside the most interesting thing about these wonderful rotary steam engines, called turbines, is their small size, their light weight, and the fact that they are so perfectly enclosed that you cannot see anything move. A turbine of 16,000 horsepower when compared in size and weight with the great triple and quadruple expansion steam engine that had been used up until recent years, is practically a watch charm—a little toy. There is only rotary motion in the steam turbine.

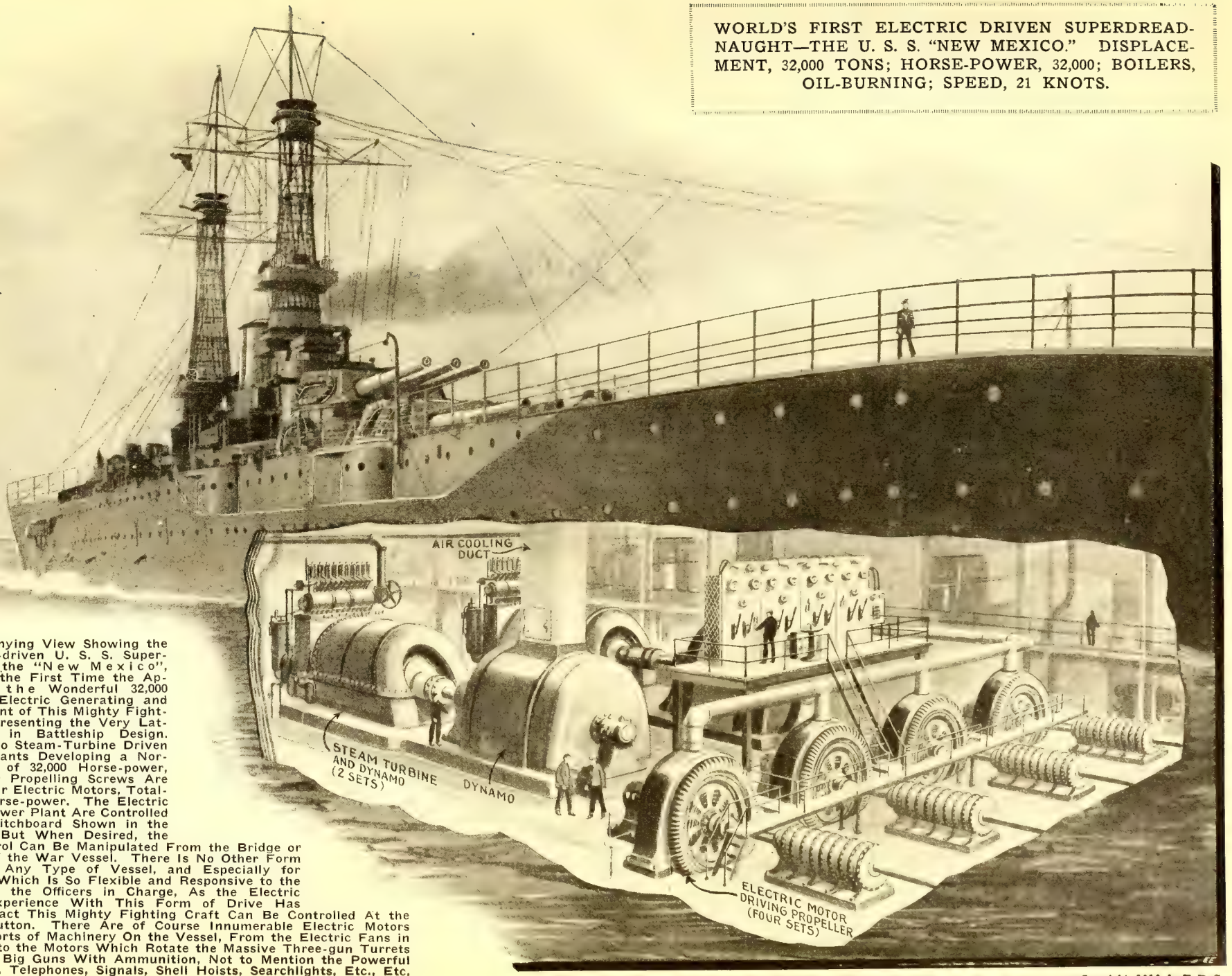
Inside the casing are ten wheels arranged side by side like the coins are kept in a bank. In the rims of all of these wheels are hundreds of buckets against which the steam strikes. The steam enters at one end of the turbine and dashes against the buckets of each of these wheels, one after the other; and as it strikes against these buckets the wheels and the shaft to which they are fixt all turn around. This shaft drives the electric generator immediately adjacent, and in it the mechanical power is turned into electricity. Then eight copper wires only slightly larger than a garden hose convey the 16,000 horsepower thru the steel walls to the next compartment where the switchboard is located. Electric fans in the power plant ventilate the room and also *cool the generator*, and the heated air is pumped outside.

The Switchboards.

When the eight electric wires leave the power plant room, they go to the electric switches back of the switchboard. Here the ship is controlled upon receipt of in-

(*Continued on page* 183)

WORLD'S FIRST ELECTRIC DRIVEN SUPERDREADNAUGHT—THE U. S. S. "NEW MEXICO." DISPLACEMENT, 32,000 TONS; HORSE-POWER, 32,000; BOILERS, OIL-BURNING; SPEED, 21 KNOTS.



The Accompanying View Showing the New Electric-driven U. S. S. Superdreadnaught, the "New Mexico", Discloses for the First Time the Appearance of the Wonderful 32,000 Horse-power Electric Generating and Propelling Plant of This Mighty Fighting Ship—Representing the Very Latest Advance in Battleship Design. There Are Two Steam-Turbine Driven Generating Plants Developing a Normal Capacity of 32,000 Horse-power, and the Four Propelling Screws Are Driven by Four Electric Motors, Totalling 32,000 Horse-power. The Electric Motors and Power Plant Are Controlled From the Switchboard Shown in the Power-room, But When Desired, the Electric Control Can Be Manipulated From the Bridge or Pilot-house of the War Vessel. There Is No Other Form of Drive for Any Type of Vessel, and Especially for Battle-ships, Which Is So Flexible and Responsive to the Commands of the Officers in Charge, As the Electric Drive, As Experience With This Form of Drive Has Proven. In Fact This Mighty Fighting Craft Can Be Controlled At the Push of a Button. There Are of Course Innumerable Electric Motors Driving All Sorts of Machinery On the Vessel, From the Electric Fans in the Kitchens to the Motors Which Rotate the Massive Three-gun Turrets and Feed the Big Guns With Ammunition, Not to Mention the Powerful Radio Station, Telephones, Signals, Shell Hoists, Searchlights, Etc., Etc.

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Recent Aërial Developments

By H. GERNSBACK



In England They Have Already Mooring Towers Used to Take On and Put Off Passengers and Freight, It Having Been Proved That It Is Easier for an Airship to Anchor at a Lofty Height Than to Come Down and Dive Into a Shed. This Illustration Shows How the Woolworth Building or Any Other Building Could Be Equipt With a Revolving Landing Tower, to Which the Airship Can Make Fast. Passengers and Freight Can Then Be Readily Landed. A Project of This Kind Is Entirely Feasible From an Engineering Standpoint.

WHEN the Zeppelin, that is, the rigid type of airship, first appeared it had many inherent faults. Probably the greatest one was the inflammable gas carried in the sectional ballonets.

As fast as the Zeppelins were constructed they were destroyed mostly by fire due to electric sparks, which set on fire the inflammable hydrogen gas.

Secondly, the landing arrangements as used by the Germans were very inefficient, and it was not infrequent that the huge airship became wrecked when coming down to earth prior to entering its mooring shed. In the air, the Zeppelin type is safe enough, and even the severest storms can be ridden out with comparative safety, that is, all storms except electrical storms, which not infrequently set the dirigibles on fire, due to lightning.

Recently, the English have proposed a novel manner for landing passengers, and no longer do the huge airships of the rigid type descend to earth to discharge their passengers or cargo. The device used is a sort of huge hitching post in the form of a high tower held fast by means of cables and stays. The upper part of the tower has a revolving top section with which the nose of the airship comes into contact, and to this it is made fast. The passengers and cargo leave and enter by means of this revolving top and descend or ascend to earth by means of elevators. These towers are anywhere from three to five hundred feet high, and the airship can "land" and make fast to the tower with comparative safety, as has been actually demonstrated in England.

It makes no difference which way the wind blows or how hard, the airship will simply take its position, similar to a wind vane, where it offers the least resistance to the wind. It will ride out the most severe storm very readily in such a position and in comparative safety. This also has been actually demonstrated.

The fire danger is now being reduced entirely by the use of an American idea, helium gas, which has approximately the same lifting power as hydrogen, but which is absolutely non-inflammable.

It does seem that for many years to come the rigid type of airship will probably be the one destined to carry passengers and freight, while for a long time, the airplane will only act as a secondary unit, or as a feeder. In other words, the airship will be used to cover long distances, while the airplane will cover short distances, bringing passengers and freight to the central dirigible depots.

We have today airships with a capacity of 2,000,000 cubic feet of gas, and it will not be long until the 5,000,000 cubic foot gas dirigible will be in use. Aviation authorities think that such airships will be in operation not later than 1923.

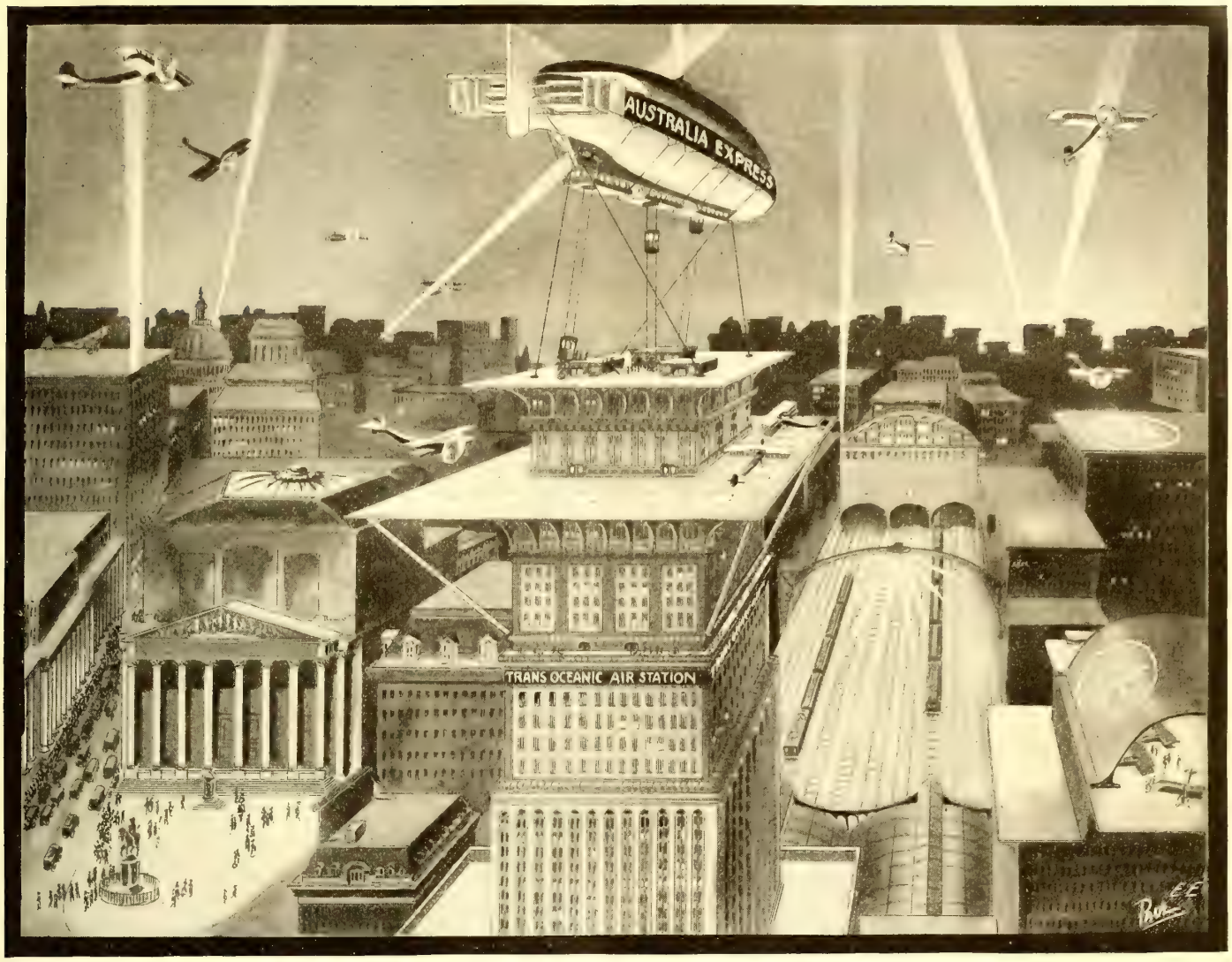
When it is considered that the huge present-day English airships have a capacity of 2,000,000 cubic feet of gas, and which can now cover a radius of 4,000 miles without coming down to earth or renewing their supplies, it will be seen that universal aërial transportation is a feature much closer at hand than is realized by most of us.

There is little doubt that before this year has ended one or more dirigibles will have crost the Atlantic Ocean. Flying at their present rate of speed, which is sixty miles per hour, it will be seen that the trip from London to New York will take only 2 to 2½ days. The huge 5,000,000 cubic feet of gas airships will probably fly at the rate of 100 miles per hour. The length of the trip will then be cut down to about 1½ days.

While the aërial tower which we discust above is probably satisfactory, it has many objections, the most important one being that it is an expensive item, and, moreover, if the airship is to rely upon such a structure, it will be almost impossible for it to come down to earth to land passengers *except at such points where the mooring towers are located.* This is a clear disadvantage.

In the accompanying illustration the writer wishes to advance an idea which so far has not been tried out, but which can be readily adapted. The idea is simply to moor the dirigible by means of four cables, which are thrown from the aërial flier. The passengers then will be able to ascend or descend from the airship by means of light elevators operated between the dirigible and earth. These elevators, electrically operated, need not be very heavy and can be constructed of aluminum, duralumin, or some such material. The power to operate these elevators can be taken from the engines of the dirigible itself, and it will be quite an easy matter to take from fifteen to twenty passengers on a single trip.

Our illustration shows the city of London, in the year 1925, with one of these dirigibles made fast to the aërial depot; we see here two elevators operating and taking on passengers and freight. The air-



The Heart of London as It Will Appear Very Shortly When the Plans Now Undergoing Completion Are Realized. It Having Been Demonstrated That It Is Very Difficult to Bring Down the Huge Airships to the Ground—Many Zeppelins Having Been Wrecked That Way—It Has Been Proposed to "Land" Airships on Top of Specially Elevated Stations as Here Shown. The Airship would Be Simply Anchored by Means of Four or More Steel Cables. Then, by Using a Number of Light Elevators or Lifts, the Passengers as Well as Freight Can Be Taken on or Put off, as Our Illustration Clearly Depicts. This Is Not a Dream of Tomorrow, but Plans Are Actually Under Way to Make This Feature a Realization. It will Be Seen That the Airplanes Merely Act as a Sort of "Feeder" and They Will Be Used Mostly to Bring Their Passengers or Freight to the Trans-Atlantic Landing Station.

ship shown belongs to the regular trans-Atlantic Service and makes the trip between London and Perth, Australia in 4½ days. Should it become necessary to discharge or take on freight at non-important centers, it will be a simple matter to moor the airship by means of its cables even over a city which has no elaborate landing station. Nothing but four points to which to make the cables fast are required. The elevators which are carried by the airship will do the rest.

Our cover illustration shows a spectacular method of an aërial rescue at sea, which immediately demonstrates the practical use of these elevators. Indeed, the airship does not need to make fast to the wrecked airplane; it will keep its position simply by running either one or more of its propellers in order to keep from drifting. This is quite simple even for the present-day airship, as it is possible by means of its propellers to hover over a certain spot even with a strong wind blowing. In this case, the elevator cables only are made fast to the wrecked flyer, the gasoline tanks of which have been set on fire. After the elevator cables are made fast, it will be a comparatively simple matter to take off the passengers, and, if necessary, the freight, for the buoyancy of the airplane in the water will probably keep it afloat for some time. After everybody is taken off, the elevator is hoisted, the elevator cables pulled in, while the airship proceeds on its way.

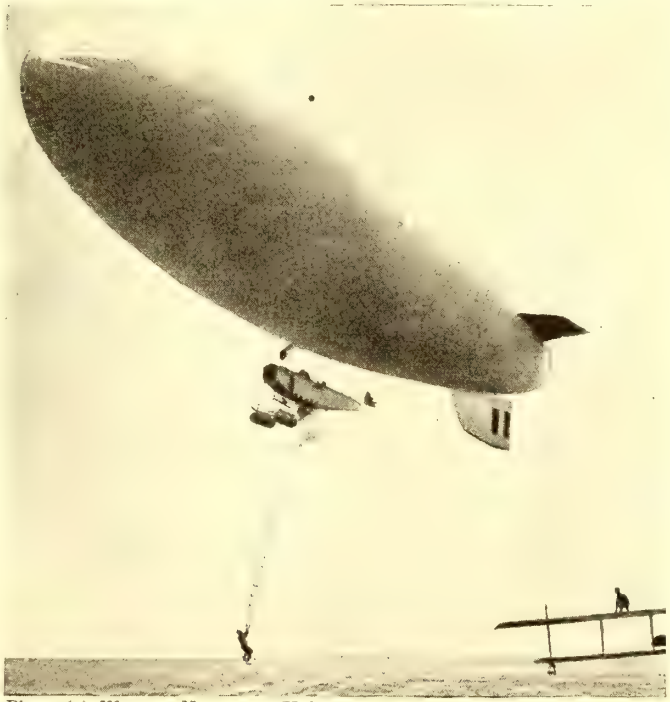
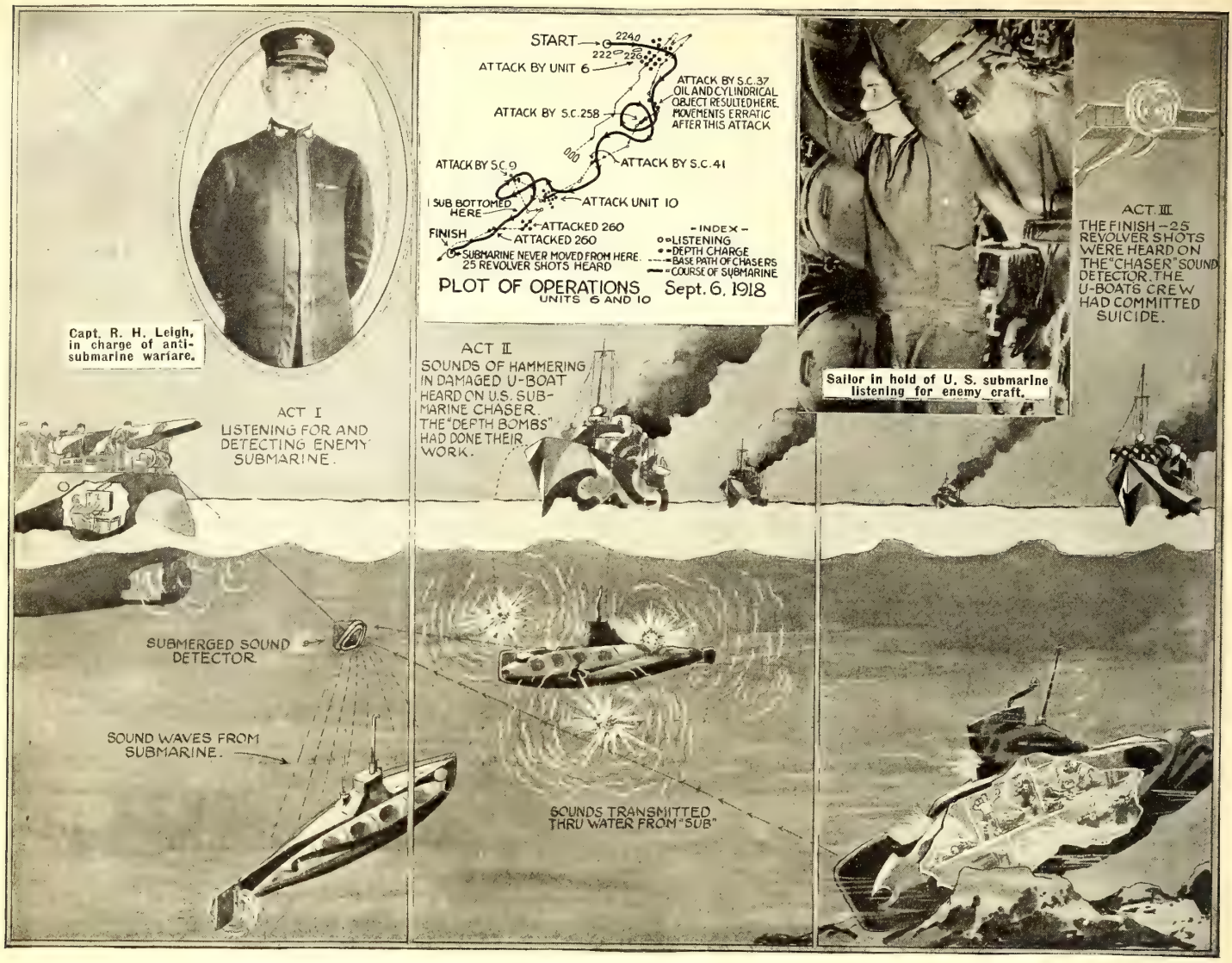


Photo (c) Western Newspaper Union

This Remarkable Snapshot Shows One of Our Navy's Dirigibles Rescuing Two Airmen Who Recently Fell Into the Sea with Their Flying Boat off Key West, Florida. One of the Aviators Can Be Seen Climbing up the Rope Ladder.

This spectacular rescue might seem to be a thing of the future, but indeed it is not. Our photograph herewith shows that the very same thing has already been accomplisht on a smaller scale. Very recently the United States Navy equipt its dirigibles with rope ladders, which made it possible to rescue aviators from the sea. That such a move was indeed wise, our photograph demonstrates better than words. Our remarkable snapshot shows one of the Navy's "blimps" rescuing two airmen who recently fell into the sea with their flying boat off Key West, Fla. The nose of the airship was simply turned into the wind, and after some maneuvering it finally managed to get directly over the disabled flyer. The two marooned airmen experienced no difficulty in grasping the rope ladder and climbing aboard the airship, none the worse for their adventure.



Hunting the U-boats by "Sound" Proved a Successful and Profitable Allied Naval Game—So Successful in Fact That, Had the War Lasted Another Year, the U-boats Would have Been Driven Completely from the Seas.

Hunting Submarines by Sound

By BREWSTER S. BEACH

How Yankee Scientists Beat the German U-Boats

THIS article describes the effort made by American scientists, under the stress of tremendous urgency, to invent and perfect an instrument to successfully locate submarines while in a submerged condition, at a time when every instant of delay meant further loss to shipping, and the fate of the Allied cause practically depended on the immediate defeat of German U-boat warfare. The Submarine Detector, as eventually evolved by them, utilizes old principles in a new and startling way. It is based on the theory of sound-wave transmission thru the water and depends for its direction-getting qualities on the peculiar and heretofore little understood faculty of the human ear to detect the direction of sound by the shifting of that sound from one ear to the other.

THE United States Navy Department, after nearly two years of the closest censorship, has just given approval to the publication of certain data relating to the development in the United States during the war of submarine detecting devices, which were used to signal advantage by this country and the Allies in prosecuting and bringing to a successful conclusion the campaign against the German U-boat.

The apparatus may be termed the composite work of the General Electric Company, Submarine Signal Company, Western Electric Company, the National Research Council, assisted and advised by many eminent scientists, engineers and research specialists—chief among whom were Drs. W. R. Whitney, Irving Langmuir and W. D. Coolidge, Prof. R. A. Millikan, Prof. Max Mason, and others.

Realizing that the prompt solution of the submarine problem was the key to a successful termination of hostilities, Secretary Daniels, immediately upon America's entrance into the conflict, appointed a special board to devise ways and means to overcome it.

At the suggestion of Dr. Whitney, director of General Electric Company's research laboratories, a group of scientists was formed at Nahant, Mass., under Dr. Irving Langmuir, where the results of extensive research activity were put to practical tests under actual conditions as nearly as possible approaching those in European waters.

Another group under Prof. Millikan, head of the Physics Department of the University of Chicago, was organized at New London, Conn., where the work of both bodies was later co-ordinated.

Out of the efforts of these two groups and the work carried on in Schenectady assisted by Allied commissions of scientific men, there grew the American Submarine Detector—a development of the old principles of sound wave transmission in water in an altogether new and startling manner, and just how efficient this "detector" proved we shall see later.

The apparatus finally perfected and put to immediate use, was first designed to hang overhead from naval craft amidship below the water line and it depended for its direction-getting qualities on the peculiar and heretofore little understood faculty

of the human ear to detect the direction of sound by the shifting of that sound from one ear to the other.*

Early Experiments

Every possible application to which electricity had been put was studied with painstaking care by experts during the development of the "Submarine Detector," and many experiments were carried on at New London and at Nahant with pliotrons, with amplifiers, with the Fessenden oscillator, which had been developed by the Submarine Signal Company, and with other similar instruments, before the proper combination of the principles of electricity and acoustics produced the final and successful device subsequently used.

Specialists in physics and acoustics from the great technical schools, such as Columbia University and Harvard, from the Research Laboratory of the G. E. Co. and the W. E. Co., and in fact from all over the United States, played a prominent part in the work done, particularly by the New London Group, altho unfortunately the armistice was signed before the latest devices developed here could be put into extensive use on the other side of the water.

Owing to the interference of sounds made by the listening ship's own motors, it was found more practical to stop the engines when about to take observations and this added greatly to the effective range of the instrument.

To overcome this obstacle, another device was developed *which could be trailed off the stern a hundred or so feet away* where the engine noises of the ship were out of range and the sound was then brought into the operator in the ship's hold.

A third adaptation of the listening principle was an instrument which protruded thru the hull and was a stationary part of the vessel's equipment. A somewhat circular device was constructed for use on submarines, but all of them were used to advantage.

While demonstrating the device to the British Admiralty, our American engineers were asked to study the question of fitting submarine detection units to airplanes, balloons and dirigibles.

After some experimentation, followed by more practical tests and conferences with the Lancashire Group of scientists at Harwich, apparatus was developed which met these needs and many *aircraft* were equipt with sound detectors *which rendered it possible for them to follow the course of the enemy submarine after they had seen her submerge, a valuable faculty which such craft did not possess until the introduction of the American detector.*

Allies Adopt Yankee Invention

However, when the devices had proved themselves eminently satisfactory after exhaustive experimentation here, the Navy Department organized a special Service Party under Capt. R. H. Leigh of the Bureau of Steam Engineering to demonstrate the detectors to the British Admiralty. Shortly after the arrival of this party abroad, the American submarine detectors were universally adopted by all the Allied navies.

It was found to be much superior in many ways to any of previous development, and came to be considered one of the most effective offensive weapons ever used against the submarine.

To sum up the results achieved by these American listening devices it is only necessary to recount a few pertinent points to illustrate the device's practicability.

In spite of it all, initial experiments proved slow of entirely satisfactory developments until the fall of 1917, when it was decided to go out to sea off Cape Cod for more thorogoing tests.

The sea was clear of craft as far as the eye could see—yet the operator with his ear to the detector distinctly heard a vessel approaching—nearer—nearer—nearer. The captain from the bridge eagerly scanned the horizon with the ship's glasses—nothing in sight.

"Send a man aloft with powerful glasses," he commanded. "The detector has picked up a craft 3 points on our starboard bow."

The sailor returned. "Nothing in sight, sir."

"I'll go aloft myself. That boat sounds as if it were very near. Why, we can hear her engine as clearly as if she were alongside."

Puzzled, the captain returned from the masthead after a disappointing vision of a calm and perfectly clear sea.

"How's she coming?" shouted the first lieutenant down the hatchway.

"Heading straight for us, sir. Sound getting louder every minute."

There was nothing to do but wait.

The captain pulled out his watch and sat down. Fifteen minutes—half an hour—an hour—ticked on!

(*Continued on page* 167)

* Another very interesting point is that when mounting microphones on each side of a vessel, the *loudness* of the incoming sound is equal in both telephone receivers, *i. e.*, if a submarine is on the starboard side of the ship, it will be heard just as loud from the port side. But, the difference can be readily detected and very accurately too, by the *phase difference* as heard in the 'phones. In other words, the sound will be heard a fraction of a second earlier in one ear than in the other. Small as this difference is, even a green operator will detect it at once.

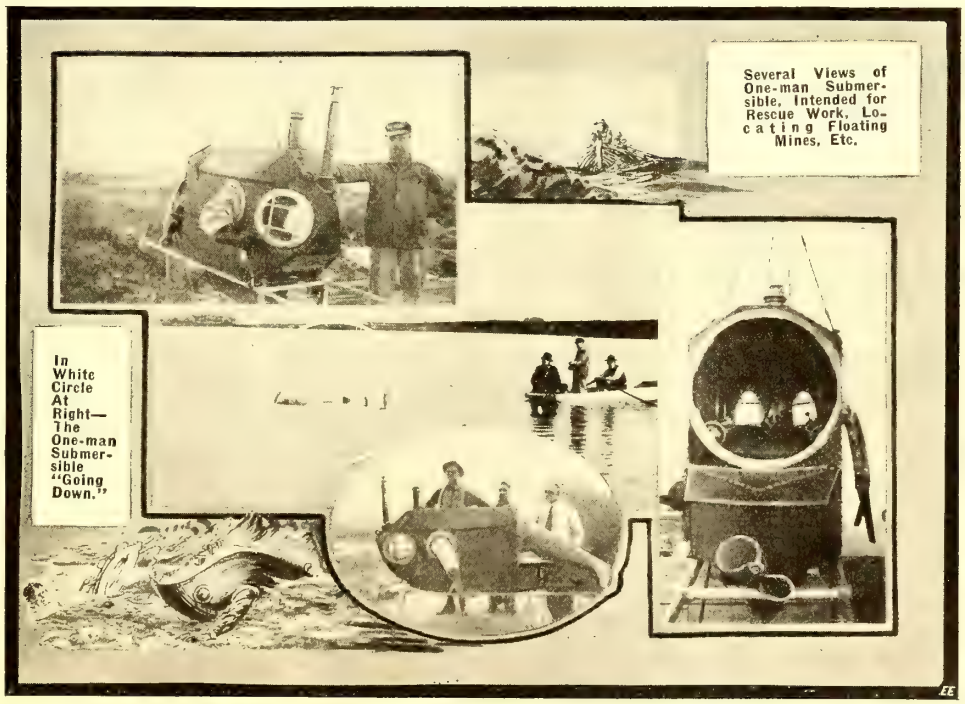
—*Excerpt from Mr. H. Gernsback's editorial in the October,* 1917 *issue of this journal.*

That One-Man Submersible

IN the March issue of this journal there appeared an illustrated article describing a newly invented, one-man submersible boat, intended for purposes of life saving, locating floating mines and other purposes. At the time the article was prepared, the Editors only had the inventor's patent to guide them in its preparation, and the illustration was prepared by one of the staff artists. But behold! This strange animal of the deep really lives, as the accompanying photographs of the actual working device prove. The inventor of the one-man submersible is W. R. Barringer, of Denver, Col., which is a long way from the sea, and it puzzled the Editors how a rank land-lubber such as the inventor appeared to be, could have the heart to work out a complete submarine or anything akin to that device. But now the secret is out, for it appears that the inventor, who was formerly in the United States Army, had gained considerable experience while in foreign lands, and he evolved the principles underlying his submersible boat while observing the methods of pearl and sponge divers in the far-distant Sulu Archipelago.

The makers of the Barringer one-man submersible, claim, among other things, that, due to its peculiar construction, no pressure is required to offset the tremendous external pressure of the water, even when submerged to such depths as 350 feet, for which this submersible is practicable. It is interesting in this connection to mention that the maximum depth reached by U. S. Naval divers in especially constructed diving suits and bells, is less than 300 feet. Moreover, in the ordinary diving suit the tremendous internal pressure of 130 pounds per square inch is necessary to remain at a 350-foot depth for any length of time. This new submersible diving outfit requires but the normal pressure of 15 pounds per square inch, regardless of depth attained. The inventor also claims that no strain is occasioned on the operator, even after a long period under water. The operator rests on a heavy air cushion and suffers no ill effects while below the water's surface. Further, the ascent and descent of the boat need not be done gradually, as in the case of the ordinary diving suit or bell, in order to accustom the body to the changing water pressure. On the contrary, so he claims, ascent may be made rapidly, and the operator's time is, therefore not wasted in slow sinking or rising.

As pointed out in the previous article, there are many interesting electrical features incorporated in this device, including electrical propelling and steering means, an electric searchlight and many other novel devices.

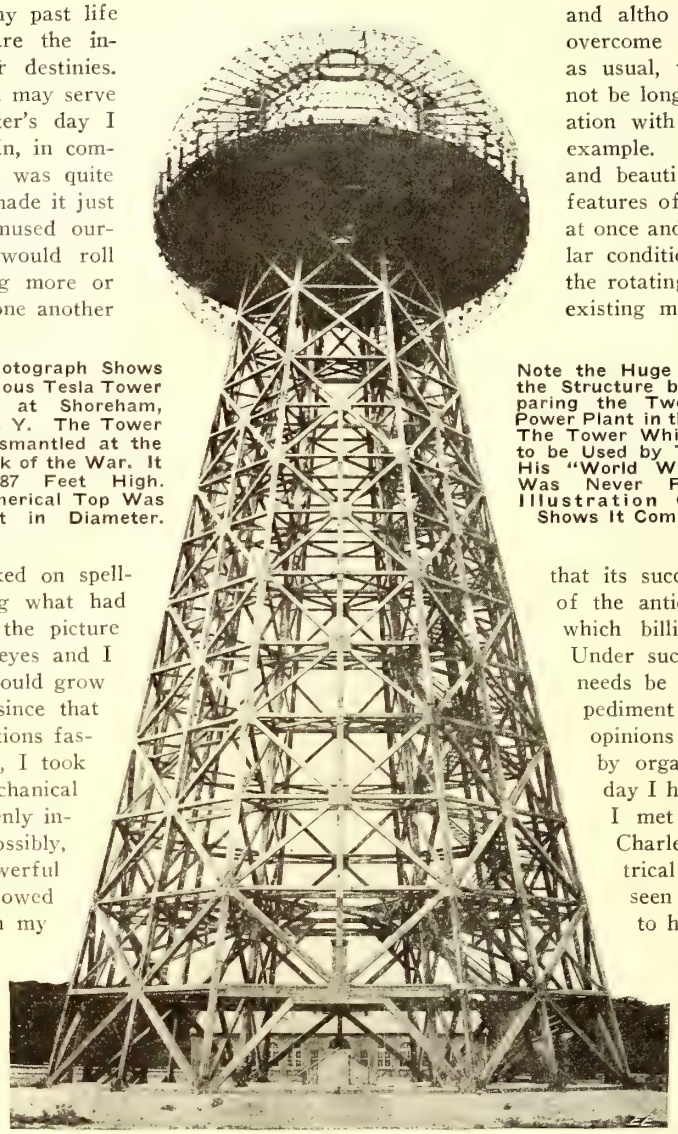


My Inventions

By Nikola Tesla

V. The Magnifying Transmitter

AS I review the events of my past life I realize how subtle are the influences that shape our destinies. An incident of my youth may serve to illustrate. One winter's day I managed to climb a steep mountain, in company with other boys. The snow was quite deep and a warm southerly wind made it just suitable for our purpose. We amused ourselves by throwing balls which would roll down a certain distance, gathering more or less snow, and we tried to outdo one another in this exciting sport. Suddenly a ball was seen to go beyond the limit, swelling to enormous proportions until it became as big as a house and plunged thundering into the valley below with a force that made the ground tremble. I looked on spellbound, incapable of understanding what had happened. For weeks afterward the picture of the avalanche was before my eyes and I wondered how anything so small could grow to such an immense size. Ever since that time the magnification of feeble actions fascinated me, and when, years later, I took up the experimental study of mechanical and electrical resonance, I was keenly interested from the very start. Possibly, had it not been for that early powerful impression, I might not have followed up the little spark I obtained with my coil and never developed my best invention, the true history of which I will tell here for the first time.



This Photograph Shows the Famous Tesla Tower Erected at Shoreham, L. I., N. Y. The Tower Was Dismantled at the Outbreak of the War. It Was 187 Feet High. The Spherical Top Was 68 Feet in Diameter.

Note the Huge Size of the Structure by Comparing the Two-story Power Plant in the Rear. The Tower Which Was to be Used by Tesla in His "World Wireless," Was Never Finished. Illustration Opposite Shows It Completed.

Scrapping the World's Engines.

"Lionhunters" have often asked me which of my discoveries I prize most. This depends on the point of view. Not a few technical men, very able in their special departments, but dominated by a pedantic spirit and nearsighted, have asserted that excepting the induction motor I have given to the world little of practical use. This is a grievous mistake. A new idea must not be judged by its immediate results. My alternating system of power transmission came at a psychological moment, as a long-sought answer to pressing industrial questions, and altho considerable resistance had to be overcome and opposing interests reconciled, as usual, the commercial introduction could not be long delayed. Now, compare this situation with that confronting my turbine, for example. One should think that so simple and beautiful an invention, possessing many features of an ideal motor, should be adopted at once and, undoubtedly, it would under similar conditions. But the prospective effect of the rotating field was not to render worthless existing machinery; on the contrary, it was to give it additional value. The system lent itself to new enterprise as well as to improvement of the old. My turbine is an advance of a character entirely different. It is a radical departure in the sense that its success would mean the abandonment of the antiquated types of prime movers on which billions of dollars have been spent. Under such circumstances the progress must needs be slow and perhaps the greatest impediment is encountered in the prejudicial opinions created in the minds of experts by organized opposition. Only the other day I had a disheartening experience when I met my friend and former assistant, Charles F. Scott, now professor of Electrical Engineering at Yale. I had not seen him for a long time and was glad to have an opportunity for a little chat at my office. Our conversation naturally enough drifted on my turbine and I became heated to a high degree. "Scott," I exclaimed, carried away by the vision of a glorious future, "my turbine will scrap all the heat-engines in the world." Scott stroked his chin and looked away thoughtfully, as though making a mental calculation. "That will make quite a pile of scrap," he said, and left without another word!

IMAGINE a man a century ago, bold enough to design and actually build a huge tower with which to transmit the human voice, music, pictures, press news and even power, thru the earth to any distance whatever without wires! He probably would have been hung or burnt at the stake. So when Tesla built his famous tower on Long Island he was a hundred years ahead of his time. And foolish ridicule by our latter day arm-chair "savants," does not in the least mar Tesla's greatness.

The titanic brain of Tesla has hardly produced a more amazing wonder than this "magnifying transmitter." Contrary to popular belief his tower was not built to radiate Hertzian waves into the ether. Tesla's system sends out thousands of horsepower thru the earth—he has shown experimentally how power can be sent without wires over distances from a central point. Nor is there any mystery about it how he accomplishes the result. His historic U. S. patents and articles describe the method used. Tesla's Magnifying Transmitter is truly a modern lamp of Aladdin.

EDITOR.

"Aladdin's Lamp".

These and other inventions of mine, however, were nothing more than steps forward in certain directions. In evolving them I simply followed the inborn instinct to improve the present devices without

(*Continued on page* 148)

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Mr. Tesla's articles started in our February issue



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THIS PHOTOGRAPH OF A MODEL SHOWS HOW THE TESLA TOWER BUILT ON LONG ISLAND, EIGHTEEN YEARS AGO, WOULD HAVE LOOKED COMPLETED. FROM ITS APPEARANCE NOBODY WOULD INFER THAT IT WAS TO BE USED FOR THE GREAT PURPOSES WHICH ARE SET FORTH IN HIS ACCOMPANYING ARTICLE.

Filming "Talking" Movies" in Glass Houses

By H. WINFIELD SECOR

YOU probably remember the old adage about "people who live in glass houses, should"—etc.—but the latest is the filming of talking motion pictures in all-glass houses or studios, and the process has been invented by one —David O. Royster of St. Louis, Mo., the "show-me" state. Mr. Royster's scheme covers an improved method and apparatus for synchronously making motion pictures and sound records.

As the inventor points out, it has heretofore been very difficult, if not indeed impossible, to make talking motion pictures which would bear a perfect synchronous relation to each other when reproduced, for the reason that the camera used in taking the motion pictures must necessarily be located a certain distance away from the object to be photographed, and being that the sound recording device is located adjacent to the camera in order to operate in synchronism with it, the distance between the receiver on the sound recording apparatus, and the actors being photographed, is such that the sound waves in traveling from the object to the recorder, do not reach the latter for an appreciable length of time. As a result the recorded sounds are not exactly synchronous with the pictures, when these sounds and pictures are later reproduced in the theater projector. And besides, with such an arrangement the sound waves are insufficient in volume to make a clear and strong record on the disc or cylinder of the talking machine.

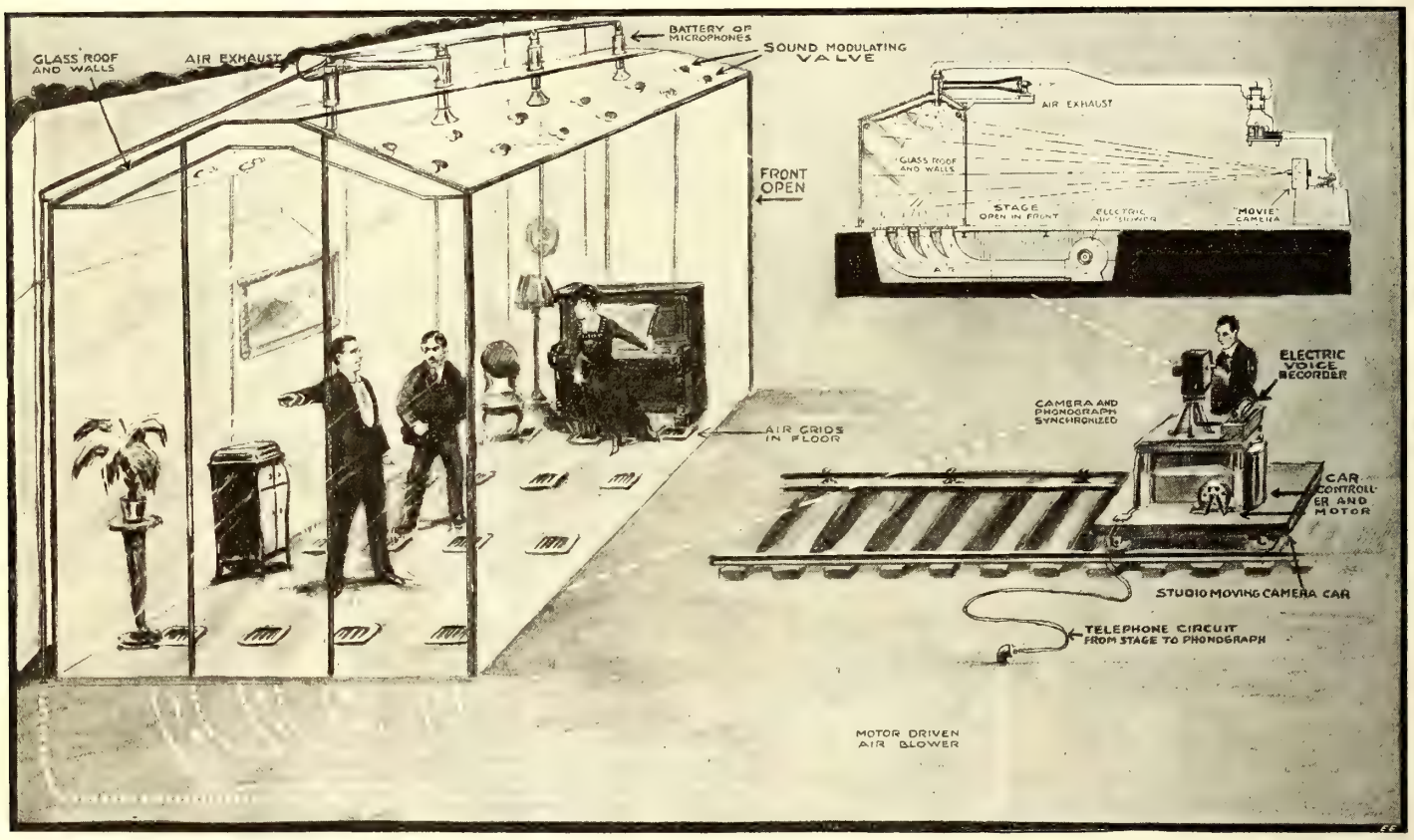
Mr. Royster, in his scheme, provides a transparent *glass studio stage,* or *all-glass house,* if the scene requires it, which is occupied by the objects to be photographed. Thus motion pictures can be made by natural light; means are also provided for concentrating the sounds produced by the speakers, which sounds are telephonically transmitted to the sound recording device, such as a phonograph, located adjacent to and operated synchronously with the motion picture camera.

As is the practise in all of the larger studios, the camera and other appurtenances, such as the sound recording phonograph, etc., are mounted on a wheeled truck, which may be moved along a track, or set of tracks, so as to take either "close-ups" or normal focus pictures, as desired, also to make changes quickly. Some studios utilize a small electric car fitted with a motor and controller, so that the camera man or his assistant can readily move the camera toward or away from the stage, as the occasion may demand. You have probably seen at one time or another a motion picture where the objects came up rapidly toward you, until the actress' face, for instance, was as big as the entire screen. This effect is obtained very easily by moving the car toward the scene. Scenes or settings which fade away, causing the objects to become smaller, are taken in the reverse manner, i. e., by moving the camera away from the stage while the picture is being taken.

There is provided in the present scheme a powerful motor-driven electric blower under the studio floor, which projects a strong draft of air upward thru a series of gratings in the stage floor, and the powerful upward vertical movement of the air thru a series of openings in the glass roof carries the sounds of the voices upward, toward the microphones or sound detectors, which effect is intensified by an electric exhaust fan at the top of the glass-enclosed stage, as shown in the diagram and illustration herewith. The battery of microphones which pick up the sounds at the ceiling of the stage are connected up with a telephone line which leads to the electric recorder on the phonograph beside the "movie" camera, there being a rigid mechanical connection between the camera and the phonograph to ensure synchronism.

Owing to the peculiar and unusual lighting arrangements with this form of all-glass stage, the "setting" or other scenery is placed back of the stage, so as to allow the daylight to pass over it and thru the glass to illuminate the stage proper. Some props and furniture can of course be placed directly on the stage. It is understood that where the light is not sufficiently strong for the taking of motion pictures, the stage can be lighted artificially. The degree of sound transmitted by the microphones fitted over the stage may be modulated by means of adjustable valves placed in front of the microphone, and also by opening more or less of the by-pass valves in the glass inner ceiling, which permits some of the air-conducted sound waves to pass between the two ceilings and out thru the fan chamber.

The apparatus as here described is comparatively simple, can be easily operated, does not require artificial light, and motion pictures and sound records of absolute synchronism can be readily made at any distance from the object within the focal length of the camera, claims the inventor. All things considered, it would seem to presents a new and successful "Movie" idea.



The Secret of Perfect "Talking Motion Pictures" Lies in the Proper Synchronism Between the "Pictures" and the "Voice," and Also in the Clarity and Even Tone of the Speech Reproduction. All Three of These Problems Have Been Solved by the Invention of the Glass Enclosed Stage Here Illustrated.



This Portable Wireless Telephone Was Perfected by W. W. Macfarlane, of Philadelphia. Photos Show Mr. Macfarlane with His Invention and Stove-pipe Aërial. With This Two Persons May Hear the Conversation Being Carried on Fifty Yards Away.

Photos by Int. Film Service

Call Up Wifey on the "Stove-Pipe" Radio

A MAN with a box slung over his shoulder and holding in one hand three pieces of stove pipe placed side by side on a board climbed into an automobile on East Country Road, Elkins Park, Pa.

As he settled in the machine he picked up a telephone transmitter, set on a short handle, and said:

"We are going to run down the road. Can you hear me?"

Other passengers in the automobile, all wearing telephone receivers, heard a woman's voice answering: "Yes, perfectly. Where are you?"

By this time the machine was several hundred yards down the road and the voice in the garage was distinctly heard.

This was one of the incidents in the first demonstration of the portable wireless telephone outfit invented by W. W. Macfarlane, of Philadelphia.

Mrs. Macfarlane, sitting in the garage back of the Macfarlane home, was talking thru the wireless telephone to her husband, seated comfortably in a moving automobile 500 yards away.

The occupants of the car were a chauffeur, a reporter and a photographer. All wore the telephone receivers and could hear everything Mrs. Macfarlane was saying. The chauffeur had no other apparatus than the receiver with the usual telephone cord attached by a metal clip to his steering wheel.

Lying beside Mr. Macfarlane was the foot-square box, the only "secret" in the whole demonstration. What is in the box is the inventor's mystery. This box weighs about twelve pounds. The other machinery used consisted only of the usual telephone transmitter and receivers and the three pieces of stovepipe standing erect on a plain piece of board. This forms the *aërial* of the apparatus.

Before starting on the automobile demonstration of his wireless telephone Mr. Macfarlane stood in the garage and directed the movements of a soldier in a field more than 200 yards away from him. This soldier assistant had a pair of telephone receivers over his head, connected by a wire with two metal clasps to his rifle (see photo herewith). He marched and halted and about-faced and left shouldered arms out there in the field the instant Mr. Macfarlane gave the order thru his little hand wireless 'phone in the garage.

The "July" Number of the Electrical Experimenter

"Hello Europe"—via Radio. Complete story of How Secretary of the Navy Daniels talked via the New Brunswick Radio Station to President Wilson in France, by Charles M. Ripley.

"My Inventions"—Part VI—by Dr. Nikola Tesla, himself. Besides a big feature surprise article by the world's master inventor.

Interesting Facts About the Electron—How big are atoms and electrons? by L. R. Jewett.

Faradic Currents and How to Apply Them. Including rheumatism, nervous complaints, and other ailments. Treatment with apparatus described in the present issue.

A Rattling Good Electric Story—"How 'Don' flashed the 'S.O.S.' ", by Mabel M. Davis.

New Electric Detector Net for Submarines.

Loop Aerials—Description of Actual Results obtained over 200 mile distances, by Prof. Lloyd M. Knoll.

Tree Wireless—How living trees receive radio messages across the ocean. The wonderful work of General George O. Squier, Chief Signal Officer, U. S. Army.

Storage Battery Testing—Practical Technique in simple language, by Harold R. Adams, storage battery engineer.

Audions operated on Alternating Current—Both Filament and Plate Circuits. Every radio man will want to read this authentic article, by Elliott A. White, formerly Instructor in Radio, Air Service School, Carnegie Institute of Technology.

Mr. Macfarlane said he would make no fanciful predictions as to what his simple, portable wireless telephone might do.

"There are all kinds of possibilities in it," he continued. "If this could have been ready for use in the war, think of the value it would have had. A whole regiment equipt with the telephone receivers, with only their rifles as aërials, could advance a mile and each would be instantly in touch with the commanding officer. No runners would be needed. There could be no such thing as a 'lost battalion.'

"No high power is necessary to operate this wireless. I am using one-tenth of an ampere in this experiment here and the results you see are so good that the voice carries as well as on the usual wire telephone. The telephone system uses about one-fourth of an ampere.

"I am working on a new theory in electricity, and in wireless. I think the accepted principle of the waves is only part of the story. There is something else. It is that something else that I am utilizing. There is no supplementary current in this system as in the usual wireless operation. There is no static and no interruption."

An umbrella, Mr. Macfarlane explains, will serve as well as a rifle for an aërial. "A plain citizen carrying a small handbag containing the compact wireless outfit and with his umbrella held aloft can walk along the street talking with friend wife at the house at the other end of the city," he said.

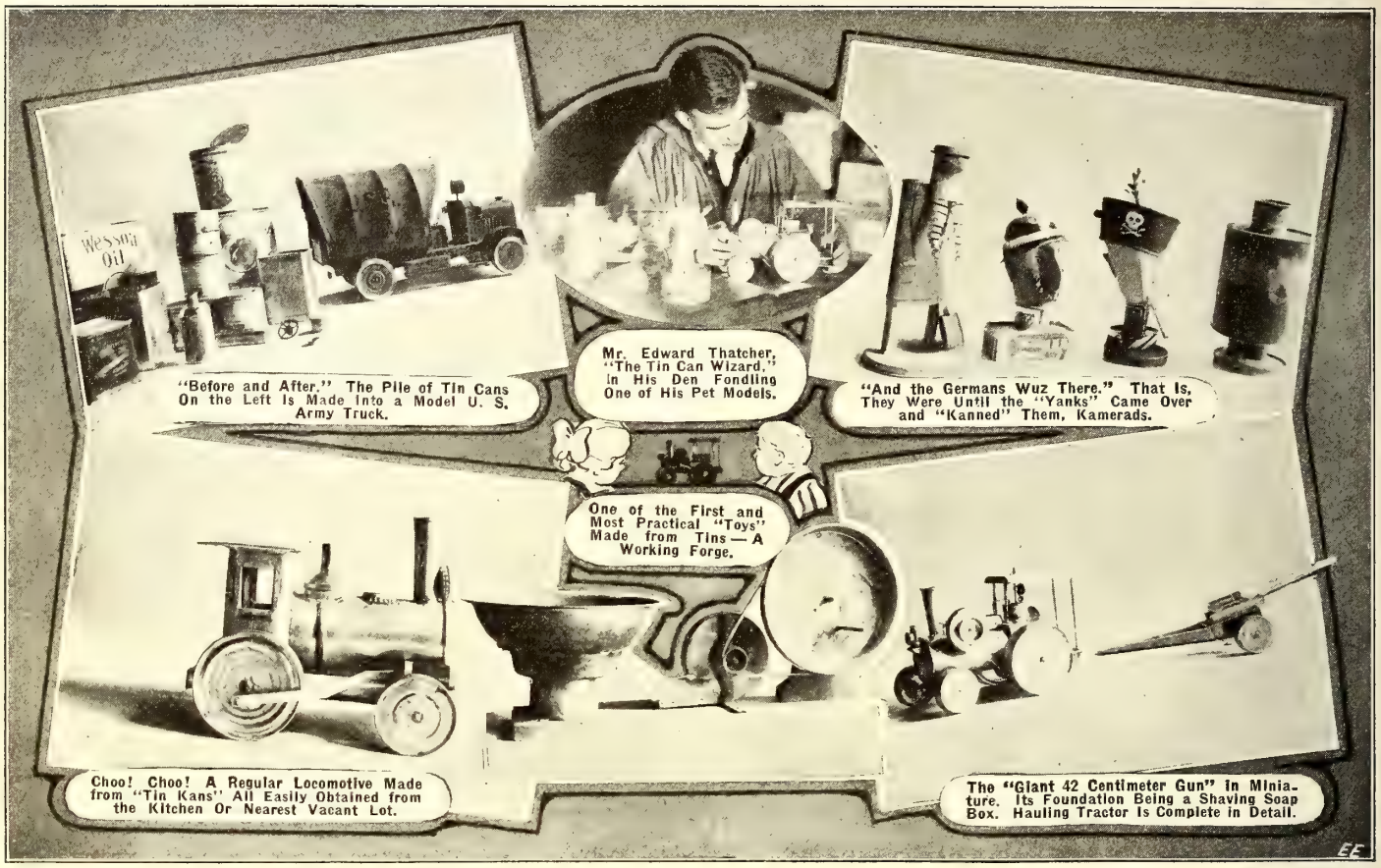
"How costly would this outfit be?" he was asked.

"Nothing new is used," he explained. "All the apparatus fits in with existing devices. Everything needed for the outfit could be bought for probably $15."

"My apparatus here is rather crude and not all the quality of current is obtained that I can get," he continued. "But it is no wild dream to say that a man riding on a train to New York can telephone his wife about bringing a friend home for dinner by using this device. It will be perfected thus far before very long. This apparatus here needs improvement, but it demonstrates the practicability of the thing. Even now I can connect up the end of the wireless in the house with the existing telephone system and thus can talk from my automobile with any person in the city."

Tin-Can Models—A New Art

By GEORGE HOLMES



IMAGINE if you can on one side a scene, wildly confusing, resembling a rubbish heap of every conceivable sort of tin-can, from the tomato to dainty tin-boxes which once upon a time held My-Lady's peach and cream complexion.

Picture, on the other hand, a scene with beautiful, splendid and practical toys, such as money could not buy, all evolved from these same tin-cans and boxes, with a little touch of imagination, inventiveness and mechanical knack, plus a pair of pliers, a soldering iron and the transformation is complete.

The originator and "wizard" of the tin-can toys is Mr. Edward Thatcher, of Teachers' College, Columbia University. It was he who hit upon the novel plan of utilizing waste tin-cans and from them making amusing, decorative and instructive playthings. He gave an inkling of this new art to his classes at Columbia and the students took it up with such zeal that these models were eligible for the recently successful public exhibition at the Art Alliance Galleries.

As his bit in the war, Mr. Thatcher was successful in having this artcraft introduced in the hospitals both here and abroad; and so helped the wounded soldiers to find a remunerative and amusing pastime which greatly aided in keeping their minds off their troubles. Even such men as were suffering from shell shock took to the tin-can toys; it would seem at first impression that they could not stand the noise of the hammering on the cans, but the reverse proved the rule. In cases where they would jump if a match box were dropt, they seemed not in the least inconvenienced by the sound of the constant tinkering of the tin-can artists and would work all day in the "toy-shops."

The possibilities of this new artcraft are practically unlimited. Where heretofore the wounded have occupied their time in the making of these toy models, the art is spreading the country o'er and will be one of the subjects taught in many schools. Some of the models here shown have been duplicated by ten-year-old boys at the Edgewater Manual Training School.

Most interesting of all is the composite view showing a toy *Army Truck*—"before and after." All the various forms of cans necessary to construct this truck are shown on the left, while on the right may be seen the completed model. The body of the truck was made from the side of a "Wesson" oil can, the wheels were made from evaporated milk cans, the seat from a cocoa box and the hood and radiator from an olive oil can. The indentations for the radiator, to resemble the cooling tubes, were faithfully reproduced by punching many hundreds of holes so as to give it that "corrugated" appearance; I think that would be the proper word, still not envying the long and tedious task it must have been to put all those holes into (or should we say "out of") existence. The radiator cap came from the top of a tooth paste tube and the side lamps and tail-light from screw caps of various olive oil cans.

Drifting back to our war atmosphere we have the steam tractor pulling a "Giant" gun. The tractor was brought to life from these various items: The fire-box and platform from a much abused sardine box, the boiler from another olive oil can, the steam whistle from the top of a "Lyons Tooth Powder" can, wheels from evaporated milk cans and the roof from the side of a square tin. The dummy driving wheels are made from the top covers of "Crisco" cans, soldered together so as to make a sort of pulley face for the driving cord. The long-range gun was built from a shaving-stick box, with the evaporated milk cans again doing duty as wheels.

These model toys are not self-propelling but could easily be made so. It would seem that Mr. Thatcher was born to the model business. He has constructed many real "live" models that work by themselves, notable amongst these being a large-size model of one of the Pacific Coast "mallet type" locomotives, that runs under its own power. The author also had the pleasure of seeing a model "tractor," built along the lines of the one constructed from tin-cans, only this one was made of brass and ran under its own steam.

Mr. Thatcher has found it advisable to write a book on this interesting subject which undoubtedly will find a great demand when it comes off the press. And so we see this new "rage" equally successful with the younger classes as well as at the Teachers' College at Columbia, where, among society folks, they call it "occupational therapy."

(*The Editor will be pleased to receive good photos of tin-can models of electrical things. To mention a few that our readers can readily construct: Telephone, electric generator, electric locomotive, radio sets, airships, etc.*—EDITOR.)

Making a Practical Electrician

THE world has never before witnest the vast opportunities that at the present moment lie before the people of the United States. Europe, with its shell torn territories and completely exhausted stocks of raw and finished materials, turns to the one country in the whole world fitted to rehabilitate its wastes and reconstruct its shattered industries.

America has a gigantic task before it—not only to feed practically the whole world, but to rebuild a great portion of it. The real business men, the men of creative genius and untiring skill, realize the enormity of the job they must undertake. They know that if the U. S. meets the test, a period of wonderful prosperity is open at its door. The one problem that confronts the business executive to-day is that of labor—*skilled* labor. Can we turn out enough trained men to meet the tremendous demand?

In no other field is the need of thoroly trained men more apparent than in the electrical world. On every side comes the cry for the trained electrician, the man of action, with vim and vigor and the "knowledge of how to do things." Daily we read of the marvelous accomplishments of the wonder of the age—ELECTRICITY. This power in the business life of to-day will play a leading rôle in the world's reconstruction. The United States is rapidly developing its own natural resources and enlarging its field of endeavor—to say nothing of the vast power houses, the new electrified railroads, and the thousands of other electrical needs of Europe. It is to the young man of to-day who is now considering what vocation to take up and who will be the worker of to-morrow, that we look with expectant eyes.

Dr. Charles P. Steinmetz, Chief Consulting Engineer of the General Electric Company, has said that, "The world needs men who know something of electricity, of the operations and control of electrical power. It needs men more every year, its very existence depends on the electrician."

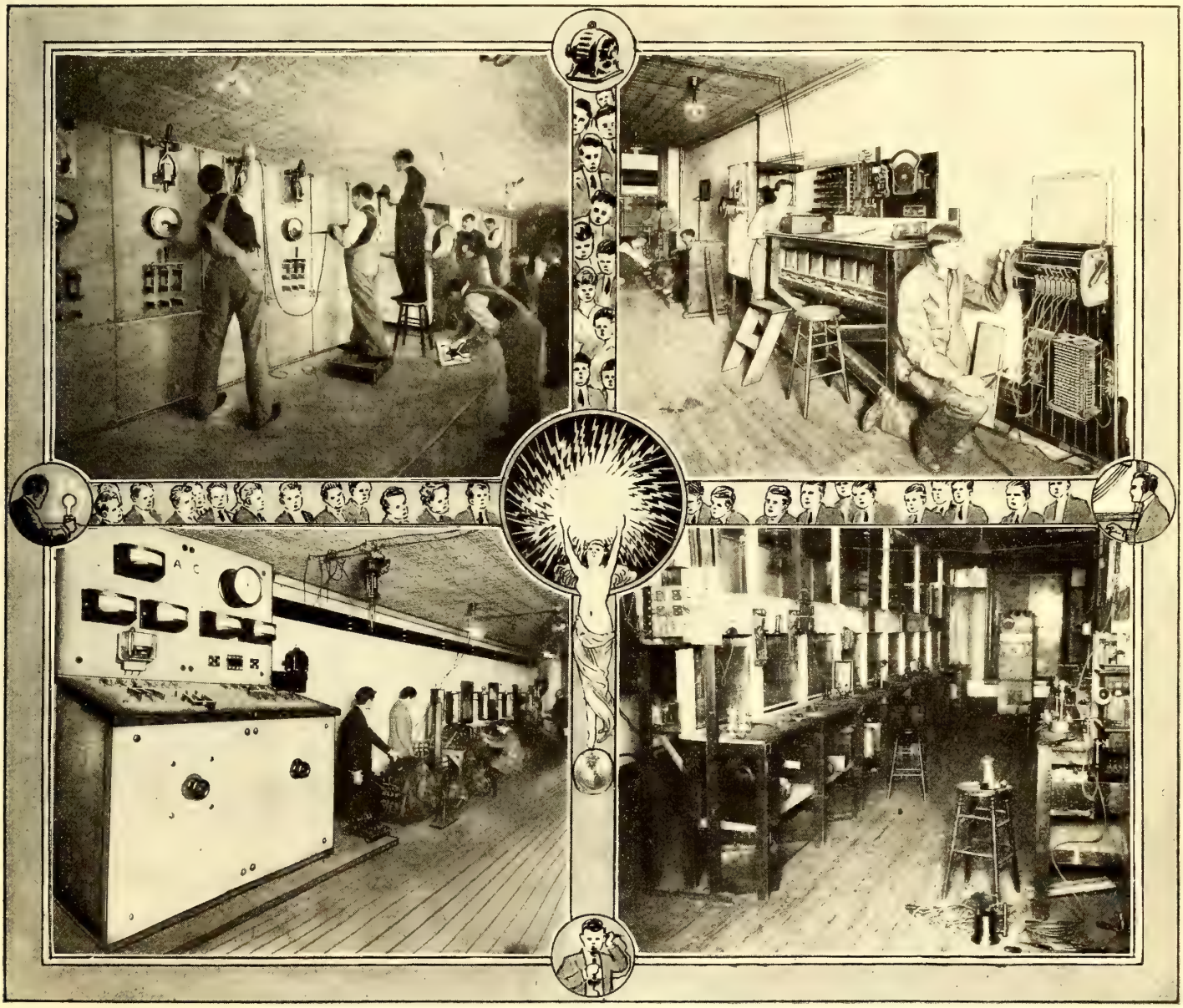
In the greatest city of the United States, in its very heart is located a school, whose aims and purposes are to teach men, both young and old and from every walk of life, the How and Why of electricity by the greatest teacher known—that of getting knowledge by actual experience.

A trained man is the finished product, one who understands the problems coupled with a broad experience in electrical engineering.

Theory is a necessity, but this busy world of ours wants more than theorists. He who is able to supplement his theoretical knowledge with the proper proportion of practical, do-it-yourself-knowledge, is the man who will get most of the world's rewards.

The school which has thus revolutionized educational methods has struck the happy medium of combining enough theory with practical work to turn out first-class electricians in the shortest possible time.

(*Continued on page* 153)



In the Top Left Photo We See the Prospective Electrician Learning the Art of Switchboard Construction. He Takes Apart, Puts Together and Connects These Boards, by Bus-bars and Other Wiring Methods. In Our Lower Left View We See These Same Men Being Initiated Into the Mysteries of Generators, Motors and All Forms of A. C. and D. C. Machines. Top Right Shows Our Men Grasping the Details of Modern Electric Vehicles. The Men Assemble, Connect and Run Complete Systems and Also Take Care of the Storage Batteries. Lower Right Shows Where the Embryo Electrician Starts on His Upward Climb in the Mysterious Art of Electricity. Here He Learns How to Connect Batteries, Bells, Buzzers, Telegraph, Telephone and Fire Alarms as Well as Many Other Systems of Inter-communication.

Close-Ups of New Scientific Movies

By GEORGE VANDERBILT

THESE up-to-date crooks had the best of everything, including a regularly equipt radio set, but ere they could use it to decoy ships to disaster, big and powerful "Reggie" had the strangle hold on our pirate Wireless Operator. Tho there were no women present, curls were in vogue in the radio shack, as can be seen in the accompanying photograph, showing the artistic hook-up of the set.

Whatever else may have happened to him, he had brawn and muscle! That, and that alone, saved Reginald Jones in the new Fox Film, "Never Say Quit," when he ran afoul of a gang of crooks on board a ship in search of sunken treasures.

The "JINX" was his constant "pal." It started by his being born on a Friday, and the thirteenth to boot, and so together some one had made a big mistake. From the very first he was in trouble, his childhood was one nightmare. As he grew older it only made matters worse.

The Rôle of Electricity and Science in the Modern Photoplay

As the gay and dashing Lothario he goes to a ball, and gets into a scrap over a girl and has to exit via the house-tops to escape the "Bulls."

Good luck seems to beckon when a rich aunt dies and leaves him a fortune. But not for Reginald! He must come to her funeral in order to get the money, and the jinx sees to it that he never gets there. On his way he is robbed by pickpockets, his eyes are blackened, and he is bruised and walloped until he thinks his head is in his shoes. He misses his train after many harrowing adventures, and so the fortune goes to charity.

To replenish his empty wallet, Reginald sets out on a voyage after sunken treasure. Adventures befall him again, for the crew turns out to be a gang of crooks. They are bent on robbing a millionaire and his daughter, who are on board.

Reginald saves the millionaire and his daughter from the dire fate the crew has in store for them. He wins the girl's hand, heart and soul, and in matrimony he believes he has conquered the jinx at last. But a year later Reginald and his wife are blest with triplets, and Reggie, superstitious cuss, ventures to believe that the jinx has had something to do with that.

In our next movie we come upon a fair and real live "Radioette." The beautiful daughter of an over-indulgent and elderly millionaire. She is abducted by a band of crooks and taken to a desert island to await the payment of a fabulous ransom by her father—or on his failing to pay it, to forfeit her life. BUT—she knew "Wireless," or, as us "hams" now call it, "Radio," and thru this knowledge outwitted the desperadoes' well-laid plans, gaining a hubby thereby, as can be seen in Metro's latest photo-

(*Continued on page* 161)



The Well Muscled George Walsh in the Fox Film "Never Say Quit" Putting an End to the Bold Crook's Machinations. Note the Radio Outfit.

We Look Pretty May Allison Over, in Metro's "Island of Intrigue" at the "Wireless Piano", Added to That the Automatic is Most Annoying to the Villain's Optic Nerve.

One of the "Wolves of Kultur" Rendered Senseless in Pathe's New Series. The Introduction of the Large Radio Direction Finder is of Special Interest.

Another of the "Wolves of Kultur" Ready to Send Off the Death-Dealing Radio Torpedo and Slowly Counting the Seconds. He Is Perhaps Unaware That a Police Whistle Is "Passe" by Most Villains.

EE



Electro-Therapeutic Ward at Bordeaux, France, Showing the Application of Intensified Rhythmic Faradization by Professor Bergonié. Altho Muscles Are Contracted Violently During This Faradization, the Patient Feels Hardly Anything.

A Wounded Soldier With a Fractured Leg Undergoing Intensified Faradization in Order to Reconstituate the Muscles of the Calf of His Leg. He Was Able to Walk Without a Cane Within Fifteen Days After the Treatment Started.

Paris Letter

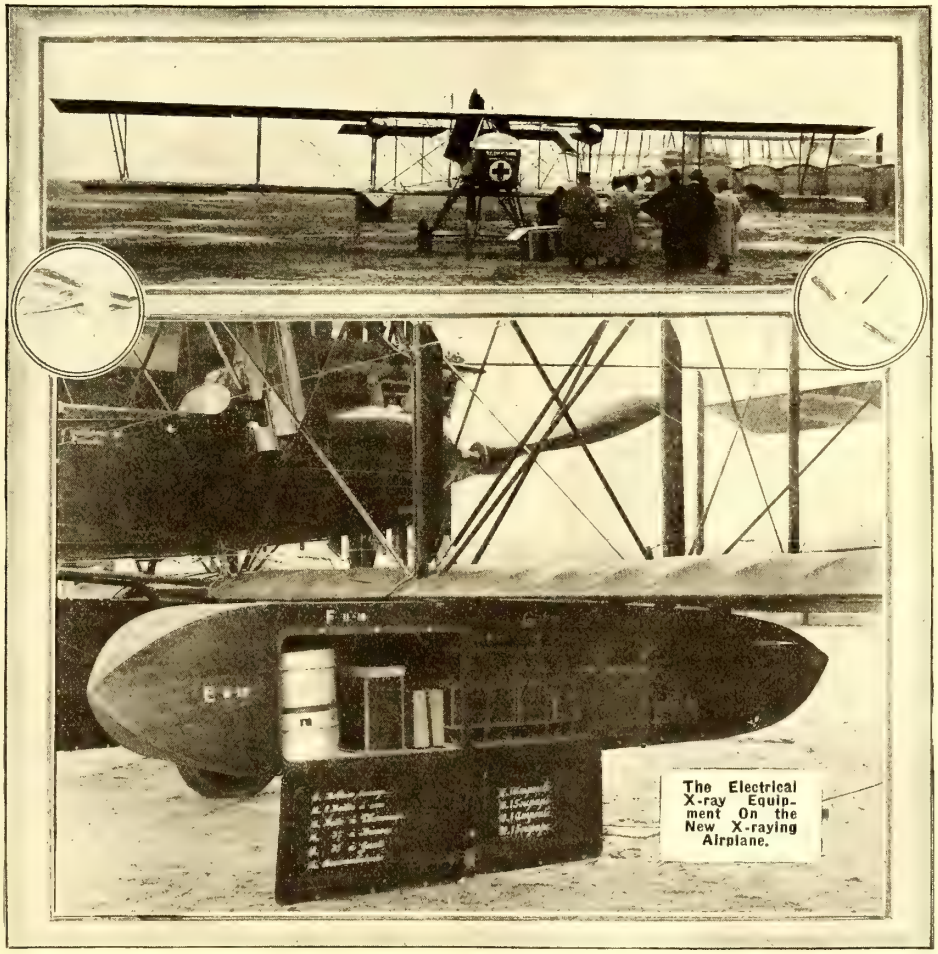
By JACQUES BOYER
Paris Correspondent, ELECTRICAL EXPERIMENTER

Paris, April, 1919.

X-RAYING AIRPLANE.

MANY great personalities of the aeronautical world have recently witnest the baptism of the "Aérochir" (from aëro and chirurgeon) at Issy-Les-Moulineaux, near Paris, at the trial of an airplane used for X-raying chirurgical purposes.

The new machine came thru the air from Ville-Coublay, having been in the air for over an hour. This flying ambulance, which can bring medical aid rapidly to the wounded, was designed by MM. Nemirovsky and Tilmant and is painted with the conventional Red Cross. It carries all the chirurgical material such as instruments for operating, sterilization, etc., all X-ray machinery, such as a spark coil, transformer, X-ray tubes, fluoroscope, as well as the personnel capable of putting the apparatus to work immediately. The attendants comprise a pilot, chirurgeon and a professional X-ray man. The entire apparatus does not weigh more than 700 kilograms. In peace times a machine of this kind may be used with great success in case of catastrophes, railroad accidents, explosions, etc., which may take place in an isolated spot. In the colonies the "Aérochir" will find large application; colonies naturally not being well populated and having few doctors, located in widely separated points, it will be an easy matter to bring quick aid to patients by means of the "Aérochir," to which distances are immaterial.



The Electrical X-ray Equipment On the New X-raying Airplane.

DR. BERGONIÉ'S NEW RHYTHMIC FARADIZATION.

Many wounded soldiers in the war have seemingly recovered, with the exception of certain muscles which refuse to resume their normal work. Formerly the best method to make these muscles return to normal conditions would be by means of continuous muscular work, as suggested by Dr. Bergonié. One method required professional work or agricultural occupations every day for an indefinite time of the affected members in order to reconstruct the muscles and put them on a normal basis once more. Unhappily, it is not always possible to do this, be it on account of nervous fatigue which sets in rapidly; be it by unseasonable weather, or also where the muscles are so situated that bodily work will not profit them greatly.

For that reason, Dr. Bergonié has brought into being what he calls an *intensified Rhythmic Faradization,* which makes it possible for the wounded to develop their muscles in a remarkably short time. Moreover, such treatment gives the muscles a very strenuous involuntary exercise produced directly by the electrical current.

From the electrical standpoint, the alternating rhythmic faradization utilizes very sharp waves of a frequency giving rise to a moderate convulsing action (50 to 55 per second). The current is produced by a special coil with a well-regulated vibrator, the coil itself giving no sparks. The waves under pressure of between 12 and 14 volts maximum have a periodicity of 15. By means of a standard metronome the current is dis-

(*Cont. on page* 151)

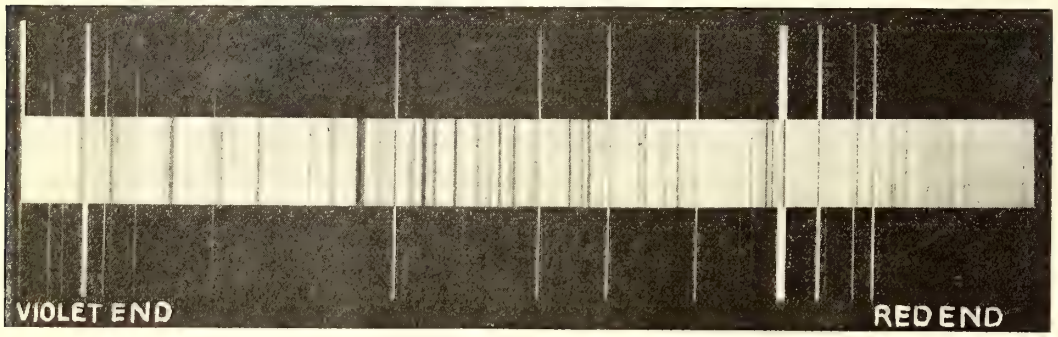
Popular Astronomy

By ISABEL M. LEWIS

of the U. S. Naval Observatory

The Evolution of the Stars

IF a ray of white light from the sun is past thru a spectroscope, which consists essentially of a glass prism or chain of prisms, it is broken up into its component rays of different wavelengths which arrange themselves in an orderly band of variegated colors: red, orange, yellow, green, blue, indigo and violet gradually blending one into the other crost by a great number of fine dark lines known as the *Frauenhofer lines* or absorption lines of the solar spectrum. The shortest wave lengths lie in the *violet* and the longest wave lengths in the *red* end of the visible spectrum. Below the red lie the infra-red and beyond the extreme violet the ultra-violet rays, both invisible to the human eye but rendered visible to a certain extent by means of photography and specially dyed plates.



1. Beta Geminorum (Pollux) Solar-type Ko Slightly More Advanced in Type Than Our Own Sun Which Belongs to Type G.

According to the first law of spectrum analysis an incandescent solid or liquid or gas under very high pressure gives a continuous spectrum, that is, an unbroken band of variegated color. If however, cooler gases intervene between us and the source of the continuous spectrum, they will absorb from the light beyond the particular rays of which they themselves consist and as a result the continuous band of color will be crost by a series of dark lines called *absorption lines,* belonging to the cooler intervening gases. To every chemical element belongs its own characteristic lines in this spectrum and no two elements ever have any line or group of lines in common.



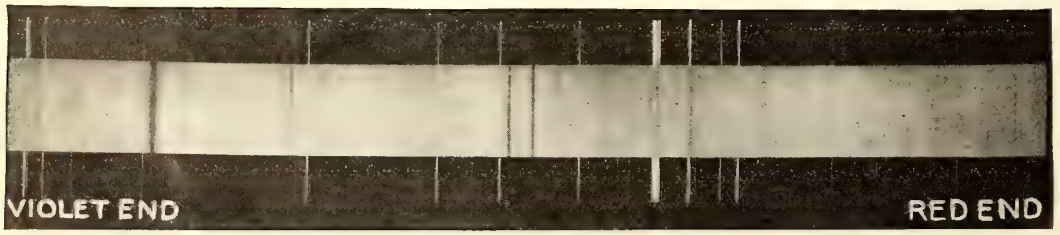
2. Eta Lonis—Helium Approaching Solar Type (Harvard Type Aop). Hydrogen Lines Have Increased In Intensity, Helium Also Visible But Fainter Than Above and a Few Metallic Lines Begin to Appear.

Applying these principles to the sun, the central core, consisting either of an incandescent solid or liquid or gas under high pressure (most probably the latter), emits the continuous band of light known as the *continuous spectrum.* The cooler gases of the surrounding solar atmosphere absorb from the light of this central core the particular rays of which they themselves consist and thus produce the multitudinous fine dark lines known as the absorption lines. It is upon the position of these dark lines that we depend for our knowledge of the physical condition of the sun, for obviously, there is nothing in the continuous band of color itself to give us any clue to the nature of the substances from which it originates. If, as sometimes happens, the continuous spectrum is crost by *bright* lines instead of *dark* lines, it shows that the intervening source of light is hotter than the source beyond. An incandescent gas at low pressure, such as incandescent hydrogen, gives a bright-line spectrum or emission spectrum consisting of bright lines upon a dark background. Such a spectrum shows that the body emitting it is a true gas. Nebulae give such a type of spectrum indicating that they are true gases. If, moreover, the central core of the sun could be suddenly blotted out the dark lines of the solar spectrum would immediately appear as bright lines on a dark background, for they belong to incandescent gases, the absorption lines appearing dark by contrast with the more intense light beyond.

It is upon these principles of spectrum analysis that our knowledge of the physical constitution of the stars depends. The sun is simply one of the stars and the solar spectrum is duplicated almost line for line in a certain type of star known as the *solar stars.* Most of the chemical elements existing in the sun's atmosphere have been identified by comparing the dark absorption lines in the solar spectrum with the lines in the spectra of terrestrial elements produced in our laboratories. It has been found *that all the elements that exist on our own planet occur also in the sun* and the same elements that exist in planet and sun enter into the composition of the stars.

By passing a ray of light from a far distant star thru the spectroscope and producing its spectrums, it becomes possible to compare the positions of its characteristic lines with the lines of the same elements in the solar spectrum. It is in this way that we learn the nature of the atmospheric gases of the stars. It must be remembered that it is the *surface* conditions of the stars and their *outer* gaseous envelopes that can be studied by the spectroscope. From the star's deep interior we receive only the continuous band of color.

The first general classification of the stars according to their spectra was made by Father Secchi, the Italian astronomer, and was publisht in 1849. It was the result of a study of the visible portion of the spectrum with a small telescope and only stars showing dark absorption lines were studied. Since that time more elaborate classifications of stellar spectra have been made—chiefly at the Harvard College observatory, where many thousand spectrograms (photographed spectra) have been studied and classified. The Harvard classification of star spectra has now been generally adopted by all astronomers The importance of the work done along this line at the Harvard Observatory can be judged by the fact that the Henry Draper catalogue of stellar spectra now in process of publication by this observatory *gives the spectra of two hundred thousand stars.* The first two volumes of the catalogue, which consists of nine volumes in all, are



1. Rigel (Beta Orionis)—A Helium Star Showing Strong Absorption Line of Hydrogen (to Left) and Helium (Near Center) and Absence of the Metallic Lines Characteristic of Solar Type Stars.

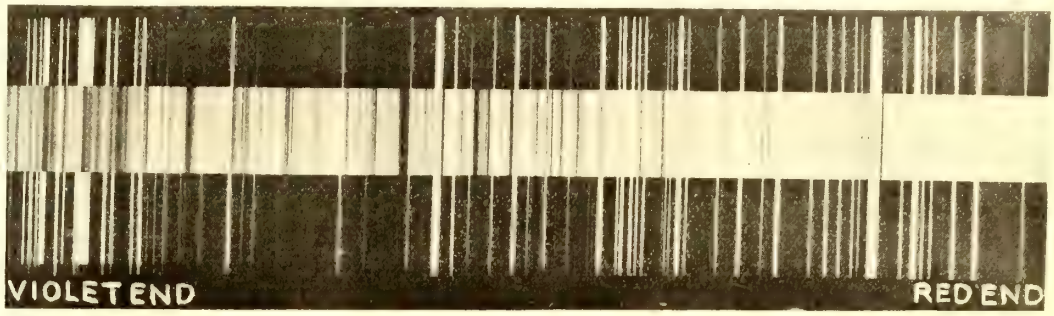
already in print. The great value to astronomy of this monumental work, which was undertaken and completed under the personal direction and supervision of the noted director, Prof. E. C. Pickering, just deceased, can hardly be overestimated. This detailed classification of star spectra shows forcibly that *evolution* is in progress among the stars. As to the exact order in which the evolution is taking place, there is still some doubt, but of the gradual transition from type to type in whatever order the evolution is progressing there can be no doubt. According to the classification of Father Secchi, which is useful for quick and approximate classification, the stars are divided into four classes or types. To Type I belong all the *bluish white or white* helium and hydrogen stars. These stars are believed to be the hottest of all the stars, and their atmospheres consist almost entirely of helium and hydrogen gases. To this class belong the Orion (helium) and Sirian (hydrogen) stars such as Rigel, Sirius and Vega.

Type II consists of the solar stars *yellow or orange* in color, whose spectra are dominated by the absorption lines of hydrogen and the metallic elements. They are generally considered to be lower in temperature than type I stars, and their atmospheres are denser and more extensive and filled with the vapors of many elements. The sun is a star of this type, and to this type also belongs such first-magnitude stars as Capella, Arcturus and Aldebaran. Type III consists of late type stars with banded or fluted spectra due to the presence of metallic compounds, chiefly of titanium oxide which appears to dominate the spectra of stars of this type and indicates a cooler atmosphere than exists in the earlier type stars, since compounds of the elements can only form at comparatively low temperatures. The absorption is strong in the violet end of the spectra of such stars, therefore they are *deeply reddish* in tinge. Antares and Betelgeuse are noted first magnitude stars of this class. Type IV consists of *deep red* stars, whose spectra are also banded or fluted, but the bands are due in this case to compounds of carbon. Their relation to the other types is somewhat uncertain, but they are believed to be connected with solar type stars by a chain of development independent of stars of the third type. That is, some solar stars develop into type III stars, others into type IV stars. Stars of this latter class are all very faint and very distant. It is believed that they are giant stars in absolute magnitude, their faintness being due to great distance.

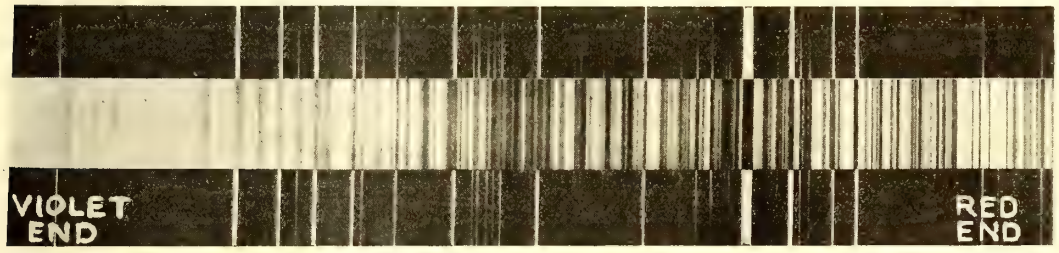
The Harvard classification is much more complete than the above. It rests upon the behavior of certain groups of lines that vary in intensity as the evolution progresses. It also assumes that the evolution of the stars starts from the gaseous nebulae and is in the direction of the late type red stars.

The spectra of the gaseous nebulae consists of bright lines of helium, hydrogen and nebulium upon a dark background. They are therefore true incandescent gases under low pressure. The first link connecting the nebulae with the stars appears to be the bright-line stars not recognized in the Secchi classification. They are referred to as the type O or Wolf Rayet stars in the Harvard notations, and their spectra show a faint continuous background (implying the formation of a central core) crost by a group of bright bands and a series of bright lines, both unknown terrestrially for a long time but finally obtained experimentally by passing a strong condensed discharge thru a mixture of hydrogen and helium in a vacuum tube. The ordinary well known hydrogen series also appears in this type, first as bright lines, but as the type progresses the bright bands and bright lines of both series become dark showing the formation of an atmosphere of cooler hydrogen and helium around the star. With the total disappearance of the bright lines and bands and the strengthening of the dark lines of helium and hydrogen, type O passes over into type B, to which belongs the beautiful blue white helium stars often called Orion stars because so many stars of this constellation are of this type. These stars have the hottest temperature and the rarest atmospheres of all the stars. The only absorption lines prominent are those of helium and hydrogen. There are a number of subdivisions of this type depending upon the relative intensity of the lines of the two gases. Toward the end of the type the hydrogen lines have become more intense than the helium lines, and faint metallic lines have begun to appear until by gradual transitions the hydrogen stars appear known as type A, or Sirian stars, after Sirius, a noted star of this type. The helium lines are now entirely gone and the spectrum of the star is entirely dominated by intense absorption lines of hydrogen. Four strong lines of this element exist in the visible spectrum (see diagram 1) and the series extends rythmically far into the ultra-violet. These stars are intense white in color and their atmospheres are composed almost entirely of incandescent hydrogen. As the type progresses the faint metallic lines of the solar spectrum become stronger. The hydrogen lines reach their maximum strength in class A. (See photo of early type stars.) The next type to appear is known as the Calcium or type F group of stars which is characterized by the growing intensity of the lines of the metallic elements, which are now closely packed together in the spectrum, and by the very marked intensity of the calcium bands in the extreme violet and the continued great strength of the hydrogen lines which surpass any of the metallic lines in intensity. (See photo of type F star Procyon). To this class belongs

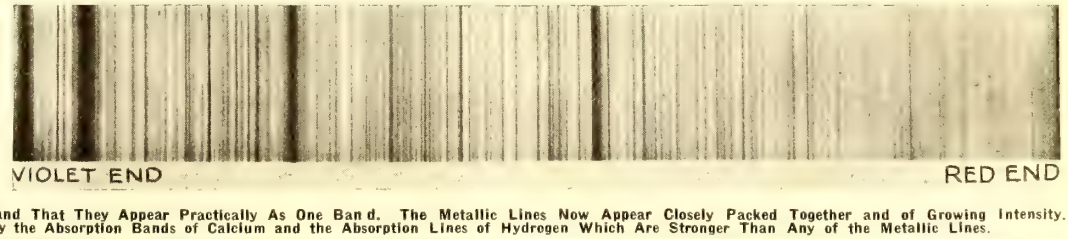
(*Continued on page* 157)



2. Alpha Tauri (Aldebaran) Advanced Solar-Type K5. Note: The Comparison Spectrum Shown Above Is That of Titanium. The Spectrum of the Star Is Superimposed Upon the Comparison Spectrum. Note in Above Spectra the Great Intensity of the Lines of the Metallic Elements Which in the More Advanced Types Have Become Stronger Than the Absorption Lines of Hydrogen Which Dominated the Spectra of Earlier Type Stars. As the Absorption Lines of the Metallic Elements Increase in Intensity the Color of the Star Becomes More and More Tinged With Red. Solar Type Stars Are Cooler (Superficially At Least) and Have Denser Atmospheres Than Stars of Type I (Helium and Hydrogen Type Stars).



Secchi's Type III, Harvard Type M Star. This Class Is Divided Into Giant (Type Ma) Stars and Dwarf (Type Mb) Stars—Color, Deep Red. The Spectrum Shown Is That of a Typical Giant (Ma) Star of This Class—Betelgeuse or Alpha Orionis. The Portion of the Spectrum Shown Is in the Blue Region. Note the Heavy Absorption in This Portion of the Spectrum and the Fluted or Banded Appearance Due to the Presence of Compounds of Titanium Oxide (Characteristic Also of Sun Spots and Indicating Comparatively Low Temperature). The Heavy Absorption of the Blue Rays Gives These Stars Their Deep Reddish Color. The Bands or Flutings Are Sharp Toward the Violet and Shade Away Toward the Red. There Is a Fourth Class of Stars Known As Type IV, Harvard Type N or Carbon Stars, in Which the Direction of the Shadings Is Reversed. These Stars Are Also Very Deep Red, Few in Number and Very Distant, the Brightest Known Being Only a Fifth Magnitude Star.

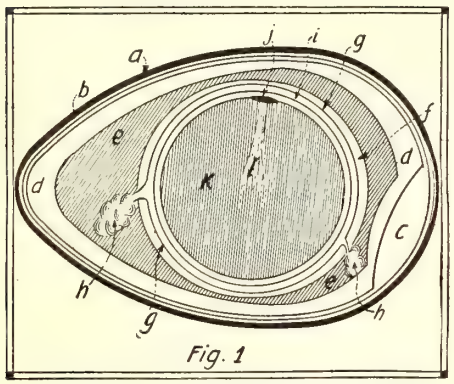


Spectrum of a Calcium or Harvard Type F Star—Alpha Canis Minoris (Procyon) Intermediate Between Secchi's Type I and Type II Stars, Color White Tinged with Yellow. The Portion of the Spectrum shown Runs From the Blue Green At the Right to the Extreme Violet At the Left. The Two Dark Bands At the Extreme Left Are the Strong Absorption Bands of Calcium So Prominent in This Type. The Other Three Dark Lines Are Absorption Lines of Hydrogen. A Fourth Line of Hydrogen Is Also Present So Close to the Second Calcium Band That They Appear Practically As One Band. The Metallic Lines Now Appear Closely Packed Together and of Growing Intensity. This Type of Star Is Dominated by the Absorption Bands of Calcium and the Absorption Lines of Hydrogen Which Are Stronger Than Any of the Metallic Lines.

Practical Chemical Experiments

By ALBERT W. WILSDON

FEW of the millions of people who eat eggs daily are familiar with, and in most cases never concern themselves with the chemical or physiological properties of this form of food. The daily consumption of eggs thruout the world is truly enormous, and the



Longitudinal Section of a Hen's Egg. a, Shell; b, Double Membrane of Shell; c, Air-Chamber; d, Outer, or Fluid Albuminous Layer; e, Thick, Middle Albuminous Layer; f, Inner Albuminous Layer; g, Membrane of the Chalaza; hh, the Chalaza; i, Vitelline Membrane; j, Germ; k, Yolk; l, Latebra. (After Macé.)

present high prices have caused many dealers to preserve eggs till the market is at a high point and then unload them, in many cases with the representation that they are *strictly fresh!* Eggs contain a relatively large proportion of *Proteid* and mineral matter which is used to furnish the salts of the bones, especially calcium phosphate, and also fat, and is one of the most concentrated forms of nutriment.

Proteids serve as a fuel for the body and also provide the important element Nitrogen, which is needed in the case of children for growth, and in the case of both children and grown people, to keep the body in repair.

Strange as it may seem, even eggs, the contents of which are contained in a brittle shell, have had substitutes placed upon the market in the guise of "egg substitutes." Nearly all these are claimed to contain all the ingredients of eggs, but most of them fall far short of these claims. There is a number of so-called *egg powders* offered for making cakes, etc., *which contain no egg at all.* They are composed of other forms of protein matter, usually casein from milk, and colored to resemble the egg in tint.

The average weight of a hen's egg is 60 grams, of which the shell weighs about 6 grams, the white 36 grams, and the yolk 18 grams. Roughly it contains 70% of water, 12% of albumin and 12% of fat.

The substance known as "white of egg" or egg albumin, when separated from the yolk, membrane and shell is a colorless, transparent, thick, sticky fluid, soluble in or miscible with water and is composed almost entirely of albumin, partially dissolved in water.

When the white of an egg is put into boiling water it undergoes a remarkable change, and is said to have *coagulated.* In this state it is insoluble in water and opaque and forms a solid mass, which, however, still contains a large proportion of water. During coagulation it is probable that chemical as well as physical changes have occurred. Thus from the foregoing we see that the white of egg is an extremely unstable and complex substance, its physical properties being so indefinite that it would be almost impossible to say that it was or it was not a definite chemical compound.

Eggs: Their Preservation and Tests

White of egg or egg albumin may, however, be taken as the representative of a group of substances which are classified together as the *Proteids,* or *Albuminoids.* They contain the five elements, Carbon, Hydrogen, Oxygen, Nitrogen and Sulfur.

Egg yolk is composed of albumin, fat, and a phosphorus bearing material of high nutritive value known as *Lecithin.* The yolk of an egg is a much richer food product than the white, containing in addition to the nitrogenous element the fat and mineral bodies necessary to nutrition.

PRESERVATION. Of particular interest to the reader will most likely be the methods of preserving and tests.

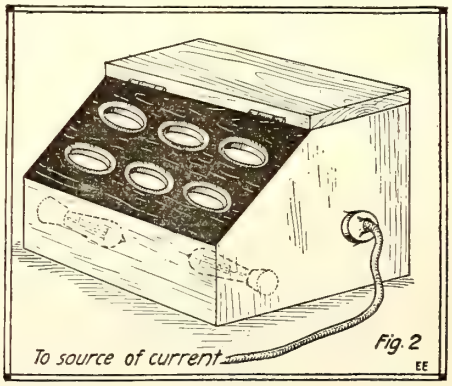
Owing to the porous nature of the shell, the moisture of the contents gradually grows less by evaporation, and the egg loses in weight. Air also passes in thru the shell pores, carrying various microbes, which result in ultimate decomposition and spoiling of the egg. Nature has provided the shell with a thin surface coating of mucilaginous matter, which, however, is easily washed off. This coating tends to partially close the pores, and for best results in keeping should not be removed by washing.

By coating the eggs artificially with a varnish or film of some kind the egg will be rendered impervious to air and water. One of the cheapest, simplest and best of these coatings is *Water-glass.* This is produced by dissolving the substance known as Sodium Silicat (or Silicat of Soda) in water, and applying the same, by dipping the egg into the solution and removing and allowing to dry. The Silicat of Soda which is thus left in a thin film over the surface of the egg penetrates and stops the pores and renders the egg-shell practically impervious both to air and water. This material possesses the property of becoming totally insoluble in water when it has once been dried so that even if the egg is afterwards subjected to contact with water the film is not removed.

One drawback to this method is that eggs so treated break more easily on boiling. This breakage may be prevented by carefully piercing the shell with a strong needle before being put into the water.

Gelatine, vaseline, wax or gum are other substances used for coating or varnishing the egg, tho they are not as efficacious as the water-glass.

Another proposed method is to immerse the eggs in boiling water for twenty seconds with the result that a very thin layer of the egg-white next to the shell becomes

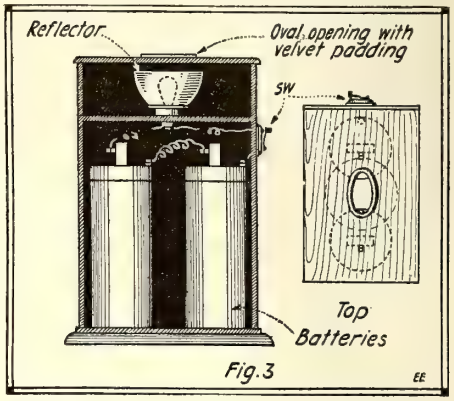


A 110-Volt Two-Lamp Egg Candling Cabinet with a Capacity of Six Eggs. It Can Be Easily Built by Anyone or Purchased as Desired.

coagulated, thus forming an impervious coating *inside the shell.*

PHYSICAL EXAMINATION OF EGGS. Various physical tests have been prescribed for ascertaining the approximate age of an egg.

THE SALT SOLUTION TEST consists of



Battery Type of Egg Candling or Testing Cabinet Which Anyone Handy with Tools Can Easily Construct. The Lamp and Reflector Can be Obtained at Any Supply Store.

placing the egg in a 10% salt solution. **If perfectly fresh, the egg will sink to the bottom. If it remains immersed in the liquid, it is to be considered at least three days old. If it rises to the surface and floats thereon, it is more than five days old.** This test is a rough one, is quickly applied, and will distinguish the really fresh egg from one which is even a few days old, but is useful only for eggs that have been kept in air. Preserved eggs cannot be gaged by these means. It is possible also to apply the sinking and floating tests on a large scale. Salt water tanks of any size may be easily constructed into which hundreds of dozens of eggs may be placed at one time, thus effecting a speedy separation of *sinkers* and *floaters,* and at a minimum expense. There are some instances where a fresh egg will not sink in these circumstances, but such cases are not numerous enough to be of any importance.

CANDLING TEST. The best method of examining eggs for freshness is *"candling,"* the process consisting in placing the egg between a bright light and the eye. **If the egg is fresh it will show a uniform rose-colored tint, without dark spots.** Moreover, there is to be found in the larger end of a fresh egg, between the shell and the lining membrane, a small air cell, occupying *one-twentieth* of the capacity of the egg, which is distinctly transparent. *In an egg which is not perfectly fresh this space, unless the egg is stored with the large end up, becomes filled with egg substances and presents the same appearance as the rest of the egg. If dark spots are found in the egg, it is certain that the egg is not perfectly fresh, and its appearance will be more or less cloudy, being darker as the eggs grow older, becoming in extreme cases opaque.* At the same time the "air chambers" mentioned before grow larger as the age increases. The so-called *"spots"* are eggs which show on "candling" black patches due to fungi.

The best of all tests, however, is to open an egg and examine its general appearance, its mobility, and its odor and taste. Eggs which have been stored some time show a tendency in the white and yolk to run together, and when this phenomenon is observed it may be certain that the egg is not a fresh one, altho no perceptible odor of

(*Continued on page* 154)

Experiments in Radio-Activity

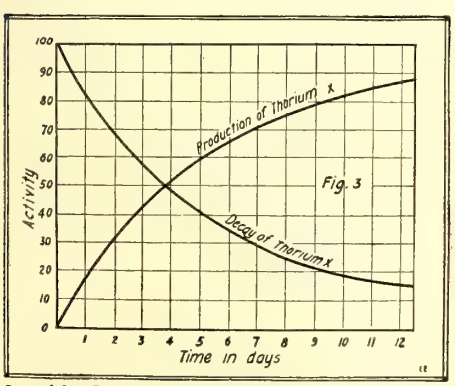
By IVAN CRAWFORD

PART IV (Conclusion)

IN the previous installments of this series the properties of the radiations from radio-active substances have been discust. It is the author's intention in this article to explain the radio-active transformations and to show that in reality *these changes are a transmutation of the elements.* Experiments will be given showing the rise and decay of the active constituents. For a more detailed account the reader is referred to Sir Ernest Rutherford's "Radio-active Substances and Their Radiations."

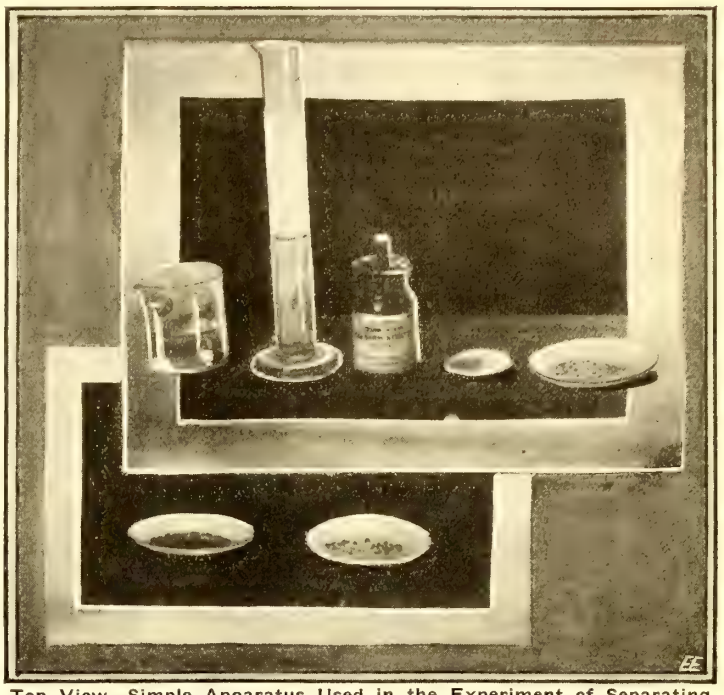
The disintegration theory was first proposed to account for the continuous production of thorium X from thorium compounds. This change from thorium to thorium X is in reality a breaking down of the thorium atom which has an atomic weight of 232, and the formation of the thorium X atom which has an atomic weight of 224. This is accomplished by the emission of two alpha particles. There are, however, two intermediary products, namely, mesothorium and radiothorium. Radiothorium is, however, chemically inseparable from thorium and mesothorium inseparable from thorium X, and are in reality isotopes. The word isotopes is used to designate two substances which have the same chemical properties, but different atomic weights. The rate of decay of an active substance may be calculated by using the formula given in the second article for the retardation of alpha particles. In this case I_e is the initial activity, I_t is the activity after time t, e is the base of the Naperian logarithms (2.7182), and λ in the case of thorium X is .19 days. Using this equation the decay curve may be plotted. The two assumptions of the disintegration hypothesis as given by Rutherford are: (1) that there is a constant production of fresh radio-active matter by a radio-active substance, and (2) that the activity of the matter so formed decreases according to an exponential law with the time from the moment of its formation.

An experiment proving the disintegration hypothesis will now be given. About 5 grams of thorium nitrat or some other thorium salt are dissolved in water. This solution should be left standing for about 2 days for reasons which will be given later. The thorium nitrat solution is then diluted to about 200 c.c. The solution should be heated and ammonia added in excess. The thorium and some impurities are precipitated as a hydroxid by the ammonia. The thorium X, however, remains in the solution with the mesothorium. The solution is now filtered and the precipitat dried for future use. The filtrate should be boiled down to dryness to remove all traces of the ammonia salts. The residue contains the thorium X. The solution when concentrated should be transferred to a watch-glass and dried upon it to facilitate handling. In the accompanying illustrations the apparatus necessary to perform these separations is clearly shown.



Graphic Curve Showing the Rapid Rise and Decay Periods of Thorium "X," in Days, as Well as the Relative Activity. The Decay Is Measurable by Means of the Sensitive Electroscope Previously Described.

The reason for letting the thorium nitrat solution stand several days before using had now better be explained. Thorium compounds have been found to give off an active gas known as *thorium emanation.* This emanation when it decays forms an active deposit. In salts this deposit is always present as the emanation is occluded in the solid, and allowed to change into the deposit. This deposit, however, decays in a short time. If the thorium solution were used fresh, the thorium X would contain some of this active deposit, thus causing an initial rise in activity instead of a gradual fall. When the solution is allowed to stand for several days the amount of active deposit remaining is negligible. No more is formed, as the emanation escapes from the open vessel not being held by the solution.



Top View—Simple Apparatus Used in the Experiment of Separating Thorium "X" from Thorium Nitrate. This Experiment Proves the Hypothesis of Radio-active Transformation or the Transmutation of the Elements. Lower View—Watch Glasses Used to Hold Thorium "X."

The watch glass or metal plate having the thorium X deposited upon it is now introduced into the radio-active electroscope. The rate of discharge is then noted as outlined in the first article. The activity should then be measured every 12 hours for about 12 days, and the results tabulated. These figures then are the measure of the decay of the thorium X at different periods. These figures may be compared with those calculated by using the equation given in the second article. The results should now be plotted on a graph.

The plotting of the decay curves of active substances is extremely simple, the ordinates represent the activities as determined by means of the ionization current, and the abscissae represent the time in days. In arranging the graph the lower abscissa should be divided into 12 divisions to represent the 12 days in this experiment. The ordinate to the left is divided into 10 parts to represent the change in activity. The initial activity is denoted by 10 and the other activities arranged proportionally on the ordinate. The activity, then, for each half day is marked on the graph by a small circle or dot. A curve joining these circles represents the decay curve of thorium X. Irregularities at the beginning may be caused by the active deposits remaining in the solution.

The thorium nitrat or hydroxid as it is after the chemical reaction can be measured in the same way as the thorium X. It will be found that the thorium hydroxid increases in activity due to the production of thorium X. The curve denoting the rise in activity of the thorium salt is the exact complement of the curve of thorium X. Two such curves are shown in the accompanying graph. They illustrate the theoretical decay and production of thorium X. This experiment shows conclusively that it is possible for one substance to change into another. If this transmutation could be controlled the goal for which alchemists sought would be realized. In this experiment the thorium gives rise to an active substance several thousand times as active, weight for weight, than the thorium from which it was separated.

As the reader goes deeper into the study of radio-activity the question may sometimes occur to him whether or not the property known as radio-activity is limited to a certain group of substances such as have been described here. This question has occurred to several scientists and has been met with various answers. It is, however, merely a subject for speculation, as it is impossible to secure any conclusive experimental evidence. The reason for this is apparent, as the rate at which they would give off rays is so small and their lives so long that they would have to be observed over millions of years to detect any visible change.

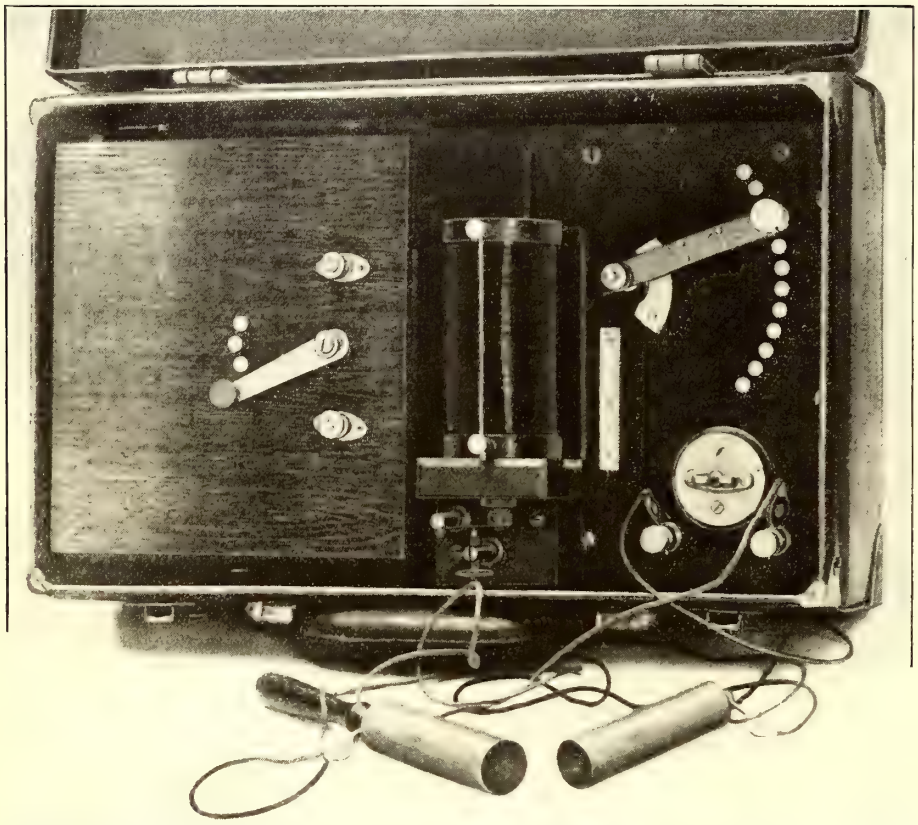
Radio-active compounds are being used more and more in modern every-day life. What was at first merely a peculiar phenomena is now an important branch of science. Prominent scientific magazines and institutions are now regarding radio-activity as a separate and distinct science. Large laboratories have been established for the study of this phenomena. Thousands of dollars have been spent in the establishing and equipping of factories for the extraction of uranium and radium from the carnotite. It has found extensive use in large hospitals for the cure and treatment of cancers and skin diseases. This line of research should appeal to every experimenter of the present day. It has given

(*Continued on page* 151)

THE CONSTRUCTOR

How to Build an Efficient Medical Coil Set

By H. WINFIELD SECOR



Appearance of Finished Medical Coil Set in Carrying Case as Built by the Writer. This Coil Is Adapted to All Kinds of Testing Work, Besides the Treatment of Various Bodily Ills, Such as Rheumatism. The Primary, Secondary or Tertiary Current and Combinations of Them Are Controlled by a Double-Pole Switch.

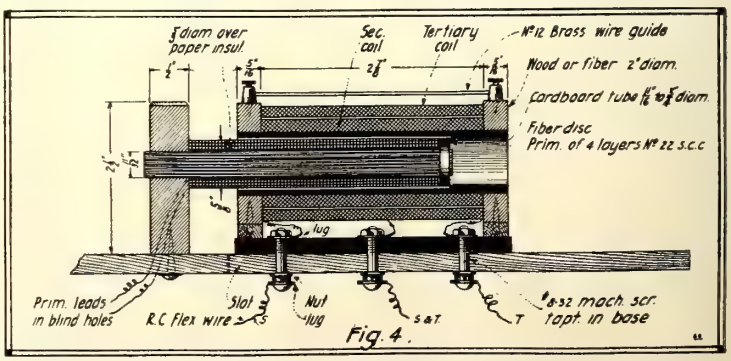
THE aim of this article is to give the constructional details so that anyone interested in shocking or medical coils may build his own apparatus at a slight cost. The outfit will produce equally as good results as any of the commercial apparatus, for all usual requirements. Medical coils are widely used for the treatment of rheumatism and other bodily ills and pains, besides furnishing lots of amusement and fun for the young folks. Not only this, but such a coil as the one here described lends itself very well to many kinds of testing, and it also can be used for telegraphing along railroad tracks for several miles, after the manner of the U. S. Signal Corps buzzer sets. We will take up the construction of the individual parts of the apparatus in detail.

Induction Coil.

The induction coil used in the present apparatus need not be as carefully insulated and constructed as that intended for producing sparks with corresponding high potentials, which constantly tend to break down the insulation between turns and between layers of wire. As the detail drawings show, the usual secondary coil is supplemented by a second fine wire winding, known as the *tertiary*, which is wound exterior to the usual secondary winding. The primary winding and the annealed soft iron wire core is mounted rigidly in a stationary block, made of mahogany or other hard wood, or else it may be cut out from a piece of black fiber, bakelite or hard rubber, whichever may be the handiest material for the builder. This primary supporting block has a hole drilled thru it, having a diameter of 11/32 inch, in which the iron wire core is to be emplaced. To make the core, you will require the softest iron wire you can procure, about No. 22 to 24 gage, measuring about 4 inches in length. The wires should be as straight as possible, and they are mounted in the upright block by placing as many of them thru the block as you can, gradually increasing the number in the hole by sticking some here and there around the outside and in the center, until as many wires are in the bundle as you can push in thru the hole. The core may be finally tightened up by driving a few small brads thru the front end and clipping these off with a pair of pliers. Afterward this core face against which the vibrator is to operate is filed off smooth, but left projecting from the block about ⅛ inch.

The next step is to insulate the long leg of the core projecting from the block, and this is done by winding some thin linen or silk tape along the core, lapping the tape slightly. A daub of glue or a piece of thread will hold the final convolution of tape. The block should previously have had two 1/16-inch holes drilled up from the base with a hand drill or drill press, thru which the two primary leads may pass without being seen. After passing thru one of the primary leads, so as to leave about 6 inches projecting and then coiled out of the way, we may proceed to wind the first layer of the primary. This is wound as evenly as possible, and, in all, four layers of the primary wire (No. 22 S. C. C. or enamel magnet wire) are put on, bringing out the final lead from the fourth layer thru the remaining hole in the upright. This coil may then be immersed in molten paraffin wax, or it may be given a coat of thin orange shellac. To give a finished appearance, a layer of black paper may be glued around it.

The secondary and tertiary coils are wound on the bobbin, as shown in Fig. 4, a wrapping of three layers of paper being placed between them. In winding the layers of these two coils, the length of the layer is made a little shorter than the bobbin, leaving a space of about ⅛ inch at each end, and a layer of thin paper, preferably paraffined paper, is placed between every layer. The size of wire for these two coils is No. 36 B. & S. gage, S. C. C. or enameled insulation. In bringing out the leads from this fine wire, it is the best practise never to rely on a single strand of this small size, which may easily break and cause no end of trouble; therefore several strands of



Section Thru the Induction Coil, Provided with Primary, Secondary and Tertiary Windings. The Tertiary Coil Is Wound Outside the Secondary and Yields a Mild Current, Very Desirable in Electro-Medical Applications.

93414

the wire should be doubled up to form a sturdy flexible lead, which should be given one or two wraps around the form and tied with a piece of thread. The fine wire forming the winding is then soldered to this heavier lead. A small winding jig, comprising two wooden uprights mounted on a base together with a piece of heavy iron wire, bent so as to form a handle or crank, and a piece of round wood such as a piece of shade roller, will serve to support the secondary bobbin while it is being wound. Proceed to wind on ten layers of the specified wire for the secondary, insulating each layer from the other by a wrapping of paraffined or other paper (but not newspaper) and when the ten layers have been wound on, the joint or common lead shown in Fig. 1 should then be put in place and the wire soldered to it. After winding three layers of paraffined paper around this coil we may proceed with the winding of the *tertiary*, or third coil, which comprises eight layers of wire, each layer separated by a wrapping of paper between. The third or outer lead, coming from the free end of the tertiary winding, completes this unit, and the coil may be finished with a few wrappings of stiff paper to protect it and give it a smooth cylindrical form. The finishing coat may be a wrapping of thin hard rubber, or simply some black paper, which may be later varnished or coated with some black shellac to correspond with the bobbin ends, as the builder may desire.

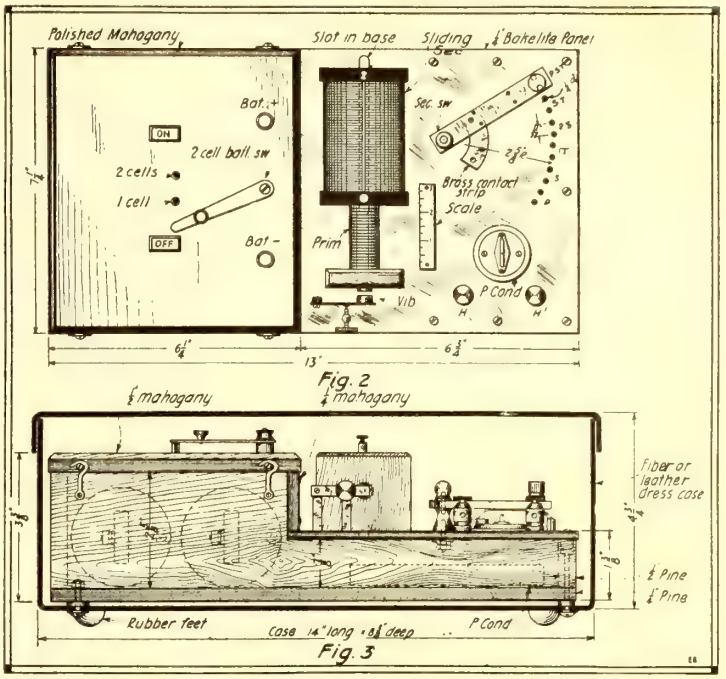
The induction coil is clearly illustrated in section by the diagram in Fig. 4, and the method of carrying the three connections from the secondary and tertiary windings is simple and efficient. Instead of the older method of providing sliding shoes and metallic rails, the writer has found it much simpler and more reliable, with no chance of intermittent makes and breaks in the current applied to the patient, to secure the three leads coming from the coils to three 8-32 machine screws threaded thru the fiber or bakelite base of the coil in the manner shown. The secondary unit, as will be perceived, is permitted to slide back and forth by virtue of the slot cut thru the wooden base of the cabinet as disclosed in Fig. 2. Three rubber-covered stranded leads such as lamp cord are firmly soldered to three lugs, clamped against the heads of these machine screws by nuts under the base, as shown. It is well to place a metal washer behind the nut, and the screws are then past thru the slot in the cabinet base and screwed into the bakelite base supporting the coil. The secondary and tertiary leads are preferably soldered to three metal lugs.

Switch Details.

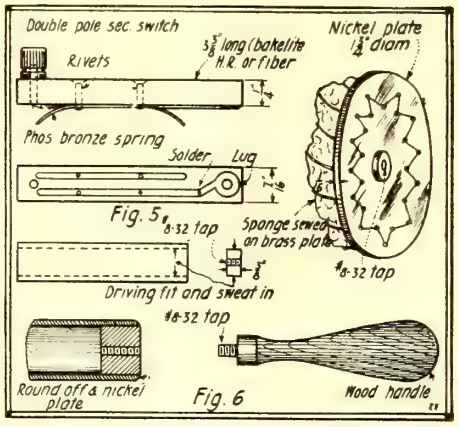
There are several switches used on this medical coil outfit. (The condenser and switch are optional, and are used mostly for producing a very strong current for shocking purposes.) There are also provided a three-point lever switch for the three positions of "off," "one cell" and "two cells" of dry battery, and a special *bi-polar* secondary switch.

The only special part which needs explanation in detail is the bi-polar secondary switch, and this is illustrated in detail in Fig. 5. The lever of this switch may be made from a piece of ¼x½-inch bakelite, hard rubber or fiber, preferably black in color. It is not necessary to give here the fractional dimensions for the phosphor bronze contact springs, as their size may be judged from the drawings, and each constructor will make these a little different possibly. They should in any case be approximately ⅛ inch in width and spaced 3/16 inch apart, so as to give as high insulation as possible between them. One of these springs remains flat at the rear, and is soldered to a brass lug, so as to be connected with the central supporting posts of the switch lever in the manner apparent. The second spring bends downward at the rear, and makes contact with an insulated brass segment, shown at Fig. 2, and which forms the second pole of this switch. The necessity of this switch will be evident from the diagram of connections, Fig. 1. The springs on the secondary switch may be of phosphor bronze, German silver, or hard springy brass, and can be quite light.

The secondary current distributing switch gives six different forms of current, namely, primary—secondary—tertiary—primary and secondary—secondary and tertiary—primary, secondary and tertiary— and therefore requires twelve contact points, which are spaced 11/32 inch apart.



Top and Front Views of Medical Coil Set, Showing Disposition of Two Dry Cells. It Works Very Efficiently on One Cell, as Proved by Tests. The Secondary Unit Is Movable.



Details of Medical Coil: Handles, Sponge, Electrode and Bipolar Switch.

Vibrator.

The vibrator is best removed from some cheap medical coil, or else made up by removing the armature spring from a buzzer or bell, which already has a platinum or silver contact mounted in the end of the spring. The vibrator contact screw and spring are supported on two round brass uprights, threaded for machine screws at the base, these uprights being made of about ¼-inch diameter stock. The spring should be about ¼ inch wide and fairly thin. It may be of steel, spring brass, phosphor bronze or German silver. The contact points, that on the spring and the point in the end of the vibrator adjusting screw, are preferably formed of small platinum points, or they may be the new tungsten points. Silver is frequently used, altho it is not very commendable for the purpose. These contact points are generally obtained from old bells or other electrical apparatus. The iron armature on the end of the vibrator spring, for use with this form of coil, should be about 5/16 inch in diameter and ⅛ inch thick. It may be riveted or soldered to the vibrator spring. It should be mounted so that the armature normally is about 3/32 inch from the iron core. (*Continued on page* 150)

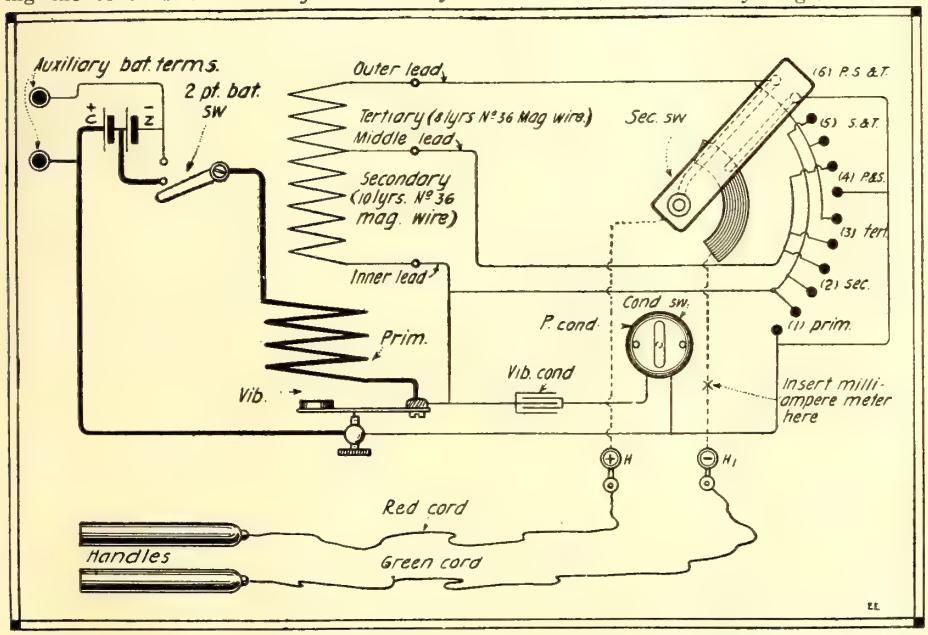
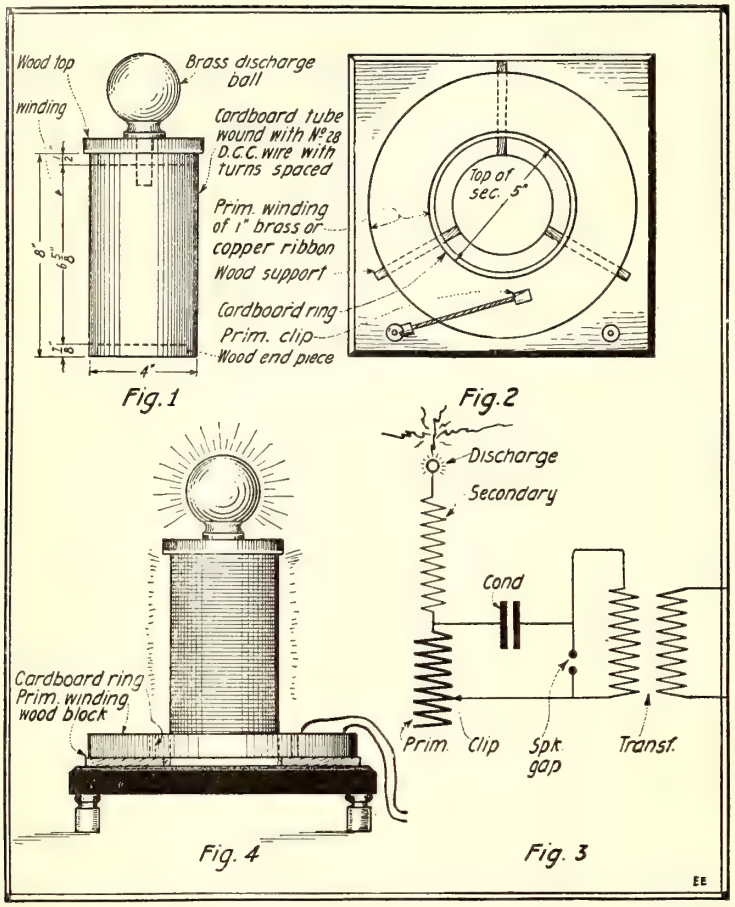


Diagram of Connections for Medical Coil Outfit Here Described. By Means of the Bipolar Current Controller any Modification of Primary, Secondary or Tertiary Current Is at Once Available.

LIBRARY

A Small High Frequency "Oudin" Coil



An 8- to 10-Inch Spark Oudin High Frequency Coil. It Can Be Excited by a One-quarter K. W. Step-up Radio Transformer or 6- to 8-Inch Spark Coil.

The high frequency transformer here described is of the *Oudin* type. All that is necessary to use in conjunction with it are a small wireless transformer or spark coil, a high potential condenser, and spark gap. The discharge obtained when the coil is excited by a ¼ K.W. transformer *will be from nine to twelve inches* in length, while the spray discharges will reach out to still greater lengths. The results obtained with this small coil will thoroly repay the builder for the few hours spent in the construction of this simple, yet intensely interesting piece of apparatus.

The secondary of the transformer is shown in Fig. 1. The cardboard tube, upon which the wire is wound, might well be a round "Quaker Oats" box cut to length. It should be well shellacked inside and out, so as to keep out the moisture. Two wooden ends should be turned or sawed out, and for the sake of appearance should be nicely stained and varnished. A discarded ball from a brass bed will be found to suit very well for a discharger. The wire for the secondary should be numbers 28 to 30 B. & S. D.C.C. or S.S.C. wire. The winding must be done on a lathe or else on a simple winding rig, as it cannot be evenly wound by hand. The turns are separated with a thread wound on with the wire. After the wire and thread are wound, the whole should be given two or three liberal coats of shellac (or better, "armalac"). The upper end of the winding should be fastened to the brass discharge ball. This finishes the secondary coil.

The primary is very easily constructed. It is made of one-inch copper or brass ribbon. The inside turn is taped to a cardboard ring, about 5 in. in diameter, and one inch high. This is shown in Fig. 2. The ribbon should be wound tightly, the turns separated by thin corrugated paper, such as used in packing boxes. The strip of paper should be about ⅝ inch wide, so as to allow sufficient surface of the ribbon exposed to make a variable contact with the helix clip. After nine or ten turns have been wound, the spiral should be tightened and taped on the outside. This makes a quite firm winding. The inside turn is connected to the lowest turn of the secondary, see diagram Fig. 3. Also a wire is led from this connection to one binding post. The clip is connected to the other post by a piece of high tension cable. The primary rests on wood supports, which may be of any convenient size. The base should be of ¾ in. wood, and 11 inches square. The edges should be beveled. Porcelain knobs are glued under the corners by means of wooden dowels inserted into the base, as shown at Fig. 4. The complete hoop-up is shown at Fig. 3. Fig. 4 shows the transformer assembled. In operation, the clip should be moved from turn to turn, until the best discharge is obtained. It might be well to say that the current from the secondary is of such high frequency that it is entirely harmless when taken thru the body, providing the spark is allowed to jump to a piece of metal held in the hand, and not to the skin direct.

Contributed by G. W. COOKE.

An Electro Harp

[*The idea here described and illustrated is the "germ" of the marvelous electrically played "choralcello"—the piano that gives absolutely pure music, owing to the fact that the strings are set into vibration by electro-magnets, not by striking them with mechanical hammers, as in the ordinary piano. With such electrically played instruments it is possible to produce "sustained" notes of wonderful purity. Those interested in this work will find that each string must be vibrated by its own magnet coil, and each coil excited by an alternating or pulsating current having a periodicity corresponding to the natural frequency of the particular string played. A buzzer specially tuned for each string may be experimented with.*—*Editorial note.*]

Any one possessing a harp or zither and a few odds and ends to be found around any amateur work-shop, may make a most pleasing and interesting instrument.

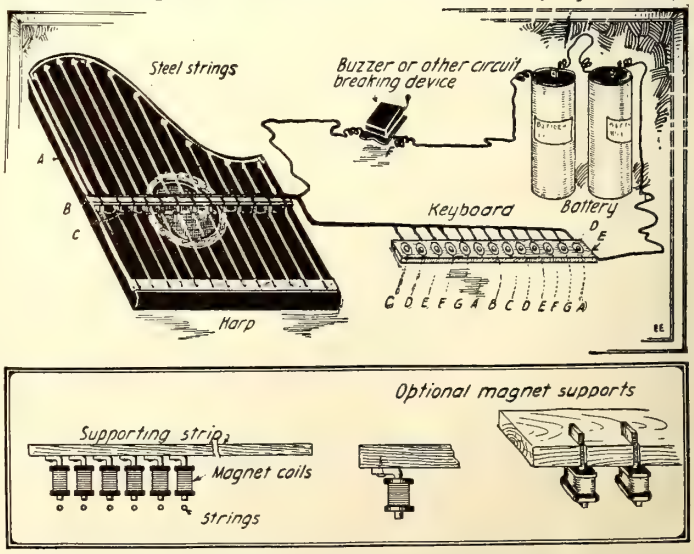
As shown in the accompanying drawing A, is an ordinary harp having steel strings. B is a wood or fiber strip on which the required number of electro-magnets, C are mounted; i. e., as many magnets as there are strings on the harp. These are suspended so as to cover, but *not touch*, the steel strings. Suitable electro-magnets are made from telephone receiver pole-pieces, which can be purchased from any supply house. A corresponding number of push buttons D, are arranged on a separate board E, serving as a key-board. The push buttons D, are lettered according to the strings they control.

The connections are as shown, each magnet being placed in series with its push-button. The other terminals of the magnets and buttons being connected, the main wires are led to a buzzer or other interrupting device F, and batteries G.

It is a good idea to construct a special keyboard, as the push-buttons cannot be played very fast. Pivoted or spring-supported strips arranged side by side can easily be assembled on a base-board, with suitable contact points mounted under each "key" strip. These contacts can be made from silver wire, platinum points off old bells or buzzers, tungsten points, or for that matter just plain brass points or springs. The smooth action of such a hand-made keyboard will really surprise you.

The instrument can be used as an ordinary piano, pressing the buttons as if they were keys.

Contributed by
CARLETON F. MAYLOT (13 years old).



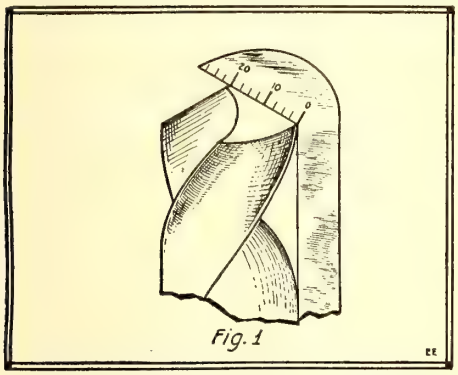
Experimental Electro-Harp Operated by a Buzzer, Which Interrupts the Current Thru a Magnet Coil in Front of Each String.

Experimental Mechanics

By SAMUEL D. COHEN

LESSON XII.

IN the last lesson we considered the theory of twist drills, and having this in mind, we shall now discuss the practical end of the twist drill. It is essential to note that in grinding twist drills it is very important to have the cutting edge



Using Grinding Gage to Test Edge of Twist Drill When Sharpening It.

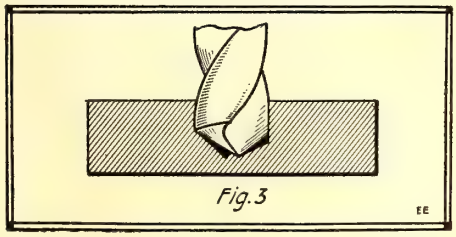
at the proper angle, otherwise the drill will not cut—or it may dig into the metal, thus spoiling the same or breaking the drill. The best angle at which the cutting edge should be ground is that of 59 degrees. A gage is usually provided for determining whether the cutting edge is ground to the required angle. Fig. 1 shows the gage being used for that purpose. This gage is a standard tool, and should be found in every experimenter's tool kit.

To acquire knowledge on how to actually grind a drill by reading, is a very difficult matter for the beginner. This is a subject which he must learn by actual practise, thus gaining experience as to the manner in which the drill is held against the abrasive (grindstone or usually an emery wheel), also how to determine whether the drill is ground properly so that it can perform its necessary function.

It is advisable for the beginner to obtain a drill grinder, which can be purchased for a nominal sum. There are two kinds of drill grinders—first, that wherein the drill is controlled by hand, and the grinding of the two cutting edges is performed separately; the second type, wherein the drill is clamped and the grinding is performed automatically. The latter is used extensively in large factories, where considerable quantities of twist drills have to be ground.

The point in favor of the grinding machine is its independence with regard to the ability of the workman; also the grinding is accomplished much faster. Fig. 2 illustrates a hand-controlled, foot-operated grinding machine.

In using twist drills, it is of extreme importance to have the cutting edges properly ground. To illustrate this, the results obtained from careless and inexperienced

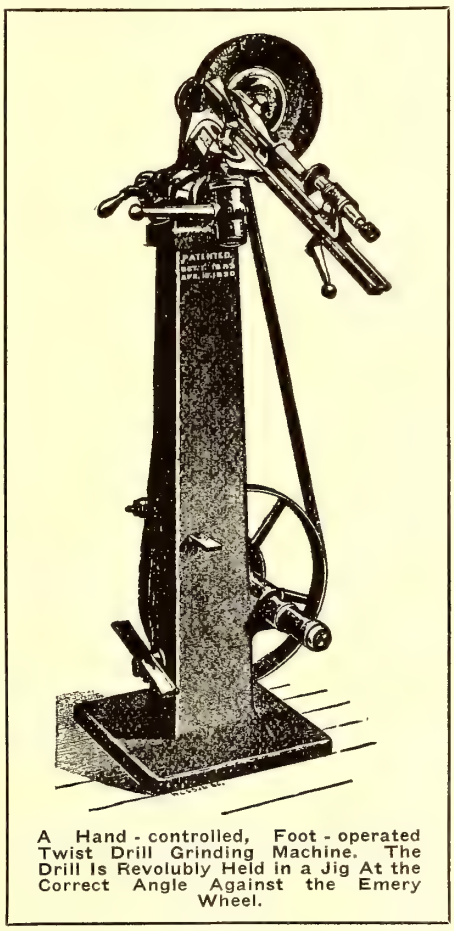


One Result of Improper or Careless Grinding of a Twist Drill. The Hole Drilled with Such a Twist Drill Tends to be Ragged, Elliptical, and in Fact Most Any Shape But Round.

use of the free-hand twist drill are clearly depicted in Figs. 3, 4 and 5. The subject is of extreme importance, and the novice is strongly advised to procure a machine that will grind his drill to the proper cutting edge angle, thereby saving some important work that he may be engaged on, which might have been destroyed by the poor, hand-ground drill.

If the sharpening is done by a free hand drill, it is advisable to observe the cutting of the metal by the twist drill: first, the chips made by the cutting; second, the size of the hole. If the cutting lips are shaped to a proper clearance, the chips will curl as they start from the cutting edge, but, if the cutting lips lack a proper clearance, the resulting chips have the appearance of being ground off, rather than freely cut. If the cutting lips are of uneven length, the hole will be enlarged over the diameter of the drill.

The next important factor with reference to drills, is their feeding speed. In order to obtain best results with drills and drilling machines, the drill should advance

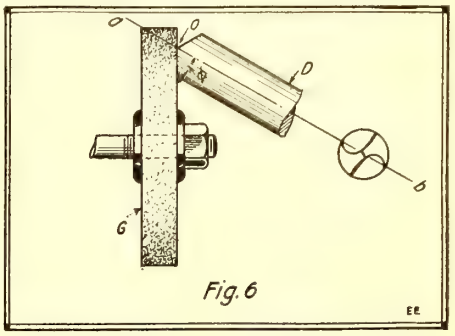


A Hand-controlled, Foot-operated Twist Drill Grinding Machine. The Drill Is Revolubly Held in a Jig At the Correct Angle Against the Emery Wheel.

into the work a definitely regulated amount each revolution. The distance which the drill advances per revolution is termed the *feed,* and must be adjusted to suit the conditions under which the work is being performed. See table at end of article.

These figures are recommended for average conditions. At times they are greatly exceeded, and at others must be greatly reduced. Feeding the drill free hand, if skillfully done, may answer in certain cases, but is less effective than power feeds, with the exception of small wire drills.

The drill speed is another important factor when considering the successful operation of twist drills. This appertains to the surface or peripheral speed of the drill in feet per minute, and is rated at the outer diameter. Under average conditions, the



In Grinding or Sharpening Twist Drills by Hand, Care Should Be Exercised to Keep the Drill Axis At An Angle of 60 Degrees with the Grinding Plane.

peripheral speed recommended for carbon steel drills is thirty to forty feet, and for high-speed drills, seventy to one hundred feet. Working conditions may at times cause a change in these figures. When the extreme outer corners of the cutting edges wear rapidly, it is evidence of too high a surface speed.

In order to grind a drill by hand, it is necessary that the axis of the drill be within 60 degrees of the grinding plane. This can be more clearly understood by referring to Fig. 6, where G is the grinding plane or grindstone, and a-b is the axis of the drill, D, to be ground. The cutting side of the drill should be kept at the required angle, $\Phi = 60$ degrees, with the grindstone surface. If now a revolving movement is made around the axis of its length toward the drill, a straight circular cone will be ground by the grinding wheel at the top, the axis of which coincides with D. If the drill is so ground that the following will be true, the drill will then perform its proper function, namely; that all the cutting lips have the same inclination to the axis of the drill; secondly, that the cutting lips be of exactly equal length; thirdly, a proper lip clearance of the surface back of the cutting edge; fourth, a proper angle of lip clearance.

In order to maintain high cutting speeds, it is necessary to use a lubricant. Those recommended below have stood the test of service.

For hard and refractory steel: Turpentine, kerosene or soda water.

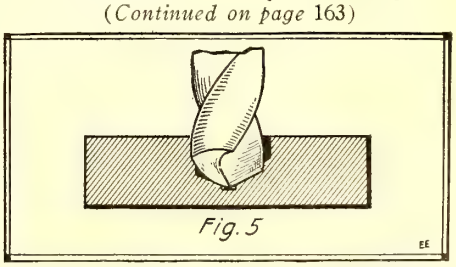
Soft steel and wrought iron drilling: Lard oil or soda water.

Brass cutting: Paraffin oil.

For aluminum: Turpentine, kerosene or soda water.

Cast-iron work: Usually worked dry.

(*Continued on page* 163)



Another Result of Unequal Grinding of a Twist Drill—and a Very Common Fault Too. The Lips Are of Unequal Lengths.

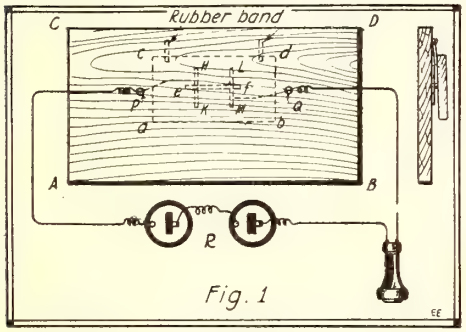
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

TELEPHONE TRANSMITTER SENSITIVE AS A DICTAPHONE

A very simple, but wonderfully sensitive telephone transmitter for experimental purposes can easily be made. As shown in the

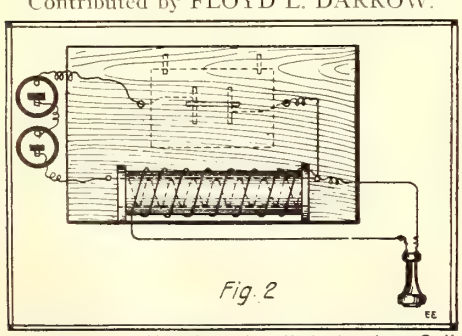


Here, ABCD = Piece of Soft Wood 5 x 3 x ¼ Inches Resting on Wooden Base. abcd = Wooden "Mouthpiece" Hanging on Back of Larger Piece and Carrying a Short Carbon Rod, ef. HK and LM = Carbon Rods Attached to the Larger Piece of Wood. Wires Lead from HK and LM Thru the Posts p and q and Two Dry Cells at R to the Standard 75 Ohm Telephone Receiver.

diagram Fig. 1, it consists of a small piece of thin board mounted on a wooden base and having two vertical carbons about 3/16 of an inch in diameter, attached by claw tacks to the back. Hanging over them is a small, thin piece of light, soft wood carrying a transverse carbon, which lightly touches the vertical ones. This constitutes the "mouthpiece." To the vertical carbons wires are attached which run through the board and connect with two dry cells and a telephone receiver. The transverse carbon resting against the vertical carbons makes a bad contact in the circuit, and the sound vibrations striking upon the *mouthpiece* produce an alternate increase and decrease in pressure, which varies the electrical resistance and current in the circuit.

To secure greater sensitiveness a small induction coil may be mounted on the front, as shown in the second diagram, Fig. 2. A few turns of No. 22 copper wire are used on the primary, and a large number of turns of No. 36 wire on the secondary. With the induction coil inserted the human voice in ordinary conversation, six feet from the transmitter, is easily heard thru the receiver, which may be placed at any distance.

Contributed by FLOYD L. DARROW.



Transmitter Showing Small Induction Coil Mounted on the Front of the Board. The "Mouthpiece" Is in Series with the Primary Winding.

SECOND PRIZE, $2.00

CONTROLLING DISTANT LIGHT WITH A MAGNET.

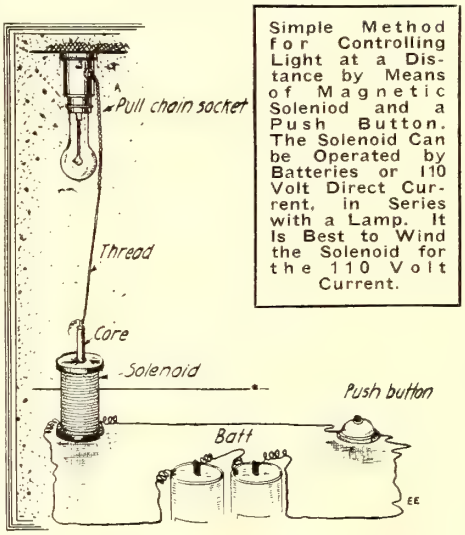
It is often convenient to have a light at the head of the stairs so connected that it may be turned on at the bottom as you go up, and turned off when you reach the top, or vice versa. But it is not always practicable or desirable to have the old wiring taken out and new installed, for this purpose. The same results can be obtained by the use of the scheme herein shown.

A common pull chain socket is used with a thread attached to the end of the chain and to the top of the solenoid core, or the chain may be fastened direct to the core for that matter. The rest of the drawing requires no explanation.

One push can be at the top of the stairs and one at the bottom, and as many others at different places as the experimenter desires. One push of the button turns the light on and another turns it off.

Contributed by

SCOTT EUGENE VANCE.



Simple Method for Controlling Light at a Distance by Means of Magnetic Soleniod and a Push Button. The Solenoid Can be Operated by Batteries or 110 Volt Direct Current, in Series with a Lamp. It Is Best to Wind the Solenoid for the 110 Volt Current.

MAGNETIZED SCREW-DRIVER A HANDY DEVICE.

I magnetized a screw-driver by holding it close to a dynamo for a few minutes, nearly two years ago, and it is still my most valued helper when it is necessary for me to do repair work on my car. It is a great help when working around the car to have this magnetized screw-driver to pick up screws and small pieces of the machinery which drop down inside, out of my reach.

In setting screws it is invaluable; simply pick up the screw by touching the head with the magnetized screw-driver, and it may be instantly set in place with only one hand. It does away entirely with the annoyance of the screw slipping away and getting lost, as it so often does. I always carry it in the tool box, and find the other fellow appreciates it when I find him having car-troubles on some lonely bit of road.

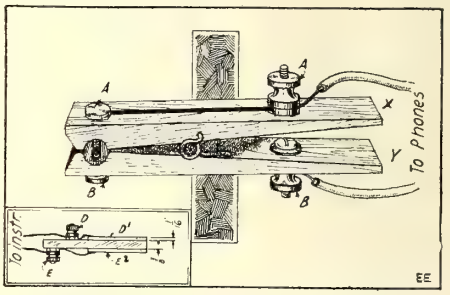
Contributed by ETHEL WEBB.

THIRD PRIZE, $1.00

A QUICKLY CONSTRUCTED "PHONE CONNECTOR."

An efficient and handy "Phone Connector" can be made in a few minutes, as follows:

Obtain a spring clothes-pin; bore a hole



A Handy, Simple and Efficient 'Phone Connecting Clip. The Clip Is Clamped, on a Strip of Fiber, Lined on Either Side with Brass Strips as Shown.

thru head where line usually goes, put a battery binding post thru each hole, so that the nut will be on the outside. Then bore two other holes one inch from the opposite end and put two more posts in. Connect the two posts on each side A to A and B to B as indicated.

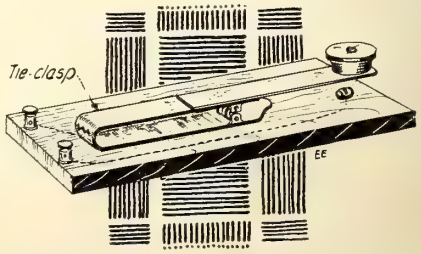
Next obtain a piece of wood 2" x ⅜" x the width of the clothes-pin; attach two strips of copper ¾" x 1/16" x ⅜" to each side. Mount two binding posts on the opposite side as D and E, then solder wire (or connect in some way) the binding posts E to plate E^2 and D to D^1. Connect D and E with the instruments and A and B with the 'phones, and pressing X and Y together, place on stationary contact blocks so as to make connection in the manner apparent.

Contributed by JOHN W. HOPKINS.

A TIE-CLASP TELEGRAPH KEY.

The telegraph key here shown costs one-tenth as much as one purchased in any store, and is smaller, neater, and just as efficient. It consists of a tie-clasp having a strip of brass, with a hard rubber knob soldered or riveted to it. The whole is then mounted on a base 3½ x 2 inches, with binding posts taken from old batteries. The illustration herewith explains fully.

Contributed by HARRY E. FUCHS.

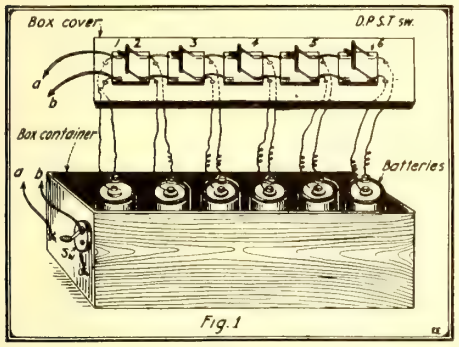


A Masterpiece! Cheap Telegraph Signaling Key Made from Tie Clasp Mounted on Wooden Base. A Brass Screw Serves as the Contact Under the Key Lever.

Connecting Up Dry Cells

By Frederick Von Lichtenow

NEARLY every experimenter who employs Dry Cells or other batteries as the main source of his current supply, keeps these cells, generally speaking, all neatly connected up—often in a dustproof container



A Neat and Effective Battery-Control Switch-Board for Connecting into Circuit Any Number of Cells, from One to Six, on Parallel.

at that—always ready for the biggest job in his laboratory, for instance his "Spark-Coil" or "Tesla Set."

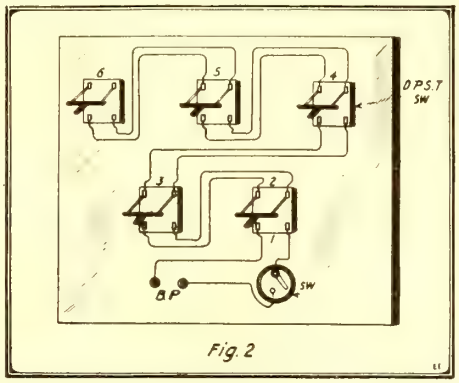
Whenever lesser pieces of apparata, such as a small motor, an electro-magnet, a buzzer, etc., etc., are to be worked, requiring only one or two dry cells, as the case may be, then these cells have to be separated from the rest of the "family", only to be put back and connected up again when the experiment is finished.

This constant disconnecting and connecting is nothing less than a genuine nuisance and does not tend to improve the condition of the connecting links, whatever they are.

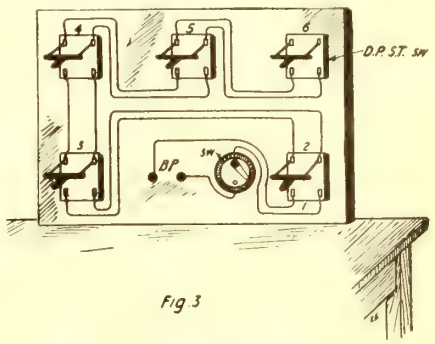
There appear now and then in the technical periodicals schemes, embodying some form of a rotary multi-point switch which are intended to remedy this trouble. To a large extent they are successful in this, but everyone of those, which have come under my observation, was suffering from two other faults, which are nearly as bad as the one above cited: First, the cells were connected up in such a manner that, with only one cell switched-in, this cell was already using energy from the next following one; and this in repetition thru the whole row. Second, as a consequence of the first fault it is impossible to properly test each cell individually without going thru the disconnecting stunt again.

The scheme treated in this article has none of these drawbacks and is the cheapest and simplest one could think of; nothing, so to speak, has to be constructed and the few necessary finished parts are obtainable anywhere at a very slight expense.

As will be seen from the illustrations, this idea of connecting cells lends itself very well to both battery-box and switch-board, whichever one prefers. The cells are arranged as if intended to be connected up in "parallel", which is clearly shown in Fig. 1. Six cells require five (small sizes) D.P.S.T.-Switches, (of which switch No. 1 serves two dry cells) with an additional circuit switch on the one side of the container. There are two binding posts brought out on the same side—one directly connected, the other to the circuit switch, as is self-evident—for the connection of apparatus.



Another Style of Battery Switchboard for Connecting up Any Desired Number of Cells on Parallel.



In this Design of Battery Switchboard the Leads from the Cells Are Brought into the Switches from the back of the Panel.

The diagrams in Figs. 2 and 3 suggest two different ways of connecting the switches, etc., upon boards, with the battery wires running in from the back (not shown in sketches) and connected to their proper places, which are marked by figures, each representing one cell.

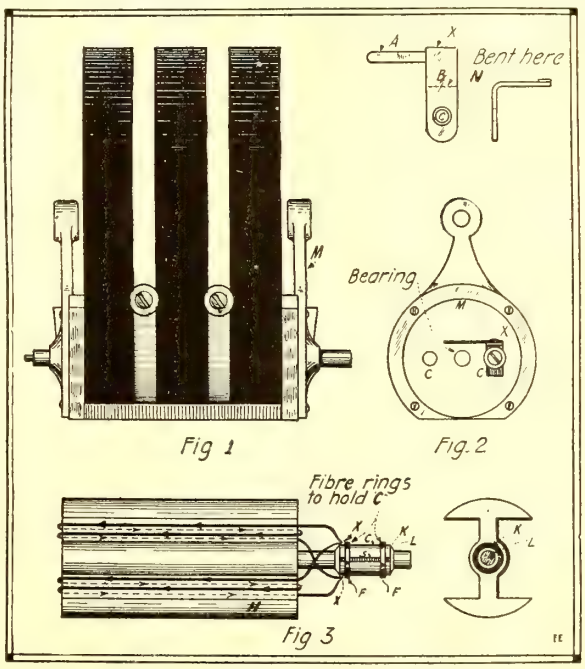
No doubt, there are several ways of eliminating those many switches without disturbing the above arrangement in the least, such as by using taps, switch-points, contact bushings in conjunction with sliding blades or rods, respectively, and other necessary parts, but these have in most cases, to be ordered, if obtainable at all, or made to order in some shop, which involves loss of time and often a respectable amount of money.

The scheme, as it is illustrated and described here, will, after all, be found to be the quickest, simplest and least expensive way of "getting there."

D. C. Dynamo from Magneto

Here is a dynamo-motor that any experimenter can make at practically no cost except a little patience and work. All the material can be purchased for a small sum. The material required are a telephone magneto and two telephone transformer coils, or about ¼ lb. No. 22 magnet wire. Also some pieces of brass, a brass tube, and some fiber and mica. Now, with all the material at hand, remove the two gear wheels on the magneto and take off the contact parts on the other end. The magneto now appears as in Fig. 1. Then take one end plate M off and drill a ¼-inch hole each side of the bearing at cc, midway between the bearing and edge of plate. Next cut two pieces of brass or copper of shape shown at N, Fig. 2. They measure about 1¼ inch. Drill a ¼-inch hole at c in each and solder a piece of spring brass A to the other end at X. Then bend into a right angle at B. These are the brushes, and they fasten to M thru cc with two battery binding posts, which are carefully insulated from the plate M.

Remove the armature of the magneto and cut away the fine wire wound thereon. Next take off about ten of the segments or laminations H, to make room for the commutator. The commutator C is made from a piece of brass tubing ½ inch long, which is slightly larger than the shaft. Now cut the tube in two halves lengthwise, being careful not to bend it. Take a piece of mica and wrap it around the shaft at L until it just fits the brass segments K.



Every Telephone Magneto Can Be Made Over, with Slight Changes, into a First-Rate "Direct-Current" Dynamo. Fine for Auto or Boat Lighting and Experimental Work.

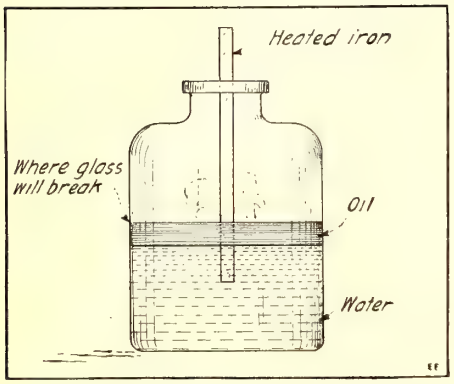
Shellac the mica to the shaft, and then shellac the segments over the mica, taking care to leave a slot S between the segments on both sides. Two short pieces of fiber tubing (rings) F, F, are then slipped tightly over C. A tight fit is necessary. These rings hold the brass pieces C securely. A word of caution here: *Place the slot S just past center as shown.* Then tie securely and put away to dry. When dry wind the armature as tightly as possible with the magnet wire in the manner indicated by arrows. Wind an equal number of turns on each side of the shaft and solder the ends to the segments of the commutator at xx. The diagram shows plainly these operations. When completed, give the windings two coats of shellac and let dry. After it is thoroly dry, place a fiber washer on each end of the shaft and assemble as originally found. Place a small pulley on the end of the shaft that protrudes and all is complete. If directions have been closely followed a nice little machine will result. *It will run either as a dynamo or motor.* As a dynamo I was able to light 4 to 5 small tungsten lamps. On 4 to 6 volts it develops remarkable power. When running as a motor it works better with one of the magnets removed, as this lessens the strength of field so that the armature revolves more freely.

Contributed by W. E. LEACH.



HOW TO CUT LARGE BOTTLES.

I herewith submit a novel way to cut large glass bottles so as to make jars. Procure a large bottle. If the top is not level or tapers it can be cut by the following means: Pour water into bottle within 1 inch of line where you want to cut. Then slowly pour linseed oil in up to the level of proposed cut. Then a red-hot iron



A Simple Way to Cut Off Large Glass Bottles, by Plunging a Red-Hot Iron Into an Oil and Water Solution Filling the Bottle Up to the Line Where the Cut Is to Be Made.

plunged vertically into the oil will cause the glass to crack at the level of the liquid and leave an open top jar.

Contributed by GERRAL EHINGER.

USEFUL LABORATORY INFORMATION.

Rain water may be used as distilled water, provided it is clean.

Baking soda is sodium bicarbonate.

Vinegar contains dilute acetic acid.

Common table salt is sodium chlorid.

Rust from a nail or other iron is ferric oxid.

Tea contains tannic acid.

Blackboard chalk is calcium carbonat.

Epsom salts is magnesium sulfate.

Sugar of lead is lead acetat.

Aqua fortis is nitric acid.

Aqua-regia is a mixture of nitric and hydrochloric acids.

Sal ammoniac is ammonium chlorid.

Sal soda is sodium carbonat.

"Hypo" is sodium thiosulfate.

Denatured alcohol is principally a mixture of wood and grain alcohol.

A porcelain mortar or pestal makes an excellent whet-stone.

Aqua ammonia is ammonium hydroxid.

"Lye" or caustic soda is sodium hydroxid.

Quicklime is calcium oxid; slacked lime is calcium hydroxid.

German silver contains no silver.

Freshly prepared ferric hydroxid is an antidote for arsenic poisoning.

The glue on postage stamps is dextrin.

Quartz is silicon dioxid.

The ruby, saffire and others gems are composed mainly of aluminum oxid.

Borax is sodium borat.

Salt-petre is potassium nitrat.

Copperas is ferrous (iron) sulfate.

Blue-stone is copper sulfate.

Hydrochloric acid and ammonium hydroxid are solutions of a gas in water.

Oxygen is made by heating potassium chlorat with manganese dioxid.

Carbon dioxid is prepared by treating marble chips with strong acid.

Hydrogen is prepared by treating zinc with strong acid.

Chlorin is easily prepared by heating a mixture of hydrochloric acid and manganese dioxid.

Sulfur dioxid is made by burning sulfur in air.

Nitrogen may be prepared by heating ammonium nitrit.

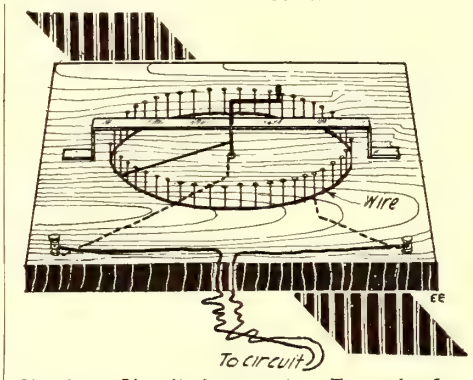
Pure silver may be prepared by treating silver nitrat with copper.

The silver is deposited as a gray powder, and may be collected by fusing into a solid.

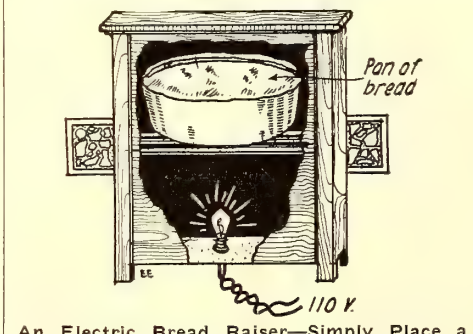
Contributed by
ARTHUR SILVERBERG.

SIMPLE CIRCUIT INTERRUPTER.

Small nails are driven in a board one-half an inch apart and connected together by wire. A crank pivoted in the center has a spring brass strip soldered to it. On turning the crank fast or slow, the circuit is interrupted.



Simplest Circuit Interrupter Formed of a Ring of Nails, Against Which a Brass Spring Mounted on a Crank Is Turned.



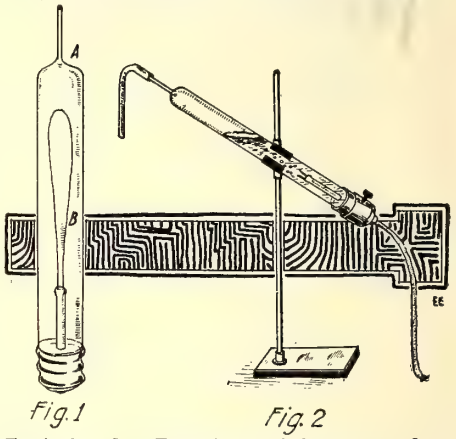
An Electric Bread Raiser—Simply Place a 32 C. P. Incandescent Lamp Under the Pan of Bread and Watch the Results.

ELECTRIC BREAD RAISER:—A box of suitable size is fitted with an air tight cover and a 32 candle-power carbon lamp screwed in the bottom of the box. The shelf that the bread rests on is made of slats, spaced about two inches apart. This is done to allow the heat to radiate freely in the box, when the bread is placed in it. The method has worked out well.

Contributed by RICHARD ANDRESS.

EXPLOSIVE GAS APPARATUS.

Having occasion to make hydrogen gas to explode in a gas cannon, I thought of the following idea: I secured an old show-case bulb and broke the tip off. After removing the filament (B), I fused a piece of glass tubing on the bulb, as shown at (A). Then I filled the bulb half full of a



Explosive Gas Experimental Apparatus Constructed of Show-case Lamp with Tube Fused on Tip End.

sulfuric acid solution, screwed it in a socket, and clamped the whole on the stand, as in Fig. 2. By running a piece of rubber tubing from the tube to the cannon, I was able to get a good explosion. Care must be taken not to disturb the platinum terminals.

Contributed by
N. KENNETH MEHAFFIE.

SILVER PLATING WITHOUT A BATTERY.

Dissolve about an ounce of silver in two ounces of nitric acid. After the silver is all dissolved throw into it a pint of water and four ounces of common salt. The salt will precipitate a powder which is pure silver. Filter off the water, or if there is no filter paper handy, pour off the water and repeat until all the effects of the salt have disappeared. To this white powder add two ounces of cyanide of potassium* and three ounces of hyposulphate of soda. Now add to all this two quarts of pure rain water and the silver mixture is complete.

The plating is done in the following manner. Hang the article to be plated in the solution at the end of a strip of lead or if more convenient, immerse the article in the solution and boil it for ten or twenty minutes, according to the thickness of the silvering desired. To obtain best results the articles to be plated must be free from grease and oil or dirt.

* **This chemical is a deadly poison and must be handled with the most care.**

Contributed by DAVID GOODMAN.

IMITATION GOLD.

Take 16 parts of platina, 7 parts copper, 1 part zinc, put in covered crucible, with powdered charcoal and melt together till the whole forms one mass and all are thoroly incorporated. Or take 4 oz. platina, 3 oz. silver and 1 oz. copper.

Contributed by
NORMAN LIVINGSTON.

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

Manager, H Gernsback

Amateur Radio Restored

By H. GERNSBACK

WINNING one war seems like a great accomplishment, but winning two wars, one after the other, is a historic occurrence for which we have few counterparts.

When on Nov. 11 the glad news came that the great war had been won, the world once more breathed freely, and so did the American Radio Amateur, who had done his "bit" in bringing the war to a successful termination. But hardly was the armistice signed than the spectre of a new war—to the amateur—crept up over the horizon threatening to take away from him the freedom for which we had fought.

A nation may be opprest by a relentless foe if conquered, or it may be opprest in a similar manner by unjust laws which curtail the freedom of its people. Indeed, when it was proposed last winter to take away from the American Radio Amateur the freedom of the ether, which would have deprived the liberties of over 300,000 young men in this country, war was declared once more. This war was to the knife; it was as short as it was decisive. But Right as usual won over Might, and the American Radio Amateur won *his* war, as the Allies won theirs.

And, as the Allies will win the fruits of their victory in the months to come, so will the amateurs reap the fruit of their victory. Indeed, the reaping has already begun. On April 15th the ban on Radio, at least for *receiving*, was officially taken off, and a mighty shout went up when Radio Amateurs were again permitted to use the ether to their hearts' content. Altho the ban for *sending* has not been removed at this time of writing, the chances are that before the next issue is in your hands the freedom of the ether will be once more restored completely.

As soon as the newspapers published the welcome tidings on April 15th that the ban on receiving was off, hundreds of thousands of amateurs began dusting off their sets and aërials blossomed forth over night by the thousands to resume their former activities once more.

And wonders upon wonders! When we put our sets away two years ago we were accustomed to hear nothing but the crisp dots and dashes in flute-like, staccato sounds coming from the high power stations which we all had learned to love. But the war has changed everything—even radio, for now the *radio telephone* has come into its own.

Where formerly there was nothing but the *tah-de-dah* in our phones, the ether is now filled with the human voice flung far and broad over the land—nay, over the oceans—and as the months roll by the dots and dashes will grow less and less, and the human voice will come in over our aërials more and more, which is as it should be.

The writer has always contended that wireless telephony was the logical outcome of radio, and in years to come only the commercial high power stations will operate their dots and dashes with their high speed machines where the voice would not be as reliable. But the future of Radio Amateurism in this country is centered upon the radio telephone. While no doubt many of us will still cling to the dots and dashes, the radio telephone will probably soon be used in overwhelming numbers.

What a wonderful world it will be in one or two years hence! You will step out into the star-lit night and myriads of voices—noiselessly and invisibly—will fill the air all over the continent, flung thru the ether. You will hear nothing and you will see nothing. When you sit on the seashore gazing fascinated at the beauty of the tides, as they follow the moon, all the while the invisible and soundless voices will be all around you—nay, even pass thru your very body. But when you step in the humble little amateur radio station and clasp a pair of receivers onto your ears, the ether will be unlocked and all of these myriads of voices will be made audible to your ears. A perfect Babel of voices will greet you, but by means of your tuning devices you will be able to pick out the very voice you wish to listen to, tuning out all the others.

It is a glorious thought that we are fortunate enough to live in an age where such things are possible, and we must prove worthy of our new-gained liberty, now certain.

And the writer regrets to say that before the war we did not realize how fortunate we were, and we did not show by our actions that we appreciated the freedom of the ether.

There was constant bickering and quarreling on the side of the amateur, among themselves as well as with commercial and government stations. Profane talk took place not infrequently thru the ether, and many of us annoyed the commercial as well as the government operators by "hogging" the ether. Hence, it was not surprising that the government tried to pass laws to curb the amateurs and curtail their liberties.

If Radio Amateurism is to prevail in the new era, the amateurs must stop their former nonsense and must settle down strictly to business. They can and should receive all they want to their hearts' content. They can and will listen very shortly to President Wilson's voice when he speaks to us from the "George Washington," where everybody is free to listen in. Amateurs can listen in to their hearts' delight, whether it be to wireless telephone or wireless telegraph. But when it comes to sending, we must mend our ways. If we do not, laws will be past sooner or later to curtail our entire liberties, and here the writer desires to make an important suggestion.

There are now a good many Radio Clubs and Associations all over the country. We cannot have too many. The suggestion is that every club and every association should appoint one or a number of expert amateurs to listen in nightly to messages that are violating the common rules, either by profane language, by "hogging" the ether, by Q. R. M. or by wilful interference. The offender should be sought out and promptly warned, and should he repeat his offense a second time, **he should be promptly reported to the Radio Inspector of the district, and the various publications catering to the amateurs should be notified.** A sworn statement relating the offense should be submitted to the publications, who will pledge themselves to publish the name of the offender.

The ELECTRICAL EXPERIMENTER, for one, will be glad to publish such names regularly, and it is believed that such measures will do more than anything else to increase the prestige of radio amateurism in the United States, and take it out of the school-boy class. There is little doubt that if we follow such procedures Radio Amateurism in the United States will become one of the great institutions of this country. We must show the world that we amateurs are serious-minded and do not use one of the greatest inventions for a

(*Continued on page* 174)

NAVY DEPARTMENT
Naval Communication Service
Office of the Director.
Washington, April 14, 1919.

Editor Electrical Experimenter
Sir:

The Acting Secretary of the Navy authorizes the announcement that effective April 15, 1919, all restrictions are removed on the use of radio receiving stations other than those used for the reception of commercial radio traffic. This applies to amateur stations, technical and experimental stations at schools and colleges, receiving stations maintained by jewelers or others desirous of receiving time signals, receiving stations maintained by manufacturers of radio apparatus, etc.

The restrictions on transmitting stations of all types are still in effect, as are the restrictions on stations operated regularly for the reception of commercial radio traffic. Both of the above classes of stations will be permitted to resume operation as soon as the President proclaims that a state of peace exists.

Attention is invited to the fact that all licenses for transmitting stations have expired, and that it will be necessary, when peace is declared, for the owners of these stations to apply to the Department of Commerce for new licenses.

Very respectfully,

(Signed) E. B. Woodworth,
Commander, U. S. Navy, Assistant Director Naval Communications.

The Above Is the Text of the Official Notification Restoring the Freedom of the Ether Once More. The Ban on Sending Is as Yet not Lifted. When Peace Is Declared, While Technically the Ban for Sending Will be Off, It Should be Remembered That All Sending Licenses Have Been Cancelled During the War and New Licenses Must Be Secured from the Department of Commerce. Address the Office of the Radio Inspector at the Custom House of Your District for Further Particulars.

The Moon's Rotation

By NIKOLA TESLA

In this article Dr. Tesla proves conclusively by theory and experiment that all the kinetic energy of a rotating mass is purely translational and that the moon contains absolutely no rotational energy, in other words, does not rotate on its axis.—EDITOR.

IN revising my article on "The Moon's Rotation", which appeared in the April issue of the ELECTRICAL EXPERIMENTER, I appended a few remarks to the original text in further support and eluci-

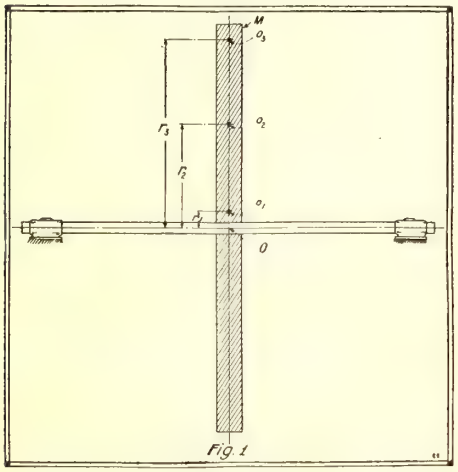


Fig. 1. In Determining the Kinetic Energy of a Rotating Mass, This Figure Shows the Selection of a Number of Points Taken Within the Straight Rod or Mass M, at Successive Distances from the Axis of Rotation O, Knowing These Values and the Speed of Rotation the Kinetic Energy of the Mass Is Readily Computed.

dation of the theory advanced. Due to the printer's error these were lost and, in consequence, I found it necessary to forward another communication which, unfortunately, was received too late for embodiment in the May number. Meanwhile many letters have reached me in which certain phenomena presented by rotating bodies, as the moon's librations of longitude, are cited as evidences of energy due to spinning motion, i. e., proofs of axial rotation of the satellite in the true physical sense. I trust that the following amplified statement will meet all of the objections raised and convert to my views those who are still unconvinced.

The kinetic energy of a rotating mass can be determined in four ways which are illustrated in diagrams, Figs. 1, 2, 3 and 4 and may be found more or less suitable.

Referring to Fig. 1, the method consists in selecting judiciously a number of points as o_1, o_2, o_3, etc., within the straight rod or mass M, respectively at distances r_1, r_2, r_3, etc., from the axis of rotation 0 and calculating the square root of the mean square of these distances. Its value being R_g, denoted radius of gyration, the *effective* velocity of the mass at n revolutions per second will be $V_e = 2\pi R_g n$ and its kinetic energy $E = \frac{1}{2} M V_e^2 = \frac{1}{2} M (2\pi R_g n)^2$.

In Fig. 2 the mass M, rotating n times per second about an axis 0 at right angles to the plane of the paper, is divided into numerous elements or small parts, most conveniently very thin concentric laminae, as l_1, l_2, l_3, etc., at distances r_1, r_2, r_3, etc., from 0. Since the kinetic energy of each part is equal to half the product of its mass and the square of the velocity, the sum of all these elemental energies $E = \frac{1}{2} \Sigma m V^2 = \frac{1}{2} m_1 V_1^2 + \frac{1}{2} m_2 V_2^2 + \frac{1}{2} m_3 V_3^2 + \ldots\ldots = \frac{1}{2} m_1 (2\pi r_1 n)^2 + \frac{1}{2} m_2 (2\pi r_2 n)^2 + \frac{1}{2} m_3 (2\pi r_3 n)^2 + \ldots\ldots$.

A different form of expression for the energy of a rotating body may be obtained by determining its moment of inertia. For this purpose the mass M (in Fig. 3), rotating n times per second about an axis 0, is separated into minute parts, as m_1, m_2, m_3, etc., respectively at distances r_1, r_2, r_3, etc., from the same. The sum of the products of all these small masses and the squares of their distances is the moment of inertia I, and then $E = \frac{1}{2} I \omega^2$, $\omega = 2\pi n$ being the angular velocity.

It is obvious that in all these instances many points or elements will be required for great accuracy but, as a rule, very few are sufficient in practice.

Still another way to compute the kinetic energy is illustrated in Fig. 4, in which case the quantity I is given in terms of the moment of inertia I_c about another axis parallel to 0 and passing thru the center of gravity C of mass M. In conformity with this the energy of motion $E = \frac{1}{2} M V^2 + \frac{1}{2} I_c \omega^2$ in which equation V is the velocity of the center of gravity.

The preceding is deemed indispensable as I note that the correspondents, even those who seem thoroly familiar with mechanical principles, fail to make a distinction between theoretical and physical truths which is essential to my argument.

In estimating the kinetic energy of a rotating mass in any of the ways indicated we arrive, thru suitable conceptions and methods of approximation, at expressions which may be made quantitatively precise to any desired degree, but do not truly de-

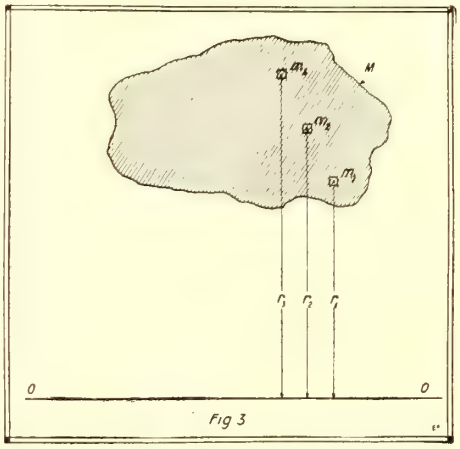


Fig. 3. Another Form of Expression for the Energy of a Rotating Body May Be Obtained by Determining Its Moment of Inertia. Here the Mass M is Subdivided Into Minute Parts m_1, m_2, m_3, ... etc. The Sum of the Products of These Masses and the Squares of Their Distances Is the Moment of Inertia, Which with the Angular Speed, Gives the Kinetic Energy E.

fine the actual condition of the body. To illustrate, when proceeding according to the plan of Fig. 1, we find a certain hypothetical velocity with which the entire mass should

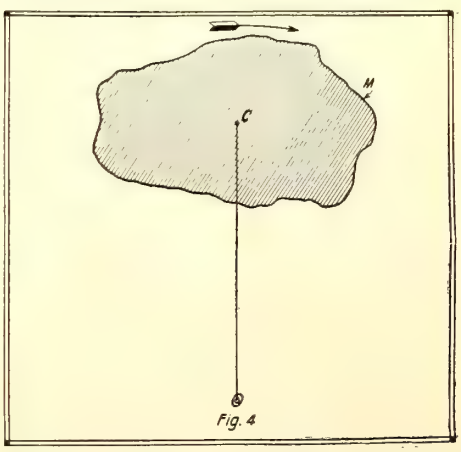


Fig. 4. In this Case the Motion is Resolved Into Two Separate Components—One Translational About O and the Other Rotational About C. The Total Kinetic Energy of the Mass Equals the Sum of These Two Energies.

move in order to contain the same energy, a state wholly imaginary and irreconcilable with the actual. Only, when *all* particles of the body have the same velocity, does the

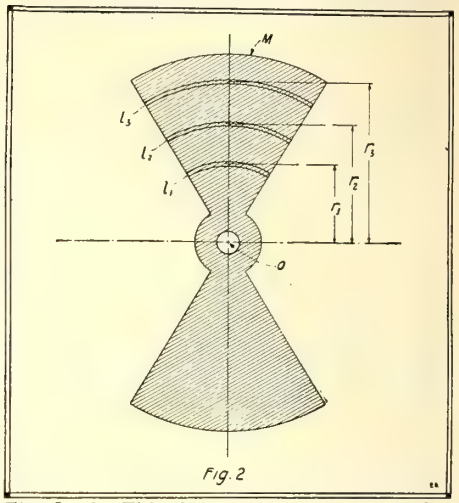


Fig. 2. In This Case the Mass M, Rotating n Times Per Second, About An Axis O, Is Divided Into Numerous Elements or Small Parts at Various Radii from O. Knowing the Kinetic Energy of Each Part, the Whole Kinetic Energy of the Mass Is Easily Determined by Taking a Summation of the Individual Quantities.

product $\frac{1}{2} M V^2$ specify a physical fact and is numerically and descriptively accurate. Still more remote from palpable truth is the equation of motion obtained in the manner indicated in Fig. 4, in which the first term represents the kinetic energy of translation of the body as a whole and the second that of its axial rotation. The former would demand a movement of the mass in a definite path and direction, all particles having the same velocity, the latter its simultaneous motion in another path and direction, the particles having different velocities. This abstract idea of angular motion is chiefly responsible for the illusion of the moon's axial rotation, which I shall endeavor to dispel by additional evidences.

With this object attention is called to Fig. 5 showing a system composed of eight balls M, which are carried on spokes S, radiating from a hub H, rotatable around a central axis 0 in bearings supposed to be frictionless. It is an arrangement similar to that before illustrated with the exception that the balls, instead of forming parts of the spokes, are supported in screw pivots *s*, which are normally loose but can be tightened so as to permit both free turning and rigid fixing as may be desired. To facilitate observation the spokes are provided with radial marks and the lower sides of the balls are shaded. Assume, first, that the drawing depicts the state of rest, the balls being rotatable without friction, and let an angular velocity $\omega = 2\pi n$ be imparted to the system in the clockwise direction as indicated by the long solid arrow. Viewing a ball as M, its successive positions 1, 2, 3—8 in space, and also relatively to the spoke, will be just as drawn, and it is evident from an inspection of the diagram that while moving with the angular velocity ω about 0, in the clockwise direction, the ball turns, with respect to its axis, at the same angular velocity but in the opposition direction, that of the dotted arrow. The combined result of these two motions is a translatory movement of the ball such that all particles are animated with the same velocity V, which is that of its center of gravity. In this case, granted that there is absolutely no friction the

kinetic energy of each ball will be given by the product of ½ M V² not approximately, but with mathematical rigor. If now the pivots are screwed tight and the balls fixt rigidly to the spokes, this angular motion relatively to their axes becomes physically impossible and then it is found that the kinetic energy of each ball is increased, the increment being exactly the energy of rotation of the ball on its axis. This fact, which is borne out both by theory and experiment, is the foundation of the general notion that a gyrating body—in this instance ball M—presenting always the same face towards the center of motion, *actually* rotates upon its axis in the same sense, as indicated by the short full arrow. *But it does not tho to the eye it seems so.* The fallacy will become manifest on further inquiry.

To begin with, observe that when a mass, say the armature of an electric motor, rotating with the angular velocity ω, is reversed, its speed is $-\omega$ and the difference $\omega - (-\omega) = 2\omega$. Now, in fixing the ball to the spoke, the change of angular velocity is only ω; therefore, an additional velocity ω would have to be imparted to it in order to cause a clockwise rotation of the ball on its axis in the true significance of the word. The kinetic energy would then be equal to the sum of the energies of the translatory and axial motions, not merely in the abstract mathematical meaning, but as a physical fact. I am well aware that, according to the prevailing opinion, when the ball is free on the pivots it does not turn on its axis at all and only rotates with the angular velocity of the frame when rigidly attached to the same, but the truth will appear upon a closer examination of this kind of movement.

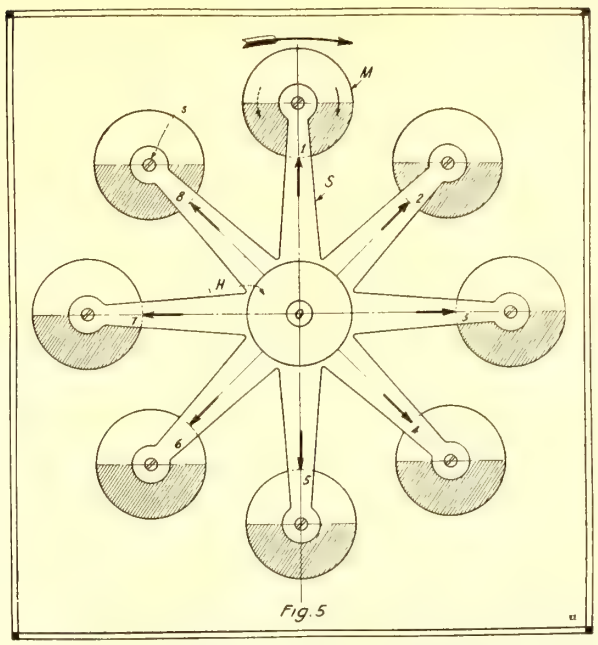


Fig. 5. This Diagram Represents a System Composed of 8 Balls M, Carried on Spokes S, and Rotating Around Center O. The Balls Are Freely Rotatable on Pivots Which Can Be Tightened. With This Model the Fallacy of the Moon's Rotation on Its Axis Is Demonstrable.

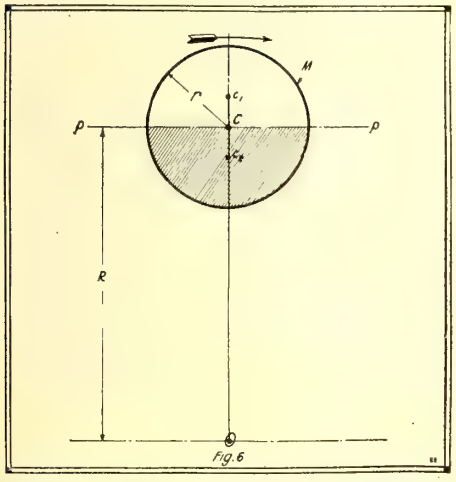


Fig. 6. Diagram Showing a Ball Having Mass M, of Radius r, Rotating About Center O, and Used in the Theoretical Analysis of the Moon's Motion.

Let the system be rotated as first assumed and illustrated, the balls being perfectly free on the pivots, and imagine the latter to be gradually tightened to cause friction slowly reducing and finally preventing the slip. At the outset all particles of each ball have been moving with the speed of its center of gravity, but as the bearing resistance asserts itself more and more the translatory velocity of the particles nearer to the axis 0 will be *diminishing*, while that of the diametrically opposite ones will be *increasing*, until the maxima of these changes are attained when the balls are firmly held. In this operation we have thus deprived those parts of the masses which are nearer to the center of motion, of some kinetic energy of *translation* while adding to the energy of those which are farther and, obviously, the gain was greater than the loss so that the *effective* velocity of each ball as a whole was increased. *Only so* have we augmented the kinetic energy of the system, not by causing *axial rotation* of the balls. The energy E of each of these is *solely* that of translatory movement with an effective velocity V_e as above defined such that $E = \frac{1}{2} M V_e^2$. The axial rotations of the ball in either direction are but apparent; *they have no reality whatever* and call for no mechanical effort. It is merely when an extraneous force acts independently to turn the whirling body on its axis that energy comes into play. Incidentally it should be pointed out that in true axial rotation of a rigid and homogenous mass all symmetrically situated particles contribute equally to the momentum which is not the case here. That there exists not even the slightest tendency to such motion can, however, be readily established.

For this purpose I would refer to Fig. 6 showing a ball M of radius r, the center C of which is at a distance R from axis 0 and which is bisected by a tangential plane pp as indicated, the lower half sphere being shaded for distinction. The kinetic energy of the ball when whirled n times per second about 0 is according to the first form of expression $E = \frac{1}{2} M V_e^2 = \frac{1}{2} M (2\pi R_g n)^2$, M being the mass and R_g the radius of gyration. But, as explained in connection with Fig. 4, we have also $E = \frac{1}{2} M V^2 + \frac{1}{2} I_c \omega^2, V = 2\pi R n$ being the velocity of the center of gravity C and I_c the moment of inertia of the ball, about the parallel axis passing thru C and equal to $\frac{2}{5} M i^2$ so that $E = \frac{1}{2} M (2\pi R n)^2 + \frac{1}{5} M r^2 (2\pi n)^2$. Neither of these two expressions for E describes the actual state of the body but the first is certainly preferable conveying, as it does, the idea of a single motion instead of two, one of which moreover is devoid of existence. I shall first undertake to demonstrate that there is no torque or rotary effort about center C and that the kinetic energy of the supposed axial rotation of the ball is mathematically equal to zero. This makes it necessary to consider the two halves separated by the tangential plane pp wholly independent from one another. Let c_1 and c_2 be their centers of gravity, then $Cc_1 = Cc_2 = \frac{3}{8} r$. In order to ascertain the kinetic energy of the hemispheres we have to find their radii of gyration which can be done by determining the moments of inertia I_{c_1} and I_{c_2} about parallel axes passing thru c_1 and c_2. Complex calculation will be avoided by remembering that the moment of inertia of either one of the half spheres about an axis thru C is $I_C = \frac{1}{2} \times \frac{2}{5} M r^2, = \frac{1}{5} M r^2$, and since $M = 2$ m, $I_C = \frac{2}{5} m r^2$. This can be exprest in terms of the moments I_{c_1} and I_{c_2}; namely, $I_C = I_{c_1} + m (\frac{3}{8} r)^2 = I_{c_2} + m (\frac{3}{8} r)^2$. Hence $I_{c_1} = I_{c_2} = I_C - m (\frac{3}{8} r)^2 = \frac{2}{5} m r^2 - 9/64 m r^2 = 83/320 m r^2$. Following the same rule the moments of inertia of the half spheres about the axis passing thru the center of motion 0 can be found. Designating the moments for the upper and lower halves of the ball, respectively, I_{O_1} and I_{O_2} we have $I_{O_1} = m (R + \frac{3}{8} r)^2 + I_{c_1} = m (R + \frac{3}{8} r)^2 + 83/320 m r^2$ and $I_{O_2} = m (R - \frac{3}{8} r)^2 + I_{c_2} = m (R - \frac{3}{8} r)^2 + 83/320 m r^2$. Thus for the upper half sphere the radius of gyration $R_{g_1} =$

$$\sqrt{\frac{I_{O_1}}{m}} = \sqrt{(R + \tfrac{3}{8} r)^2 + 83/320\ r^2}$$

and for the lower one $R_{g_2} =$

$$\sqrt{\frac{I_{O_2}}{m}} = \sqrt{(R - \tfrac{3}{8} r)^2 + 83/320\ r^2}$$

These are the distances from center 0, at which the masses of the half spheres may be concentrated and then the algebraic sum of their energies—which are wholly translatory those of axial rotation being nil—will be exactly equal to the total kinetic energy of the ball as a unit. The

(*Continued on page* 156)

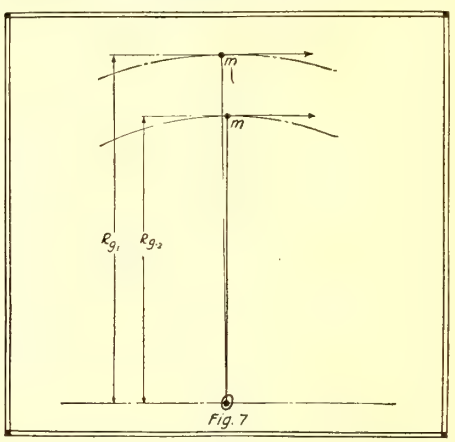


Fig. 7. Here Two Masses m-m, Are Considered as Condensed Into Points, Attached to Weightless Strings of Different Radii. If Both Strings Are Cut, and the Masses Considered as Joined, Then There Will Be No Rotation About the Common Center of Gravity.

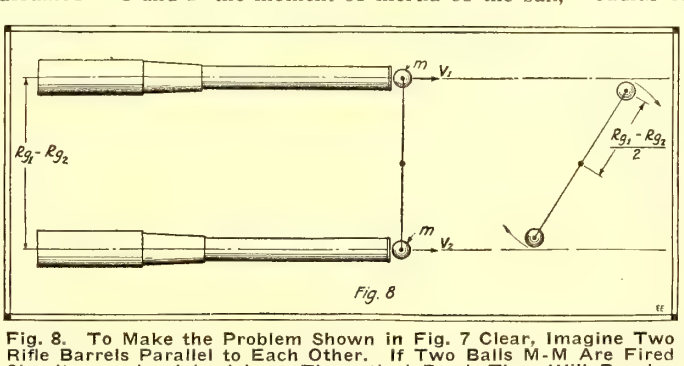
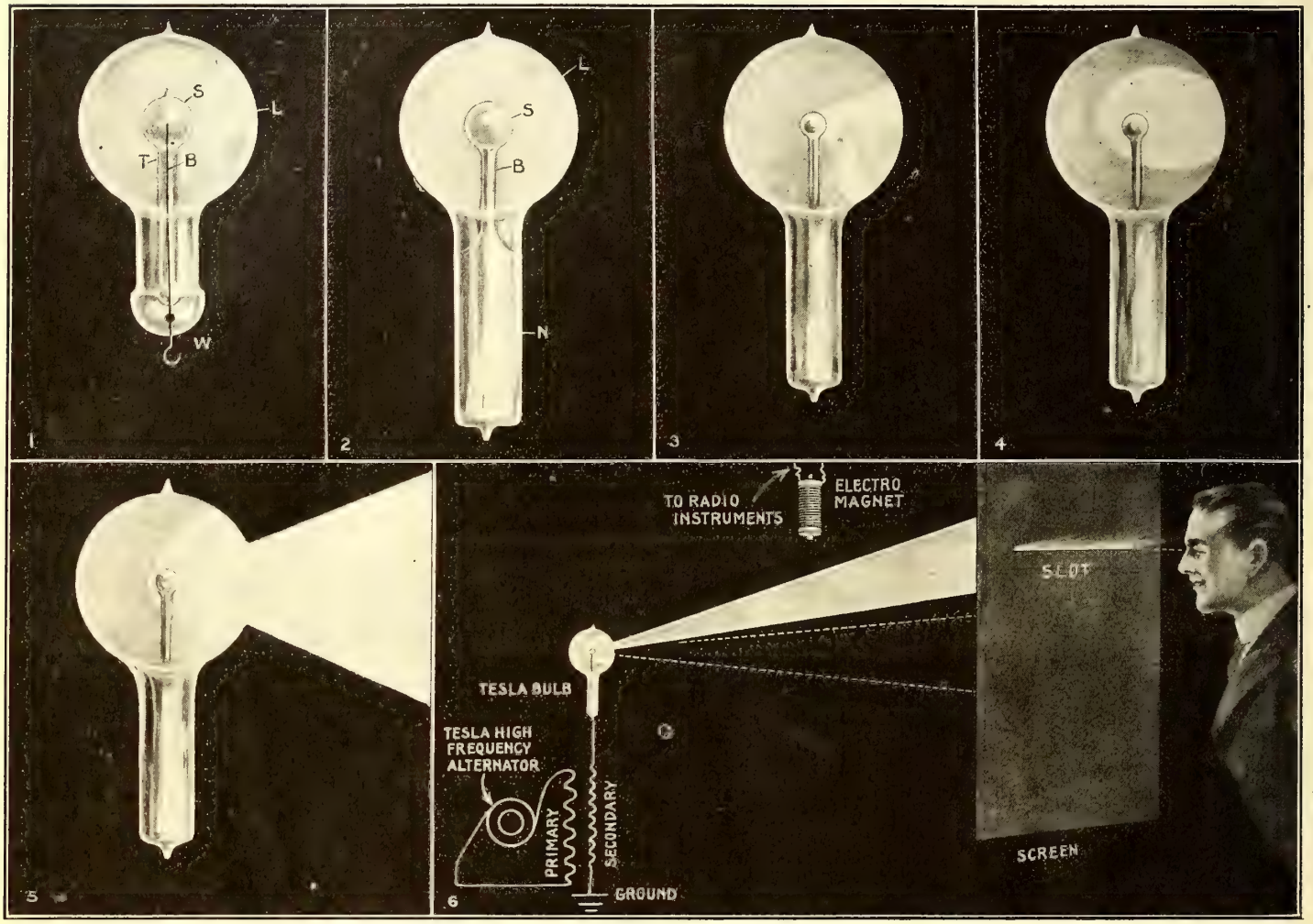


Fig. 8. To Make the Problem Shown in Fig. 7 Clear, Imagine Two Rifle Barrels Parallel to Each Other. If Two Balls M-M Are Fired Simultaneously, Joined by a Theoretical Bond, They Will Revolve About Their Common Center of Gravity, Proving That the Moon Possesses Only Kinetic Energy of Translation.

RADIO DEPARTMENT

Tesla Bulbs



Early in Nikola Tesla's Researches—in Fact as Far Back as 1892—He Discovered a Most Peculiar and Wonderful Vacuum Bulb Phenomena. The Effect was That, Under Certain Critical Conditions, This Bulb Would Cause a Ray to Be Shot off in the Manner Shown, Which Ray Would Revolve or Oscillate Under the Influence of a High-Frequency Current and in Synchrony with It. By Utilizing This Principle, Dr. Tesla Believes It is Possible to Produce a Radio Detector More Sensitive Than the Audion or Fleming Valve.

IN the May issue in his article, "True Wireless," Nikola Tesla mentions the forerunner of the Audion, a Vacuum Bulb, which he used in his earlier experiments.

We have been in receipt of numerous letters from many individuals interested in this bulb who desire further particulars as to its operation, etc.

Accordingly, we publish herewith some excerpts from a lecture by Dr. Tesla delivered before the Institution of Electrical Engineers and Royal Institution, London, February, 1892.

"I think it best at this juncture to bring before you a phenomenon, observed by me some time ago, which to the purely scientific investigator may perhaps appear more interesting than any of the results which I have the privilege to present to you this evening.

"It may be quite properly ranked among the brush phenomena—in fact, it is a brush, formed at, or near, a single terminal in high vacuum.

"In bulbs provided with a conducting terminal, tho it be of aluminum, the brush has but an ephemeral existence, and cannot, unfortunately, be indefinitely preserved in its most sensitive state, even in a bulb devoid of any conducting electrode. In studying the phenomenon, by all means a bulb having no leading-in wire should be used. I have found it best to use bulbs constructed as indicated in Figs. 1 and 2.

"In Fig. 1 the bulb comprises an incandescent lamp globe L, in the neck of which is sealed a barometer tube b, the end of which is blown out to form a small sphere *s*. This sphere should be sealed as closely as possible in the center of the large globe. Before sealing, a thin tube *t*, of aluminum sheet, may be slipt in the barometer tube, but it is not important to employ it.

"The small hollow sphere *s* is filled with some conducting powder, and a wire *w* is cemented in the neck for the purpose of connecting the conducting powder with the generator.

"The construction shown in Fig. 2 was chosen in order to remove from the brush any conducting body which might possibly affect it. The bulb consists in this case of a lamp globe L, which has a neck *n*, provided with a tube *b* and small sphere *s*, sealed to it, so that two entirely independent compartments are formed, as indicated in the drawing. When the bulb is in use the neck *n* is provided with a tinfoil coating, which is connected to the generator and acts inductively upon the moderately rarefied and highly conducting gas inclosed in the neck. From there the current passes thru the tube *b* into the small sphere *s*, to act by induction upon the gas contained in the globe L.

"It is of advantage to make the tube *t* very thick, the hole thru it very small, and to blow the sphere *s* very thin. It is of the greatest importance that the sphere *s* be placed in the center of the globe L.

"Figs. 3, 4, 5, indicate different forms, or stages, of the brush. Fig. 1 shows the brush as it first appears in a bulb provided with a conducting terminal; but, as in such a bulb it very soon disappears—often after a few minutes—I will confine myself to the de-

(*Continued on page* 179)

Alexanderson's "Barrage" Receiver

The Highly Perfected Tuning Device That Riddled the German "Radio Barrage"

E F. W. ALEXANDERSON, consulting engineer and radio expert, related before a large gathering of leading American radio experts, at the April meeting of the Institute of Radio Engineers held in New York City, how Yankee ingenuity overcame German efficiency in the battle to control the air by wireless during the war. As in the fighting on land and sea, the Americans won!

The Germans installed powerful wireless apparatus at strategic points, and blocked communication with a barrage of meaningless messages that interfered with the sending and receiving of important messages. Something had to be done, and when the American Navy unfurled its battle flag in foreign seas it overcame the German interference with the wireless, and so made a remarkable stride in the science of aërial communication.

Mr. Alexanderson was one of the engineers who perfected the barrage receiver, as the device is termed. This invention permits an operator to tune out the powerful messages sent from points near at hand, and pick out of the clashing of radio waves the message sent from greater distances. In a word, he can isolate all messages except the one he desires to hear.

The problem of combating the barrages of senseless messages became serious as the war wore along. It was rather disconcerting to an Allied operator receiving an important message to have something like this break in on him—"Don't eat apple pie on Thursday. Yours till the watch on the Rhine stops. Gott mit Uns," yet it was just such messages that literally flooded the air when the wireless of the Allies was working.

Mr. Alexanderson explained two new devices at this lecture—the first, the "bridge receiver," which permits the speaker in a radiotelephone communication to break in on the second party at any time, and the wonderfully clever radio "barrage receptor."



Alexanderson Radio Receiver—"Barrage" Section.

The first invention, the "bridge receptor," gives to wireless telephony the same efficiency as the ordinary telephone. It enables the user to interrupt the person he is talking with without manipulating any apparatus. It will make it possible in the early future for a subscriber to converse with another subscriber in Europe while using the ordinary telephone installed in his home. He also will be able to speak to friends on ships in midocean.

The object of this development was briefly to provide means for neutralizing the overwhelming intensity of the transmitted signal so as to make the receiving set sensitive to the faint impulses of the distant signal. Popularly speaking, the corresponding equivalent in sound waves would be to have an ear which could be so adjusted that a person could stand close to a steam whistle without hearing the whistle, but listen to a person speaking from a distance of a few hundred feet (about a hundred meters). A successful solution of this problem was found as described. This method of reception which is characterized by a static bridge neutralization may be properly classified as the "bridge receiver."

The Barrage Receiver.

During the war the same problem presented itself again in a form which called for a new solution. Distances are only relative, and a steam whistle located in Germany might make such a noise that it would completely drown out both in England and France the sound of the voice calling from America. To find a way to counteract such a continuance was seriously considered by the Inter-Allied conference in February, 1918; and appeals for a solution were conveyed to the author by the French representative in this country, Lieut. Paternot. The solution to this problem, which was adopted by the American as well as the French government after the first demonstration, has become known as the "barrage receiver." This name appears appropriate because the word "barrage" has not only the military mean-

(*Continued on page* 171)

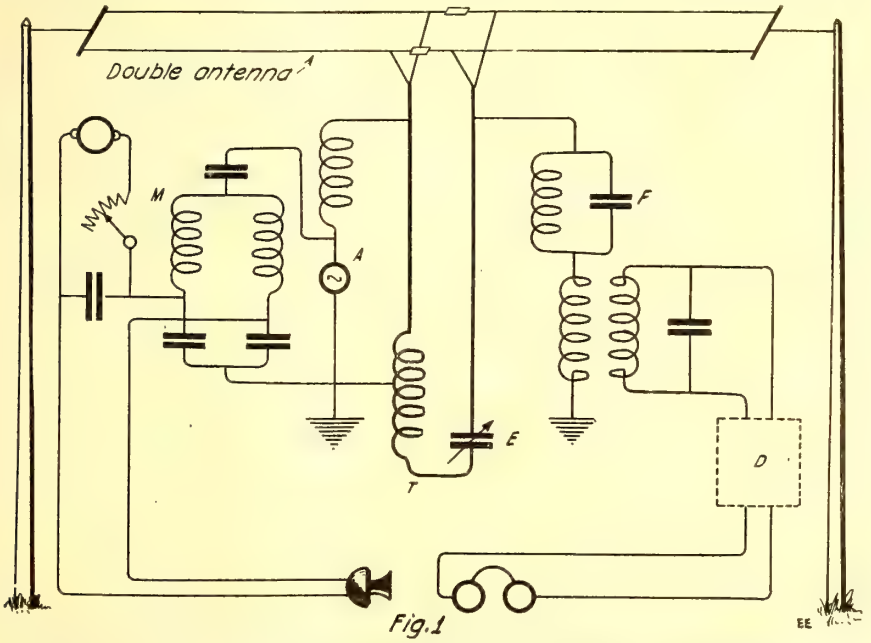


Fig. 1

System of Duplex Radiotelephony with Inductive Neutralization Described by Mr. Alexanderson Before the Institute of Radio Engineers. M—Magnetic Amplifier; A—Alternator; T—Neutralization Transformer; E—Exposure Condenser; F—Frequency Trap; D—Detector.

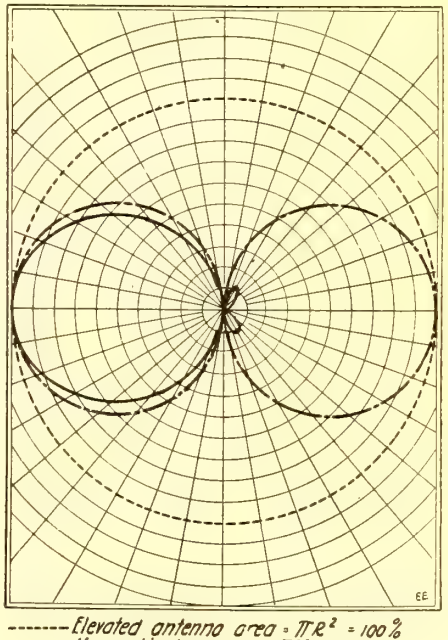


Fig. 3. Relative Directive Reception with Different Types of Receiving Systems.

The Rogers Underground Aërial for Amateurs

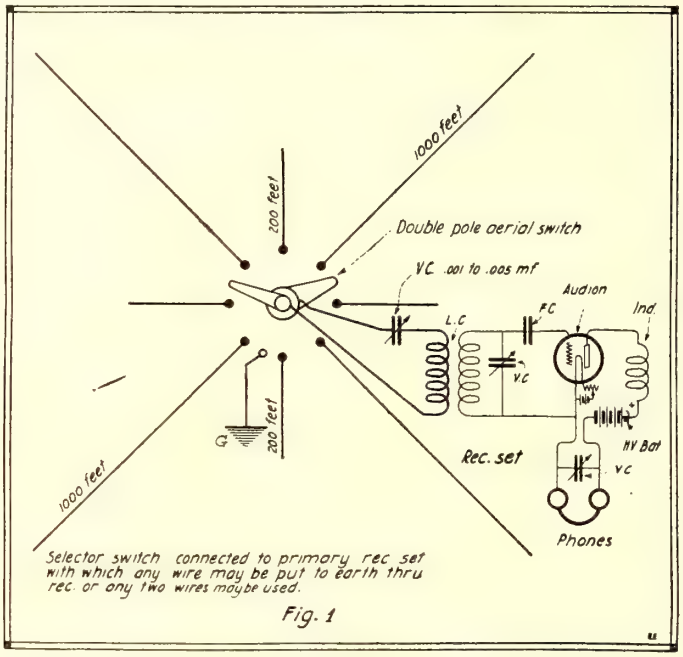
Specially Prepared with the Collaboration of Mr. James Harris Rogers

SINCE the publication of the original article on the Rogers Underground Wireless System, published in the March, 1919, issue of the ELECTRICAL EXPERIMENTER, the Editors have been literally besieged by hundreds and thousands of letters from radio experimenters in all parts of the world, asking for data on the construction of *Rogers underground aërials* suited to the requirements of the Wireless Amateur. The original article contained a great deal of valuable data, which should be carefully read and digested by every radio man, whether he be a student or a professional. In the present article an effort has been made to answer some of the questions which have seemed to annoy the average radio "bug" considerably, — especially those residing in cities where it is difficult and frequently impossible to bury an aërial longer than a few feet. We may say right here, that for those experimenters so situated, there is a solution, or in fact, two solutions, namely—to use a *spiral antenna,* such as has been tried out successfully in U. S. Naval tests on the Rogers System, and which spirals may be buried in the ground a few feet, or placed in a well or other body of water; and secondly, for the experimenter who is not allowed to disfigure an apartment house or other pretentious dwelling with an ugly looking aërial, there is the newly developed *loop antenna,* which can be used right in the radio room. Indoor aërials have been greatly perfected during the war, and now by means of greatly improved and highly sensitive wireless receiving instruments and amplifiers available, particularly those using audions as detectors and amplifiers, they are excellent, and satisfactory results are obtainable by means of a concentrated loop or spiral antenna, small enough to be placed in the radio laboratory.

For the present, we will listen to the sound advice given by our mutual friend, Mr. James Harris Rogers, on some of the practical outstanding features of his underground system, used in conjunction with straight-away single wire underground aërials, as well as loop aërials. Among other things, Mr. Rogers has the following to say regarding the installation of simple underground aërials:

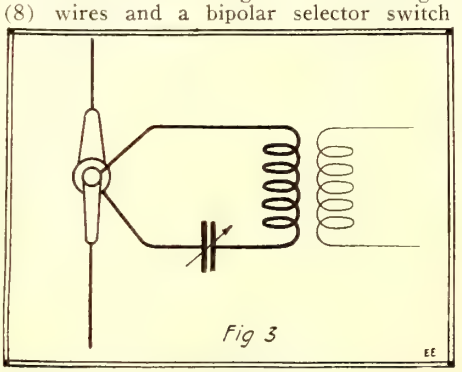
Mr. Rogers Talks to the Amateurs.

"The first installation of my underground antenna was made in the woods about a mile from my laboratory and consisted in burying wires in the earth; the wires radiated from the station as the spokes of a wheel,—*some wire bare* and *some insulated;* their lengths varied from 200 to 1,000 feet. (See Fig. 1).



Rogers Underground Aërial System for General Requirements, Showing Bipolar Selector Switch Connected to Primary Circuit of Receiving Set. Any Aërial Wire May Be Grounded Thru the "Set," or Any Two Wires May Be Used as Desired.

"It is obvious that a number of persons can receive at the same time, one operator to each wire. There is no interference, one with another. Figure 1 shows eight (8) wires and a bipolar selector switch connected to the primary receiving circuit. With this switch any individual wire may be *grounded,* or any *two wires* may be used. *Bare wires give the loudest signals but static is more pronounced.* The deeper the wires are buried, the better the signals, with a corresponding reduction of static. Short wires show a remarkable degree of directivity; long ones to a less degree and in proportion to their length. (See Figs. 2 and 3).



Using Two Ground Aërials for Receiving. The Aërials Should Lie in the Plane of the Station Being Received.

"When using two wires at right angles to each other, signals are heard from any direction. (Fig. 4).

"*The system works best in fresh water or very wet earth.* The primary circuit should have a variable condenser (.001 m.f. or higher capacity) in series. When insulated wires are covered with metal, lead, iron, etc., some remarkable results are obtained. These wires may be entirely enclosed in an iron gas pipe, for instance, (Fig. 5), or the joints may be connected by rubber hose. (Fig. 6).

"Here are some measurements taken with this last form of aërial:

Audibilities with *one bulb* only, on "Nauen" station, Germany:

Length Antenna	*When signals are weak*	*When better*	*When best*
2,000 feet..	15	25	50
2,500 " ..	30	50	100
3,000 " ..	60	100	200
3,500 " ..	120	200	400
4,000 " ..	240	400	800

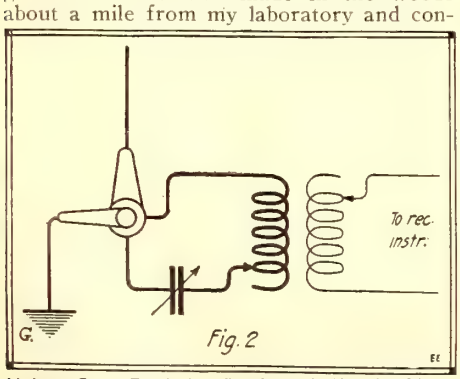
"Regarding the tests with loops I will state briefly that I have successfully tried different forms and sizes.

"I first had a well bailed out and lowered a loop antenna into it; the well was 50 feet deep. (See Fig. 7). The signals were as loud at the bottom as when above the earth. I next had the well filled with water and the results were the same, excepting that **the note of the sending station became higher and higher as it was lowered.** Upon revolving it I found the directional characteristics were the same in the water as when out. These tests were made about two years ago, and I at once realized that *loops* or *cages* could be used in the dugouts of France, or on submarines when submerged.

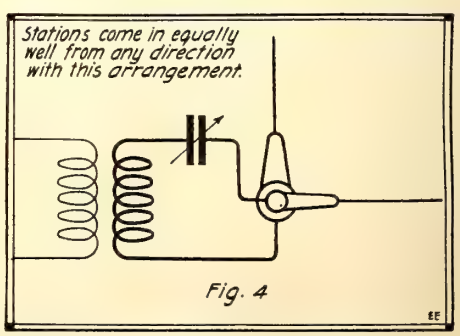
Regarding the dimensions of loop antennae used on submarines, these coils measure about 3 feet square in some instances. The wires are very heavily insulated and placed in a box filled with pitch, the connections are lead below and the coil can be revolved for directional observations."

Kind of Wire Used for Underground Aërials.

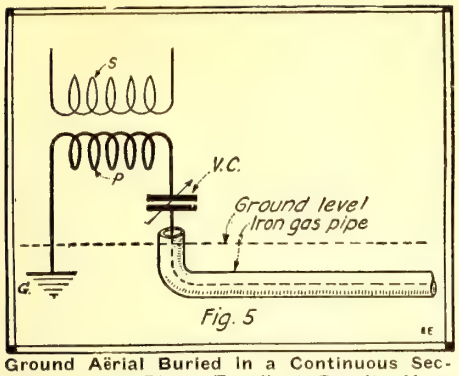
Most of the inquiries from Radio Experimenters and those intending to install experimental stations, and wishing to make use of the "static-proof" Rogers underground antenna, on which signals may be received *even thru a thunderstorm,* indicate that the greatest problem to solve seems to be the size and the kind of wire to be used, and how it shall be buried. Some very excellent results have been obtained in



Using One Buried Aërial and Earth Gives Same "Directivity" as When Two Wires Are Used.



With This Arrangement the Signals Came in Equally Well from Any Direction. A Good "Stand-by" Hook-up.



Ground Aërial Buried In a Continuous Section of Iron Pipe. Excellent Results Have Been Obtained with This Scheme.

experimental work carried on at one of the leading American universities with aërial conductors laid on the ground, and where the experimenter has the time and space to try this out, he may gain some useful and valuable knowledge by experimenting in this direction. Ordinarily the wire, of whatever kind it may be, as used when installing the Rogers underground aërial, is buried about **three feet deep in the earth.** For most Amateur requirements, the wire only need be about 100 to 200 feet long, and so the digging of the ditch is not such a great problem; in fact, it can be plowed open, at least part of the depth, and where rivers, brooks or ponds are available the insulated wire can be placed in them directly and allowed to rest on the bed.

Regarding the choice of wire to be used, it becomes evident that even bare copper or other wire may be utilized when desired, as Mr. Rogers has pointed out in the above contribution. The size of this wire should be about No. 12 or 14 B. & S. gage, the heavier the better.

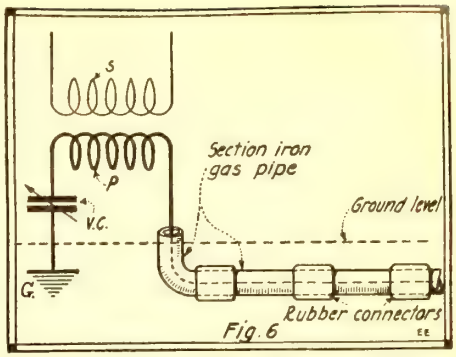
The official U. S. Navy reports of tests on the Rogers Underground System mention that no increased efficiency is obtained by using more than one wire, and that this may be a No. 12 or 14 B. & S. gage, weather-proof or rubber-covered copper conductor. In any case, the free end of the wire should be well taped, and preferably covered with some rubber cement, so as to keep it insulated. Experiments have been tried both by Mr. Rogers at his Hyattsville, Md., laboratory, and also by the Navy Department, with underground aërials placed in terra cotta pipes, but this construction is rather expensive, and the results obtained do not justify its use.

Other forms of wire used both by Mr. Rogers and the Navy Department experts include lead-covered telephone cable, which is, of course, thoroly damp-proof, while a conductor holding considerable favor with the inventor is the heavy rubber-covered, high-tension, auto ignition cable. This is highly efficient for aërial requirements, as it is stranded and therefore of low high frequency resistance.

In any case, a little common sense and logic will give the answer to many of the simple problems arising in connection with the installation of these aërials, such as, for instance, the length of aërial to be used for a certain range of wave lengths. **It is manifest that the longer the antenna, the longer the wave length to which it will properly respond.** Considering that an antenna is used having a length of, say, 150 to 200 feet, then practically all the shorter wave lengths up to 600 meters and more should be readily picked up on this antenna, especially with the variable condenser hooked up in series with the primary of the loose coupler, as shown in the accompanying diagrams. Naturally the wire buried in the ground has a higher electrostatic capacity than the old-style antenna wires, elevated 40 to 50 feet above the ground, and we can reduce this capacity as desired, so as to tune any certain wave lengths, by connecting another capacity in series with it; in exactly the same manner as short wave lengths are tuned in on the regular elevated aërials, by connecting a variable capacity in series with the antenna circuit, and the primary of the loose coupler. Long wave lengths are tunable by using large condensers and loose couplers preferably.

AUDIONS ON ALTERNATING CURRENT

Well, "Radio-Bugs," the very latest thing in Audion circuits is to cut out the expensive high voltage batteries, which are forever deteriorating and necessitating the purchase of new ones, or else the use of messy miniature storage batteries, and to operate your Audions, both filament and plate circuits, with ALTERNATING CURRENT. Sounds impossible, doesn't it? But it is a fact, nevertheless. Don't miss this important article, which will be worth many dollars to you, to appear in the next issue of the ELECTRICAL EXPERIMENTER. Read this special article entitled "Operate Your Audion Receiving Set on A.C." by Elliott A. White, formerly instructor in Radio at the Carnegie Institute of Technology, with diagrams and complete data on the building of the transformer, and other details. This is but one of the big feature Experimental Radio Engineering articles we have in preparation for the July number. It is the greatest revelation you ever read in Radio literature. Don't miss it, "Radio-Bugs"!



Here the Iron Pipe Jacket Surrounding the Buried Aërial Is Divided up into 20-Foot Sections by Means of Rubber-Hose Connectors; a Later Development.

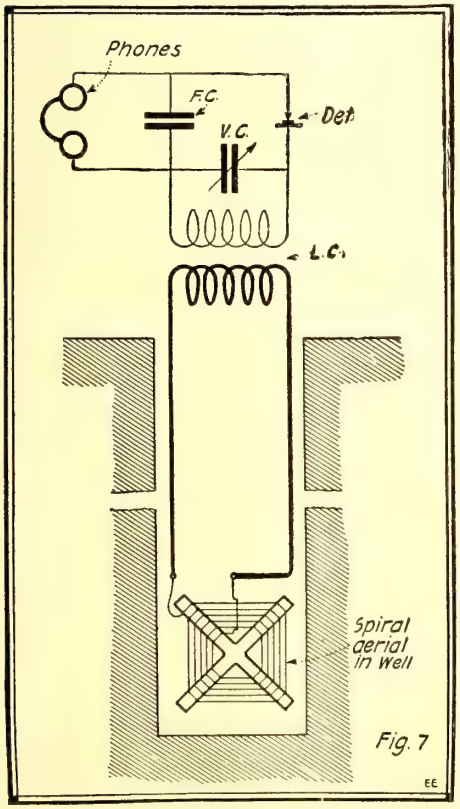
Spiral or Loop Aerials.

As shown in the diagram, Fig. 7, interesting results were obtained with a spiral antenna, composed of a dozen or so turns of insulated wire, such as high tension cable or No. 14 R. C. solid conductor lowered into a well, both with and without water in it.

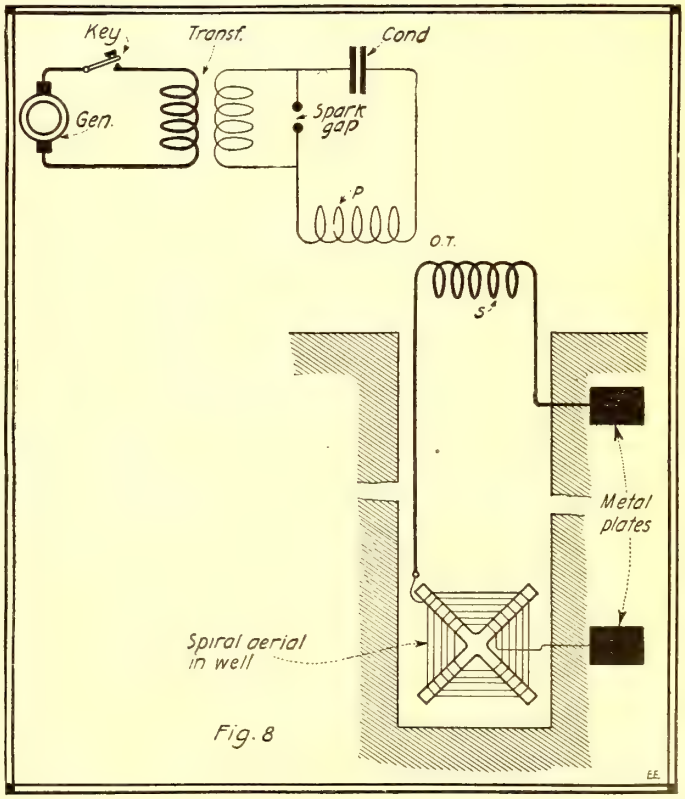
As pointed out in the original article on the Rogers underground system in the March issue, very promising results have been obtained in transmitting with the underground antenna, and Fig. 8 shows how a small transmitting set was operated with such an aërial, coupling the exciting or spark gap circuit with the antenna oscillatory circuit by means of a two-coil oscillation transformer, L, C. In this case two metal plates, about one yard square, are placed in the earth adjacent to the well, one of which connects with the secondary, S, of the oscillation transformer, while the other plate connects with the free end of the spiral antenna.

If the spiral antenna is used, it should be mounted so as to be revolvable on its vertical axis, and it should be placed in the vertical plane as shown in Figs. 7 and 8. Excellent results have been and should be obtained in transmitting with the underground antenna, with the usual insulation incident to the form of conductor above

(*Continued on page* 187)



Some Very Surprising Results Were Obtained in Receiving with a Spiral Antenna Lowered into a Dry Well. Slightly Different Results Were Noticed with Water in the Well.



Distances up to Fifty Miles Have Been Covered Very Successfully in Transmitting with the Rogers Underground Aërial. In This "Transmitter," the Spiral Antenna Is Placed Down in a Well, Metal Ground Plates Being Connected as Shown.

Learning the Code

By HOWARD D. WILDMAN

IN the June, 1918, "E. E.," page 101, there was an article by Mr. Rockwood, relating to Thomas Reed's idea in the January issue, about a new scheme for learning the Continental code. Mr. Rockwood says he tried the scheme himself, but found he often accented in the wrong place and so got the wrong letter. I foresaw this possibility before I tried out the idea and hunted up one substitute word—L—"lo-*cal*-ity." The others I found O. K. Mr. Rockwood says the catchword for "J" is "Jerusalem." It isn't. It is "Ja-*pan-now-owns*," and I have found that you can't get it wrong.

Now as to my experience—before I read Mr. Reed's article I knew only two or three letters—e, i, t. I read the article and memorized the catchwords.

Before this I had tried several times to learn the code, but I was apt to get .—.. for .—. or ..—. for ——.— After memorizing the catchwords, in an hour or so, I could write a sentence and then rewrite it correctly in dots and dashes. At that time I had no key, receiver or anything but an A. C. toy transformer, a rheostat and a few other instruments. I made a key and receiver and practised sending to myself. A friend of mine learned the code meanwhile by memorizing the dots and dashes—a long process, during which time I learned to recognize the sound in the receivers. To this day he occasionally, when sending, shouts to me, "Hey, what's 'P'", or something similar, and I can always tell him.

Mr. Rockwood says one must by this method learn the system and then *unlearn* it. This is not quite true. One *gradually* gets to send without using the catchword. Finally one gets to the point where one sends or receives as Mr. Rockwood says it should be done. This comes of itself without effort, after a little familiarity. My friend will sometimes take .—— to be "U," etc. My experience proves that if he had learned by catchwords, this would not happen. I don't confuse .,—. with .—.. or .— with —. The catchword positively prevents mistakes in sending, as you wouldn't send —. for "away," nor ..—. for "lo-*cal*-it-y."

For receiving, the catchword is useless. This can be readily seen as ..—. would not readily call to mind "fi-li-*pi*-no.". But by using the catchword to send to one's self you learn to recognize ..—. as "F." After some practise, when you want to send "F," you do not think "fi-li-*pi*-no," or ..—. but send it without thinking.

You say—"Of what use then, is the catchword? It is learned only to be discarded again." The catchword serves to teach the code, so that the student can send to himself and teach himself to receive.

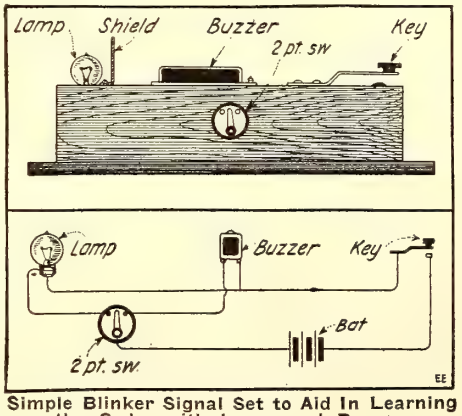
Thus we see the catchword is of no help in receiving. But at first it is a great help in sending, as it prevents confusion.

Briefly then, the idea is to be able to send so as to teach one's self to recognize .—.. as "L," etc.

A BLINKER SIGNAL SET.

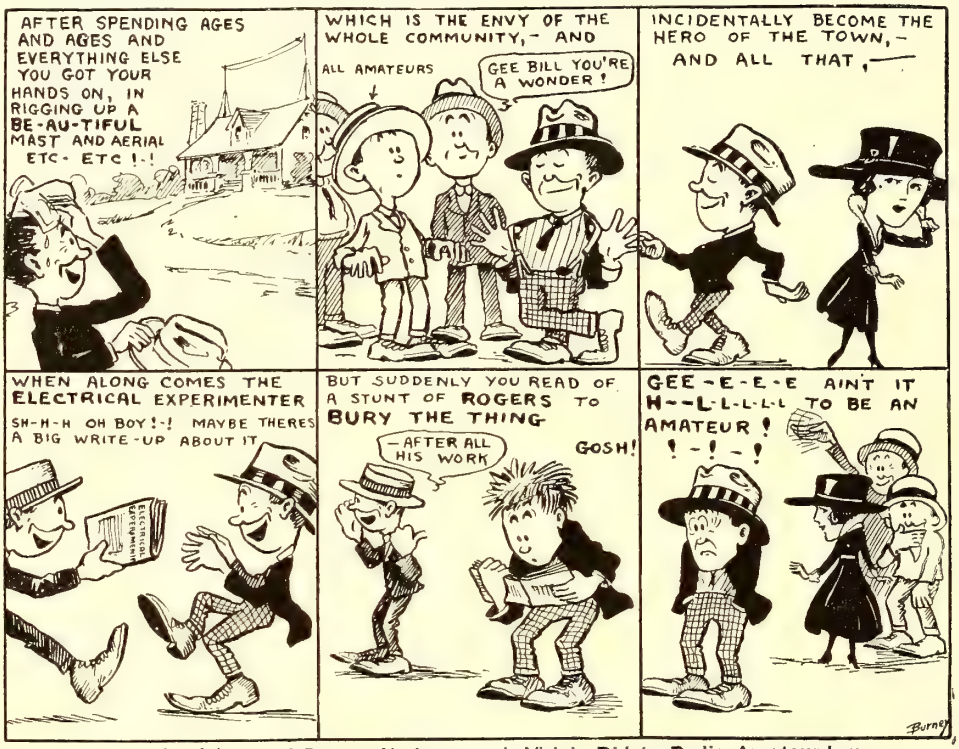
This device consists of a key, dry-cell buzzer, 2 point switch and lamp. The lamp is used for signaling at night, the key being used to make the dots and dashes which the lamp flashes. The buzzer is used when it is impractical to use the lamp.

First procure or make a wooden (small cigar box), just large enough to contain a dry (or flashlight) cell. On top of this box a strap key made from a strip of brass and with a poker chip for a knob is placed. A flat-headed screw serves as a contact point. In the center of the box is placed a box-type buzzer, and near the end opposite the key, a hole is drilled just large enough so that the lamp will fit snugly. A piece of tin is bent to the shape shown and serves as a shield to the operator's eyes. This also acts as a reflector. By using the hook-up shown, either the lamp or buzzer may be put in circuit by using the 2 pt. switch screwed to the side of the box.



Simple Blinker Signal Set to Aid In Learning the Code, with Lamp and Buzzer.

Contributed by P. J. FAULKNER, JR.



What the Advent of Rogers Underground Aërials Did to Radio-Amateurdom—By H. B. Burney.

RADIO IN THE NAVY.

THE development of wireless by the Navy Department during the war has been so remarkable in many phases that it is almost unbelievable. Apparatus known before the war to only a few scientists and perhaps a few of the more progressive amateurs has been developed by the Navy and placed in practical use to such an extent that it has entirely revolutionized radio operation and will eventually be so applied in commercial work as to greatly increase the scope of radio communication. The work of the radio operator will be so broadened that he will rank as a highly skilled technical specialist.

The development of the radio telephone, radio compass, direction finder, submarine listener devices, etc., have depended largely upon the development of the "audion" and its application to radio communication. The use of the various methods for the elimination of static have permitted the employment of extremely sensitive audion receiving sets employing a number of steps of amplification. This depends, of course, upon the application of the audion. All of these things have so complicated the art of operation as to require a very much broader and technical course of instruction than has heretofore been found necessary.

The Navy Department has approved plans for the centralization of all instruction in radio work in one of the great training stations in the Middle West where they are now organizing a school comprising a course of instruction to cover all these modern phases of radio practise, together with a thoro course in practical electricity.

The development of radio during the war has so interested scientists and others in the many advantages to be obtained from its various applications that it is certain that it will never return to the comparatively limited field which it formerly occupied.

The future in store for those possessing thoro acquaintance of the modern phases of radio work is unlimited. The entire Navy personnel is now, practically, in the course of reconstruction and offers an exceptional opportunity for men interested in electrical and scientific lines. The Naval service has need of, and promises rapid advancement to anyone willing to put forth the same effort in the service as would be necessary for him to make a success in civil life. The opportunity to secure a training in the most modern phases of radio work cannot be duplicated elsewhere.

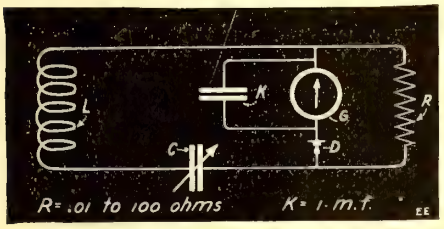
Those interested in the service may apply to the nearest recruiting officer and request from him information concerning enlistment as "Apprentice Seaman for Radio" or, should further information be required, write to the Officer in Charge of the Radio School, Great Lakes, Illinois.

USE OF CONTACT DETECTORS IN RADIO MEASUREMENTS

By Dr. L. W. Austin,
U. S. Naval Radio Laboratory.

For many measurements in radiotelegraphy it is necessary to use a radio frequency-current indicator of known resistance. If the current to be measured is small it is generally customary to use a thermoelement and galvanometer. The most sensitive thermoelements are either of the vacuum type or the welded tellurium type. The vacuum thermoelements can be obtained of any desired resistance and are very sensitive, but are slow in action and frequently show a bad zero drift. In addition, the deflection usually shows considerable divergence from the current-square law. The tellurium platinum elements are quick acting and follow the current-square deflection law with sufficient accuracy for all practical purposes. They are, however, so fragile and difficult to manufacture and transport that no manufacturer has yet undertaken to supply them commercially. It is also impossible to make the contact resistance much less than 10 ohms. It is to be noted that the resistance in both the vacuum and tellurium types changes considerably with the amount of current flowing.

On account of the difficulties mentioned, the sensitive thermoelements in our laboratory have been replaced, for the most part, by a shunted contact detector circuit arranged as shown in figure 1. Here *LC* is any oscillating circuit having inductance and capacity, *D* is a contact detector, *G* a high resistance galvanometer, *K* a paper condenser of one microfarad capacity, and *R* a resistance which may have any value from 0.1 to 100 ohms. The greater part of the radio-frequency current passes thru *R*, while a small portion is shunted thru the condenser *K* and the detector. The direct current from the detector after passing thru the galvanometer returns thru R. On account of the high resistance of the detector, the total resistance of the detecting system is practically identical with *R*, as has been experimentally tested between 0.1 and 100 ohms.



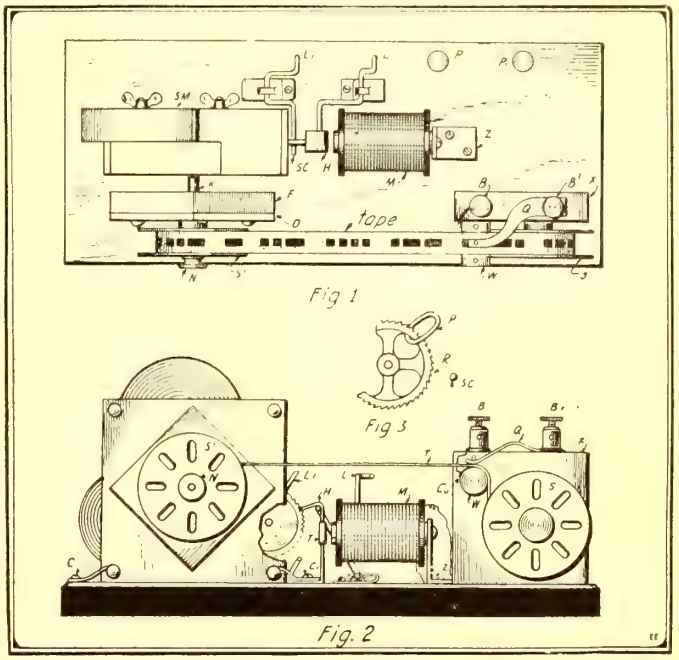
Owing to Several Difficulties Experienced with Sensitive Thermoelements in the Radio Laboratory, the U. S. Naval Radio Laboratory Utilizes Instead the Unique Arrangement Here Shown. This Scheme Comprises a Shunted Detector Circuit, where L-C is Any Oscillating Circuit Having Inductance and Capacity; D is a Contact Detector; G a High Resistance Galvanometer; K a Tin Foil and Paper Condenser of One Microfarad Capacity, and R a Resistance Which May Have Any Value from 0.1 to 100 Ohms. The Greater Part of the Radio-Frequency Current Passes Thru R, While a Small Portion is Shunted Thru the Condenser K and the Detector. The D. C. from the Detector After Passing Thru the Galvanometer Returns Thru R. The Sensibility of this Arrangement is Much Greater Than That of the Best Vacuum Thermoelements of Equivalent Resistance.

The sensibility of this arrangement is much greater than that of the best vacuum thermoelements of equivalent resistance.

In the case of most of the well-known detectors the proportionality between deflection and current-square is excellent. Galena, while the most sensitive of any of the detectors tried, shows a slight deviation from the square law. For absolute current measurements the system must of course be calibrated by comparison with a known thermoelement at the time of experiment.—*Journal Washington Academy of Sciences.*

Automatic Code Transmitter

I present herewith design of an automatic tape transmitter that I constructed and which runs very well. Details: Motor—This is an alarm clock which had "given up its ghost." I pulled it out of its case, removed the balance wheel, hair spring and the little lever—whatever its name is—and also the ratchet wheel, which I kept. I also removed the face, both hands and the driving mechanism for the hour hand. I then drove on the minute hand shaft a block of wood 2 inches by 2 inches by ½ inch, so that the shaft did not come quite thru the block (Fig. 1). On F I screwed a block of thin wood 2 inches by 2 inches with an 8/32 bolt 1 inch long thru the center of it, and a nut on the bolt (Fig. 1, K); on this bolt I put an empty typewriter spool, S, which I held on by bolt and nut (Fig. I, N). Light spools for the purpose can easily be made up by the experimenter from fibre and brass odds and ends.



The Paper Tape Used in This Code Teaching Instrument Can Be Cut from the Border of a Newspaper, and the Dots and Dashes Punched in It With a Conductor's Ticket Punch.

Transmitter—On the base I fastened (Fig. 1, X) a wooden upright 2½ inches by 2½ inches by ½-inch in line with (Fig. 1, F). The peg, W, covered with copper sheet, Cn, is inserted in a hole in the wood; in W are inserted two small brads to keep the paper tape in proper alignment. Cu is connected to B and a fine brass brush, Q, bears on the tape and connects with Cu when an opening appears. S is another typewriter ribbon spool running on a headless wire nail.

Regulating Devices—Speed—The ratchet wheel aforementioned is treated by cutting out about one-third of it, Fig. 3, and also an oval of wire, P, is fastened loosely around the rim of the wheel (R); this ring hits on Sc, Fig. 1, which is a wire held in a spring binding post so it can be regulated. This regulator and the cut ratchet wheel are used to keep the spring motor from running away with itself.

Brake and Release—Consists of a thin copper spring, H, Fig. 2, fastened in common with one of the two clips which hold the motor down, H, has some sheet iron wound around it at T to form an armature, so that the electro-magnet, M, fastened on support, Z, can act on it.

The auxiliary release, L, is a bent copper wire (No. 14 B. & S. gage), which swivels on a spring post to release the brake H.

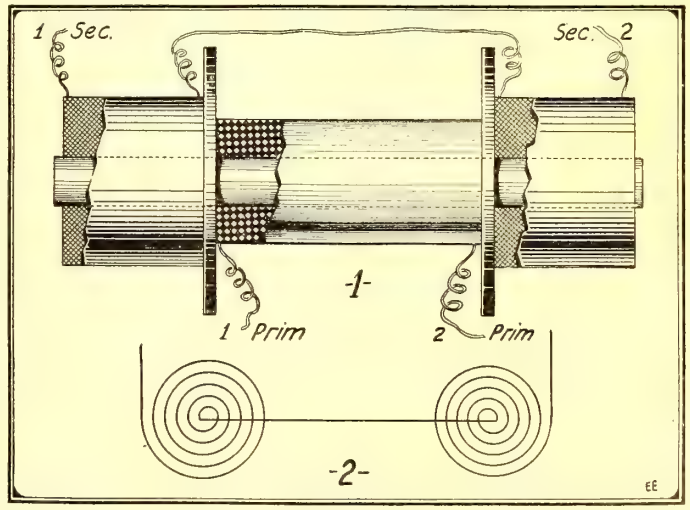
The electro-magnet is connected to binding posts, P and P, and is wound full of No. 28 B. & S. gage magnet wire.

Contributed by
GEORGE HARRINGTON.

A New Type of Transformer

A great many experimenters are in the position of having outgrown the "spark-coil" stage, but do not have the necessary funds to buy or construct a transformer using the 110 volt A. C. They are then burdened with a spark coil, which they usually attempt to use by means of an electrolytic interrupter, which will use an excessive amount of current without a very high degree of efficiency. In some cases the spark coil has been taken apart and an attempt made to use the secondaries. But it is easy to see that this cannot be done on the usual type of open-core transformer, for after winding three or four layers of heavy wire on a core about two inches in diameter, the total size is too great to permit the secondaries to be slipt on over the coil.

A plan that has given very good results is shown in the diagram. As will be noted, the primary is wound in the center of the core, *and a secondary slipt on each end.*



Novel Construction of Transformer from Two Spark Coil Secondaries, with the Primary Coil Placed Between Them.

The core is constructed of soft iron wire

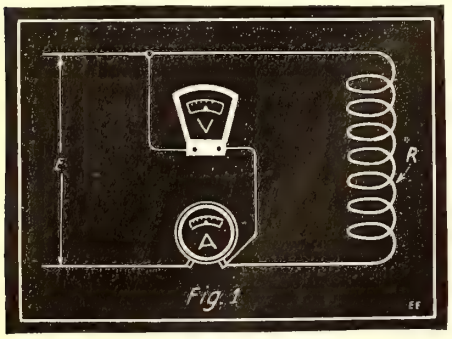
(*Continued on page* 174)

Choke Coils--Theory and Design

By F. E. AUSTIN

Professor of Electrical Engineering, Thayer School of Engineering, Dartmouth College, Hanover, N. H.

THE writer who is constantly in receipt of inquiries from those desiring to know how to construct choke coils to meet certain requirements, takes this opportunity to explain somewhat briefly the theory underlying the



When a Coil of Magnet Wire Is Connected to an A. C. Circuit, the Current Is Measured by an Ammeter and the Potential by a Voltmeter. The Current Absorbed Depends upon the Number of Turns and Kind of Core Used in the Coil.

construction of choke coils, and to give directions for the construction and operation of such coils.

Choke coils are simply coils of insulated copper wire thru which alternating currents are allowed to pass and by means of which the *amount* of the alternating currents may be regulated as desired. The regulation is effected by the action of the counter-electromotive-force induced in such coils due to the continuously varying magnetic field set up by the varying alternating currents. The consideration of the variation of counter-electromotive-force is therefore the important question in the building and operation of all choke coils.

When a coil, formed by winding a number of turns and layers of double cotton covered copper magnet wire about an insulating tube of say hard fiber or cardboard has an alternating pressure applied to its terminals, as indicated in Fig. 1, an alternating current flows thru the wire of the coil according to the well known equation:

$$I_{ac} = \frac{E}{\sqrt{R^2 + (2\pi f L)^2}},$$ in which I_{ac}

denotes the current in amperes, indicated by an ammeter connected with the coil as indicated in the figure; E denotes the applied alternating pressure in volts, indicated by a voltmeter at V in the figure; R denotes the resistance of the coil in ohms, which may be measured by experiment, using a voltmeter and an ammeter with *direct current* or by the use of a Wheatstone bridge testing set, or which value may be *calculated* from the size of the wire and its length; f denotes the frequency of the applied pressure in cycles per second, and L denotes the so-called coefficient of inductance of the coil. Should a direct current pressure be applied to the terminals of the coil, the current would be exprest simply by Ohm's law as:

$$I_{dc} = \frac{E}{R}$$

It is evident by comparing the two equations, if the applied pressure *A. C.* and the applied pressure *D. C.* should have the same numerical value in volts, there would be much less resulting current according to the first equation than from the second, if the term exprest by $(2\pi f L)^2$ has any considerable numerical value. This of course depends upon the value of f and of L. The value of f is fixt by the value of the ordinary commercial frequencies of power circuits, ranging from 40 to 100 cycles per second, with 60 cycles as a very common frequency. The value of L depends upon the square of the number of turns on the coil, and very largely upon the material that is inserted into the coil to serve as a core.

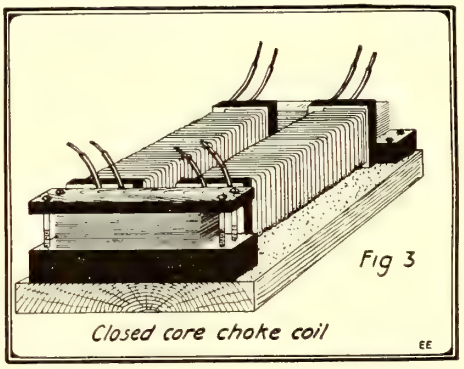
The value of L is exprest by a unit called the *henry*, may be very easily and quickly ascertained by experiment for any coil, and may be quite accurately calculated from the number of turns wound on the coil, the area of cross-section of the central hole thru the coil and the length of the coil, when there is no iron or other magnetic material near the coil.

Let us examine somewhat carefully the first equation. First, suppose the value of f is O; then $2\pi f L = O$ and the equation becomes:

$$I_{ac} = \frac{E}{\sqrt{R^2}} = \frac{E}{R}$$ or Ohm's law.

When $f = 0$, the current is a direct current, and Ohm's law should be applicable. Next suppose $L = 0$; then also will

$$I_{ac} = \frac{E}{\sqrt{R^2}} = \frac{E}{R}$$ and Ohm's law again ap-



A Well-Designed Choke Coil of the Double-Pole, Closed-Core Type. One-half of the Winding Is Placed on Each Leg of the Laminated Sheet Iron Core.

plies. The value of L can be 0 only when the wire constituting the coil is not wound in the form of a coil; that is only when it is *straight*. The *A. C.* current in a straight wire is the same as the *D. C.* current if the numerical value of the *A. C.* pressure is the same as the numerical value of the *D. C.* pressure.

For illustration, suppose the value of L is, first, 1 *henry* and that $f = 60$. The numerical value of the term $(2\pi f L)^2$ becomes $(2\pi \times 60 \times 1)^2 = 377^2$; (very nearly). It may readily be appreciated that the $2\pi f L$ term has a very important bearing on the numerical value of I_{ac} when the values of E and R are fixt. The value of E is always fixt by the pressure of supply, the value of R is of course fixt when the coil is wound. Usually the frequency is also fixt by the frequency of the supply, which leaves L as the only variable quantity remaining that allows a variation in the current denoted by I_{ac}. After a coil is wound, the value of L is not variable unless the windings on the coil may be varied. This of course is not feasible except within rather narrow limits. The coil may be wound in sections, with taps, arranged for connecting with apparatus, thus allowing a variation in a comparatively few steps.

If the coil is provided with a movable iron core consisting of varnished iron wires, the means are provided for not only giving a very wide variation to L, but for making the variation absolutely gradual.

Suppose, for example, that a coil has an ohmic resistance of 5 ohms and a coefficient of inductance of .0162 *henry*. Find the current in the coil when an alternating pressure of 110 volts at 60 cycles is applied to the terminals of the coil? Making the proper numerical substitutions in the fundamental equation gives:

$$I_{ac} = \frac{110}{\sqrt{(5)^2 + (2\pi \times 60 \times .0162)^2}}$$

$$= \frac{110}{\sqrt{25 + (377 \times .0162)^2}} = \frac{110}{\sqrt{62.7}}$$

$= 13.9$ amperes.

With an applied direct-current pressure of 110 volts the current in the same coil will be found from:

$$I_{dc} = \frac{110}{5} = 22 \text{ amperes.}$$

The coiling of the wire, therefore, accounted for $22 - 13.9 = 8.1$ amperes.

In order to reduce the current to 13.9 amperes on a direct current circuit, it will be necessary to introduce a resistance in series with the coil having a value of

$R_x = \frac{110 - 69.5}{13.9} = 2.9$ ohms. This may

be understood better by consulting figure 2, which represents the coil connected in series with an auxiliary resistance R_x across a 110 volt circuit.

The current in this arrangement may be exprest by:

$$I_{dc} = \frac{E}{R + R_x};$$

and if the proper numerical values are substituted in this equation the result will be:

$$13.9 = \frac{110}{5 \times R_x}$$, from which

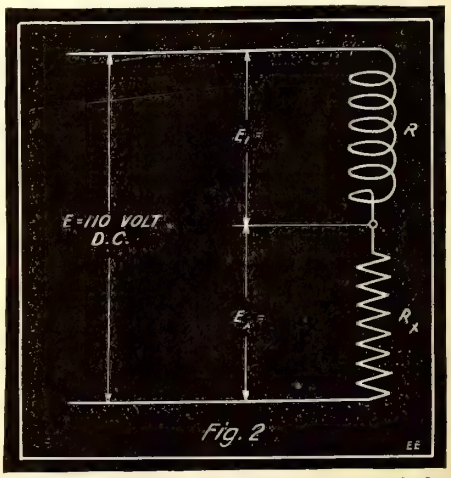
$(5 + R_x)\ 13.9 = 110;$

$5 \times 13.9 + 13.9\ R_x = 110$

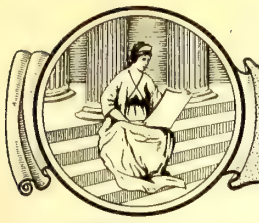
$13.9\ R_x = 110 - 5 \times 13.9$

$$R_x = \frac{110 - 5 \times 13.9}{13.9} = 2.9 \text{ ohms.}$$

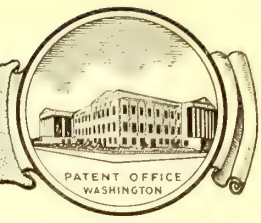
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Experiment with Choke Coil Designed for A. C. Circuit Connected to D. C. Circuit, Showing the Effect of Inductance or Impedance on the Current Consumed.

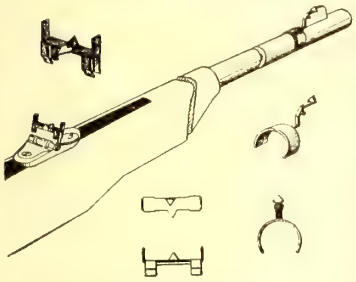


LATEST PATENTS



Luminous Attachment for Gun-Sights.

(No. 1,292,211, issued to Harold S. Young and F. H. Ihde.)

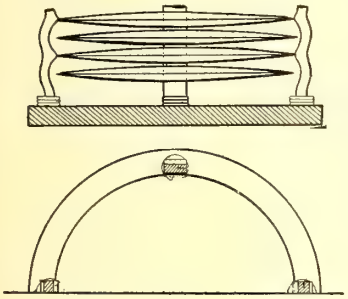


The sighting plate mounted on the front end of the firearm is coated with a covering of luminous paint, or some such other light-radiating pigment, which can be easily discerned at night. The benefit of this improvement in sights is that the marksman looking thru his rear sight can easily discern his forward point or sight due to the fact that the same is covered with this radium paint.

Electrical Condenser.

(No. 1,292,589, issued to R. F. Darmezen du Rousset and Chas. E. Brandt.)

It is a generally accepted fact that in electrical condensers formed of flat conducting surfaces separated by some dielectric the charge is unequally distributed from the center to the edges, its density being greater toward the perifery where the ruptures are always produced. In this new form of invention a condenser is provided whereby it is

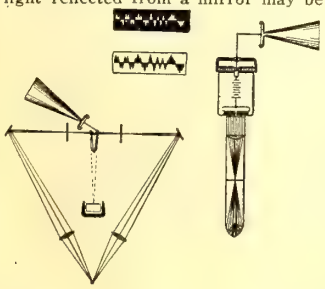


possible to localize the maximum tension at the central point of the system, and also increase the capacity for a given diameter. It consists of a number of discs arranged in the form of a quenched gap, wherein metal plates with concave surfaces are used, and between these various plates insulating discs are placed.

Photographic Phonograph.

(No. 1,291,702, issued to Frank W. Adsit.)

One of the principal points in this new invention is the providing of means for registering on a film the graphic representation of sound. Another object is to provide a means in connection with this film whereby a light reflected from a mirror may be

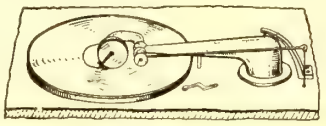


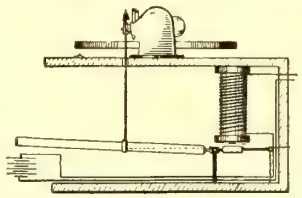
registered on either one side or the other of a center line down the film or on both sides of this simultaneously. It is also possible by special means to reproduce these graphic representations registered on the film, so that musical sounds or voice currents may be reproduced.

Automatic Record Stop for Phonographs.

(No. 1,291,985, issued to D. M. Manson.)

The principal innovation in this invention is an electrical means, whereby after a record has been played the needle will be carried back to the starting point, so that the playing of the record may be repeated. The invention as a whole consists essentially of an arm secured at one end to the sound box crook, magnetic means being provided for drawing down the opposite end of the arm, thereby raising the sound



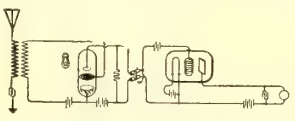


box and needle from the record. Also a means is provided for counterbalancing the weight of the sound box during its return or downward movement. An ingenious scheme is devised whereby the tapered tube, by means of an adjustable stop, can be designed to be turned in any position to correspond with the starting point of the record, and a spring connected to the tapered tube and bracket, whereby the taper tube can be turned from the center ot the record when the needle is out of contact with the record and brought back to the starting position.

System for Amplifying Variable Currents.

(No. 1,297,188, issued to Irving Langmuir.)

This invention is merely a means devised for utilizing an electron discharge and comprises several novel systems of connections whereby the weak currents can be reproduced as stronger currents. Taken as a whole, it is merely a modifica-

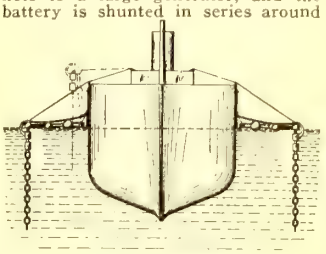


tion of the several step amplifier, as has appeared heretofore. In general it has some new points of interest, but taken as a whole, the invention boils down to the fact that it consists of a number of electron discharge devices connected in cascade for the amplification of currents. The bulb itself is made of quartz previous to an ultra-violet light, and into which are sealed in the usual manner an electron-emitting cathode and anode. The cathode of this particular bulb consists of potassium or sodium, which will emit electrons when illuminated by a source of light.

Magnetic Protector for Ships.

(No. 1,293,539, issued to John and Sophie Pies.)

The principal device is a form of arm extending from the ship on each side attached to an electro-magnet with a flexible chain hanging in the water, and arranged with a number of floats to depend from these extending arms. One circuit is formed in series with these magnets to a large generator, and the battery is shunted in series around

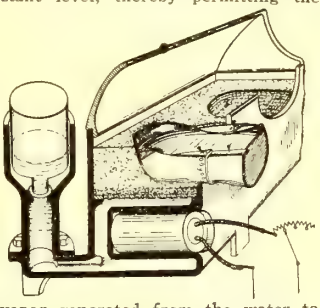


the two chains that hang from either side of the ship. The apparatus is arranged to detect submerged torpedoes, mines, etc., due to the fact that their presence would increase the conductivity between these two chains and cause the circuit to be closed and ring the bell.

Electrically-Heated Apparatus for Moistening Shoes.

(No. 1,294,533, issued to W. W. Reed.)

It has been found that much of the cracking and breaking of shoes incident to the lasting operation can be avoided by preliminarily treating with a hot vapor. A tank is provided which will maintain the water automatically at a constant level, and an electrical heating unit arranged to heat the water. A layer of absorbent material is placed on top of the heated water, and an automatic means provided for maintaining the upper surface at a constant level, thereby permitting the

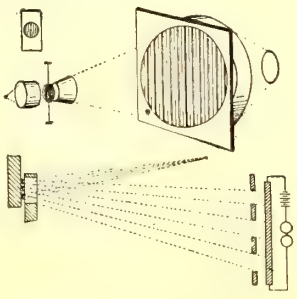


vapor generated from the water to be diffused equally around all portions of the shoe.

Selenium Relay.

(No. 1,293,098, issued to A. N. Hovland.)

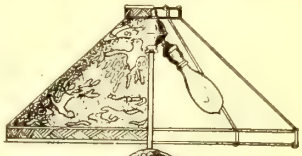
This new form of relay is built on the principle that a conducting wire placed in a magnetic field will be displaced laterally when an electric current is past thru the same. This fact is made use of, for instance, in wire galvanometers and in light-writing apparatus, also that the magnetic field is used to produce a very sensitive relay, utilizing one or more photo-electric cells on the general type of a selenium cell. A shutter means is provided for decreasing and increasing the resistance of the cell, and by such means it is possible to relay currents.

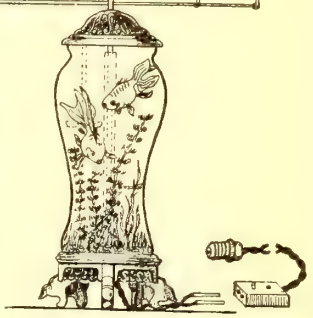


Illuminated Aquarium.

(No. 1,297,254, issued to Natsuo Sato.)

A novel and attractive improvement on the usual form of aquarium, which consists of a bowl which is permanently illuminated from above by electric lamps, and which are concealed in the lamp, and intended for use in drawing rooms. It consists of a metallic tube which runs up centrally thru the apparatus, and thru which tube also is run electric wires to operate the bulbs under the lamp shade. Were this tube to be in actual contact with the water, it might possibly cause some chemical reaction, which would be detrimental to the fish in the bowl The inventor overcomes this by using a glass tube over the metal pipe, which



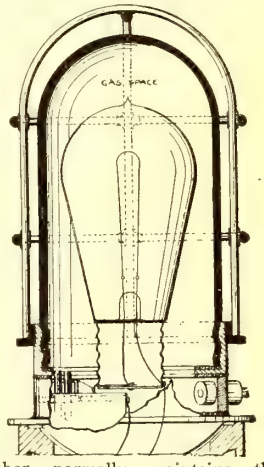


may be formed in one piece with the bowl or may be separate and cemented together in order to prevent leakage. The bottom of the bowl is arranged to present a pleasing appearance with a bed of sand.

Electric Gas-Detecting Safety Lamp.

(No. 1,294,806, issued to C. G. Hunt and John H. Coyle.)

The main feature of the invention consists of a lamp and a sealed chamber, with a source of light in said chamber. A means is provided whereby a gas pressure inside the



chamber normally maintains the light, but if fumes are present on the outside, this external pressure will cause the light to be extinguished. It operates on the principle that the internal pressure of the gas will normally maintain the light, but should the gas pressure in the chamber be brought to an inferior or superior pressure to that without the chamber, then the light will be extinguished.



WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $3.00 each month for the best photos. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $3.00 PRIZE WINNER—J. CARROLL TOBIAS

I AM an appreciative reader of your magazine and wait anxiously for it to arrive from month to month. I find lots of enjoyment in looking over the photos of Amateur "Labs", and so am sending a "shot" of my own little workshop.

In this room many interesting and educational experiments are performed in chemistry, electricity, metallurgy and electro-chemistry. I have apparatus for both qualitative and quantitative analysis, electric furnace analysis of iron, steel and carbon compounds and for the analysis of coal gas and by-products. A complete bacteriological outfit is also one of my valued possessions and by its means microscopic examinations of water are conducted. This about completes the chemical end.

In the electrical division I have motors, a generator (A.C., 60 volt, 60 cycle), a 50 watt D.C. generator, step-down and step-up transformers, high frequency alternator, high-frequency high-voltage transformer, Oudin coils, Tesla coils and spark coils. I have an electric arc furnace by means of which I conduct small experiments in the production of synthetic gems, electrolytic rectifier, electrolysis apparatus and "bunches" of other "junk". At present I have under construction an A.C.-D.C. switchboard, also a three-step audion amplifier and two long wave loading coils. When the "Lab" is drest out in all its new furniture, I will send you another series of photos.

Another photo shows my radio set which has just been unsealed and which I know is just "hankering" to have the old oscillations flowing once more thru its coils. Another view shows my battery switchboard and electrical work bench with spark coils, Tesla coil, Oudin coil and other "stuff".—J. Carroll Tobias, 106 N. High St., Bethlehem, Pa.

HONORABLE MENTION (One Year's Subscription to the ELECTRICAL EXPERIMENTER) —CHESTER A. WRIGHT

Herewith are photos of my radio station. I have been a steady reader of the ELECTRICAL EXPERIMENTER for some time and get many good ideas and hook-ups. My apparatus is mostly home-made, consisting of a condenser made of heavy plate glass with aluminum sheets. The rotary spark gap is made of a 1700 R.P.M. fan, and the disc of an Edison disc record. It gives a very good tone. My oscillation transformer is made of heavy brass ribbon and is very easy to adjust. I use a Clapp-Eastham 1 K.W. transformer. My receiving apparatus consists of home-made couplers from which some very close tuning can be had. I use an audion and galena non-jarable detector, both with great results. I also have Murdock variable condensers, and two sets of Brandes' phones.—Chester A Wright, 611 Green St., Greensburg, Pa.



Science in Slang

By EMERSON EASTERLING



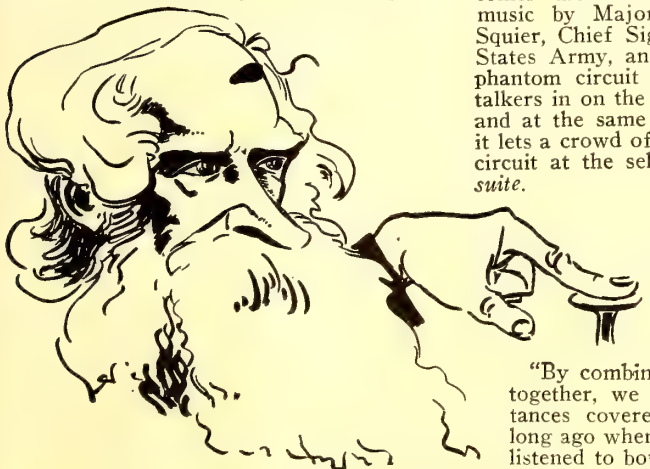
"A FUNNY thing happened the other day," laughed Punk Loomis. Stokes looked up from the telephone directory. "A guy," continued Punk, "was standing under a belt in the factory. The fellow had on rubber boots. He was talking to his wife, and when she started to leave—you see, they were newlyweds—he reached over to kiss her. WOW! You ought to have seen them! One of them got it in the nose—the other on the lips—and it cracked like a young bolt of lightning. You see, the rubber boots made a Leyden jar out of the man—a human condenser. That kiss sure had a kick."

"I guess that was about as funny to them as it was to the lady who was cleaning clothes and set the rag, saturated with gasoline, on fire in her hand by drawing a spark from the friction of the wool and silk. Both were static, you know." Here he turned and walked to the telephone and asked for long distance. In a few minutes he returned.

"Quite a commodity, this telephone. In the old days when the citizens thought it proper to run in marathons in the 'altogether,' if I should happened to have been let loose at that time, and happened to have gotten word to a guy the same distance as the present case here, I should had to have waited for at least a week—with the best runner that the country had, to tell the adjoining country to go to hades—for the answer."

"Can you reel off another sentence like that without stopping for air again?" asked Bender.

"Jumping over such improvements as Paul Revere and the pony express brought about, we land up at the chapter in scientific history where a bird by the name of Morse, with three other names before it, two of them Sam and Finley—I don't know the other—it don't make much difference anyway. What we are driving at is the fact that after muttering, 'If the presence of electricity can be made visible in any part of the circuit, I see no reason why intelligence may not be transmitted by electricity,' he rigged up a couple of magnets and an arm and anvil—behold! We have the *telegraph sounder.* Then the next thing was to contrive a series of dots, dashes and spaces to convey that intelligence he was speaking of. It took a lot of salesmanship for Sam to get his trick across, but perseverance wins out in the finale—so, first act in the comedy of the telegram.



Sam Finley Morse, the Dash and Dot Kid, Also the Ancestor of the Telegraph Messenger.

Keeping the Wires Hot

"Then another guy—you've heard of him, Bell, Alexander Graham, Proff. in vocal hygiene or physiology—drops in on us. This student of the art and mechanics of the first cause for conversation got down into the throat of the matter and found out a lot about the reason why some men leave home. While trying to make the telegraph do more work for the number of wires used, it is related that this gentleman was alleged to have developed the *telephone*—but none would recognize in the original article any resemblance to the present instrument of long-distance chatter.

"Another duck—Prof. Elisha Gray—would have landed the fish if it had not been that Bell got his draftings in the patent office (no, not the Phoney Patent Offizz) and beat the dear old chap out of the glory. Which all goes to show that some great minds do run in the same channel. But Gray should worry. He is guilty for the *telautograph* being on the market. No, he is not Elisha of the fiery chariot.

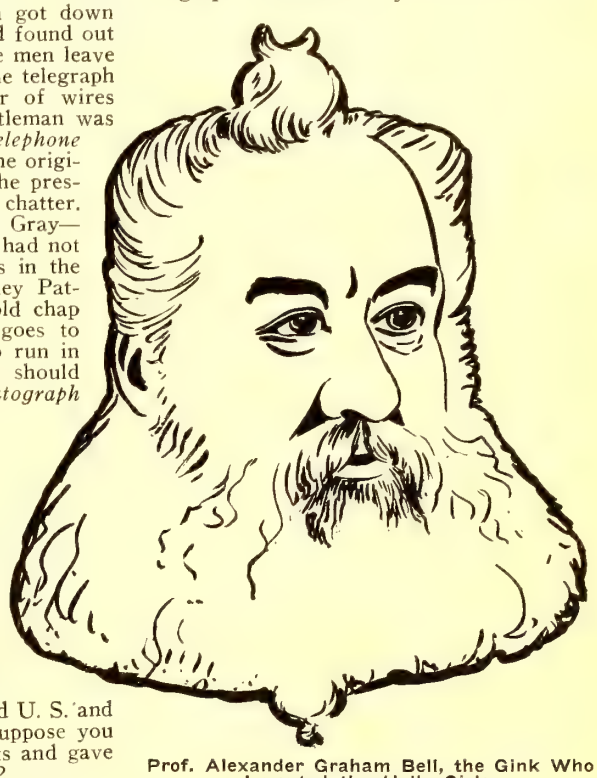
"Europe was a long way off until Cyrus Field succeeded in stringing an *undersea cable* between the two continents in one piece. That made him get in rich with Congress, and he got a medal to show his friends for the stunt, too. It was in 1858—the time that George Washington was fighting the battle of Waterloo—that the cable had one end in the good old U. S. and the other in Europe. I don't suppose you care, but Cyrus gave a few kicks and gave up in the city of New York, 1892.

"You know of Nick Tesla (his picture is on one of the other pages), the fellow that pulled one over on Columbus in the egg stunt. Well, he just had to do something for the telephone and invented a *repeater* for it. Then Tom—who? Edison—improved it a lot. And a gob of other guys boosted the proposition along. Some wise guy hops along and steps on two circuits, and sticks another to work on the same lines—Hoovering on wire. It was on the same order that Bell tried to do with the telegraph, only different. They dubbed it the *phantom circuit,* altho it is not as mysterious as the name implies. Then along comes the *multiplex system,* words and music by Major General Georgie Owen Squier, Chief Signal Officer of the United States Army, and right away he goes the phantom circuit one better by letting five talkers in on the line simultaneous together and at the same time. Not only that, but it lets a crowd of 'brass pounders' in on the circuit at the self-same operation, *tout de suite.*

"De Forest, in his wireless experiments, slipt them the pass to get in on that stunt by creating the *Audion.* That is why the system is referred to as the *wired wireless.*

"By combining wireless and the lines together, we get some pretty long distances covered by the voice. Not so long ago when some notable English guy listened to both oceans at the same time over the telephone we thought it was grand. To-day that's commonplace. Now, if the guys around the player stop coughing, and they have good conditions and sensitive instruments, it is possible to hear Hawaiian hula players do their song and dance in New York City over the wire and wireless.

"I doubt if Sam Morse knew what he really did when he constructed his first telegraph instrument. Just think of the



Prof. Alexander Graham Bell, the Gink Who Invented the Hello Girls.

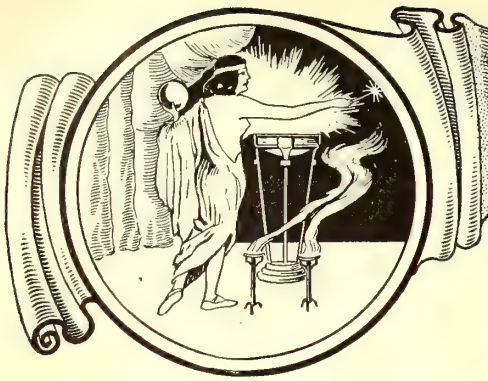
war and sporting (accent on the sporting) wires! What would we do without them? Take the business as a whole. We would feel like we were lost without 'phones and 'wires.'

"When the real thing marches in, a load of by-products comes out on the next section. When Edison called up over a 'phone and instead of saying 'Are you there?' or 'Is this you?' he said 'Hello!' That took like 'Over the top,' 'Lay on, McDuff' and such slogans, saws, or what-you-call-'ems. Now we would think a boob crazy were he to say 'I am talking—is there anybody on the other end of the line?' 'Hello' is good anywhere, China, Africa, or Chile, but not in France, where it is 'Alloh.'

"Now, if we can only get rid of the central station," said Punk Loomis, "and replace the live hello-girl with an automatic one that will not get tired or angry when the customers cuss over the 'phone, then we will have it down pat."

"You're 'way behind the times," came back Stokes with an impatient gesture of his head. "What you want to do is to take a flying trip to Chicago and give their automatic telephone rinktum the once over. And, believe me, it is some contraption. Of course, Windy City citizens have the regular Bell 'phone also, so when they get tired of cussing the hello-girls they can switch to the automatic, which is some indoor sport. The two systems necessitate the use of two telephones in one office, and on any Monday morning you can see your Windy citizens doing the hula-hula trying to talk into two phones and to two cus-

(*Continued on page* 155)



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

ROTATING MAGNETIC FIELD QUERY AND ROGER'S RADIO SYSTEM.

(1004) J. M. McDonald, St. Louis, Mo., writes:

Q. 1. Asking several questions about the rotating magnetic field and Tesla "electric egg" apparatus.

A. 1. We give you the following suggestions in answer to your questions. The rotating magnetic field is very clearly explained in the April number of the ELECTRICAL EXPERIMENTER, containing an article by Dr. Nikola Tesla on his induction motor and how it works, which we are sure will make the matter plain to you, as a clear hydraulic analogy is given therewith.

In connection with the "electric egg" apparatus, we would advise that the two opposite coils are connected so as to give North and South poles respectively.

Elsewhere in the present issue you will find a special article on the "Rogers' Underground Wireless System for Amateurs." This will answer many questions such as the one you ask concerning the length of aerial, etc., and briefly we might say that for short wave lengths of about 200 to 300 meters, a wire (rubber covered auto-cable) about 300 feet in length could be used. When the free end of the wire is grounded, the signal strength is reduced. Generally speaking, and for ordinary amateur and even commercial requirements, but one wire is found necessary.

VALUE OF THE "SOLAR CONSTANT."

(1005) Emmanuel Bellon, Peoria, Ill., writes this department:

Q. 1. About the value of the mean "solar constant."

A. 1. There seems to be indeed much promise in the development of an efficient solar energy plant, and while little has been done along this line in a commercial way of late, yet some very interesting work has been accomplished by a number of scientists, who have worked on the problem. It is a most interesting and valuable field to work in.

The result of nearly seven hundred tests conducted by the Smithsonian Institute of Washington and in various parts of the world, has resulted in accepting 1.93 *calories per square centimeter per minute*, as the mean "solar constant." This is equivalent to 7.12 British thermal units per square foot per minute. The best body for the conservation of the radiant energy into heat energy is a dead black one.

RADIO QUERIES ON MIGNON RECEIVING SET.

(1006) A. S. ———., Chicago, Ill., inquires of the Oracle:

Q. 1. What is the coil around the Audion used for in the Mignon receiving set, and also what is the object of the metal coupler core?

A. 1. Concerning the Mignon type R. W. No. 3 radio receiver, would advise as follows:

Regarding the two specific points you mention first, about the coil around the Audion tube, this is hooked up with one of the tuned oscillatory circuits, so that the oscillating magnetic field created within it, would act electromagnetically on the electron stream within the detector, somewhat in the same manner as is the case where a permanent steel magnet is placed in proximity to a vacuum tube detector to improve its operation. The effect on the electron stream is to either concentrate it or spread it, thus making the path from grid to plate either more conductive or less conductive, depending upon the polarity and position of the magnetic field.

To Our "Oracle" Friends

Do you realize that not one day passes when we do not receive from 150 to 250 letters addrest to "The Oracle"? If we were to publish all the questions and their answers we would require a monthly magazine five or six times the size of the ELECTRICAL EXPERIMENTER, with no other matter but questions and answers. Of late the influx of letters has become so heavy that several of our associates have been forced to discontinue important editorial work, in order to answer the mail. This we are certain you do not wish. You do not want your magazine to lower its present high standard. You want the best, the very best, and you know we never have failed you yet.

Moreover the multitude of letters are wholly unnecessary. Most of the questions Readers ask every day have been answered before in "The Oracle." Therefore ere you sit down to write us, look over your back numbers, and nine times out of ten you will find the answer.

We strive hard to publish only such matter as has not appeared before in our columns, and for that reason, only a small fraction of the queries received by us are actually publisht.

Your magazine is steadily coming to the fore as the greatest publication in the scientific world. To keep up its present high standard and to make it a better and bigger magazine requires a tremendous amount of untiring effort on the part of the Editors. Therefore, in the future, we CANNOT in your own interest, answer questions by mail, free of charge.

For questions requiring an immediate answer our fee is 25 cents for the first three ordinary questions, and 25 cents for each additional question. We will gladly advise fee for special questions entailing considerable research work or calculations.

Stamped and addrest envelope should be enclosed with the queries, and moreover, any sketches accompanying them should be drawn in ink on separate sheets. Write plain and, PLEASE, PLEASE BE BRIEF.

Editor of "The Oracle."

Concerning the disc core transformer in the Mignon coupler, so far as we understand, this disc core was either of iron or some other alloy of a ferrous nature. Apparently the designer aimed to or tried to give the impression that this form of transformer would be much more efficient than the standard radio coupler, owing to the presence of the ferrous core, which of course would give a much higher permeability, or flux carrying power.

We refer you to the March, 1917, issue of the ELECTRICAL EXPERIMENTER, page 811, where you will find complete diagrams and explanation of the Mignon adjustable disc core receiving transformer and circuits, written by Mr. Ernest Mignon, the inventor, himself.

RECORDING RADIO SIGNALS

(1007) W. T. Smith, Stockton, Kansas, wishes to know:

Q. 1. Of methods in use for recording radio-telegraphic signals.

With reference to apparatus sufficiently sensitive to record wireless signals at considerable distances, would suggest that you look over the article entitled, "Radio Amplifiers," which appeared in the November, 1918, issue of the ELECTRICAL EXPERIMENTER. A great number of different types of amplifiers are there described, and data is also given on their make-up.

Finally, we would suggest that there are two methods now in use commercially for recording wireless signals. The first one, which is employed at the Marconi Trans-Atlantic Radio Stations, utilizes two to three stage vacuum valve amplifiers, and the signals are recorded on a phonograph or "Dictaphone." The second method is that which has been used by the De Forest engineers, and this system of recording wireless messages or signals, utilizes two, three, or higher Audion amplifiers to boost the signals to a sufficient strength to operate a polarized relay. This, in turn, actuates a Morse register or tape recorder. The De Forest people have also successfully employed a Poulsen *telegraphone* for recording the signals after amplification by an Audion amplifier.

It might interest you to know that the De Forest experts have perfected a six-stage Audion amplifier with an *amplifying capacity of one million times.*

DESIGN OF PHONOGRAPH HORNS.

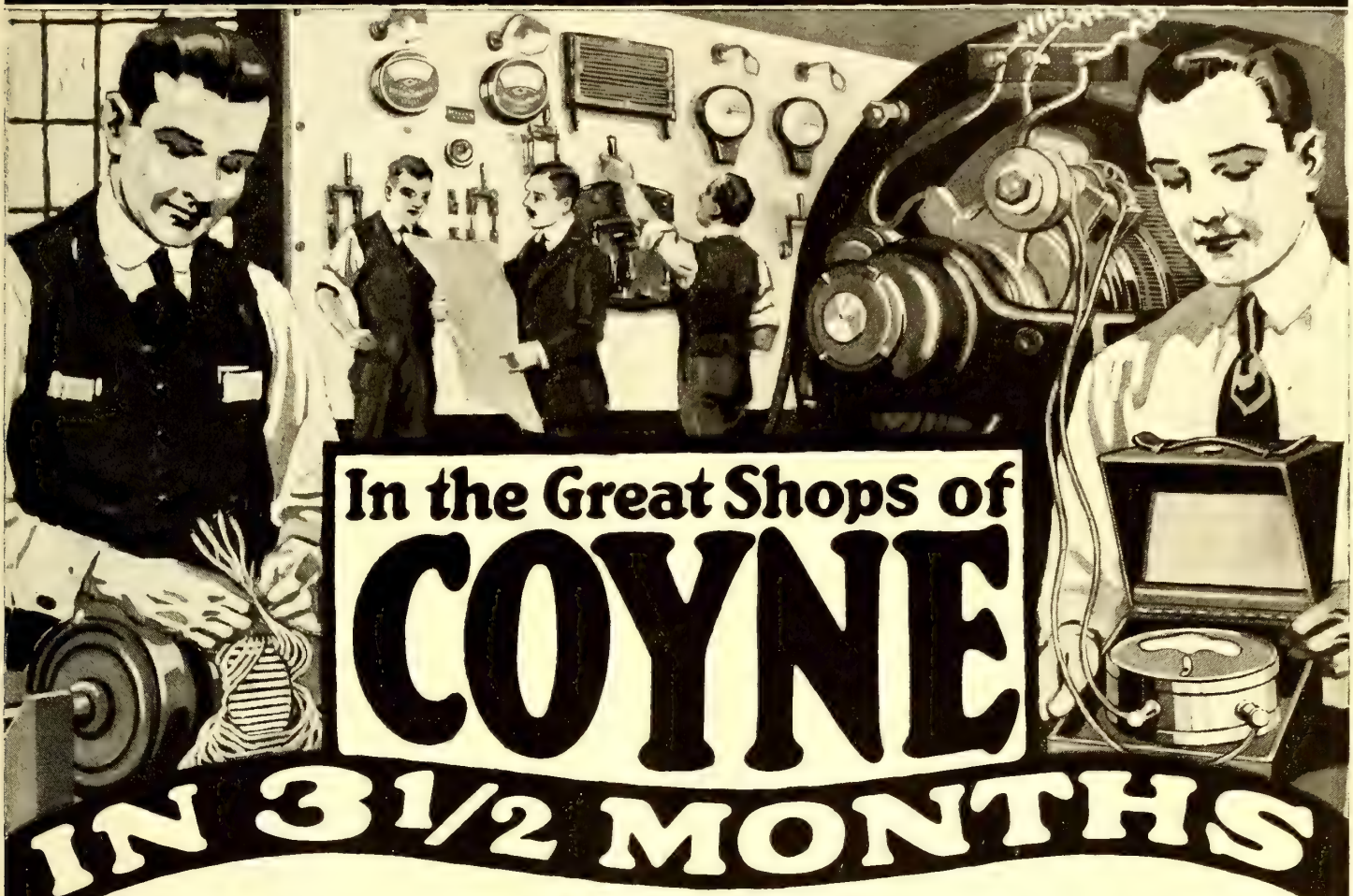
(1008) Howard L. Quick, Jr., Brooklyn, N. Y., wants data as follows:

Q. 1. How a large phonograph sound chamber or horn should be built?

A. 1. Relative to construction of phonograph sound box or horn, which in every case should be of some hard wood, an eminent sound authority, Prof. Dayton C. Miller, gives data as follows: The horn is best constructed of some hard wood such as maple, mahogany, hollywood or oak. The

(*Continued on page* 146)

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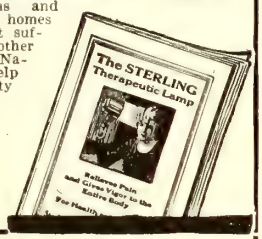
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Ann Arbor - - Michigan

THE ORACLE

(*Continued from page* 144)

wood for ordinary size horns may be ½ to ¾ inch stock, finished perfectly smooth inside and preferably varnished. Glue the joints and do not nail them. Mahogany is very well suited to the purpose indeed. The wood stock used should be quite thick, as the whole principle of the phonograph sound chamber is to vibrate the column of air within the chamber, and with this object in mind, and as pointed out by some of the highest scientific authorities on acoustics, the walls forming the chamber should not be thin enough to vibrate, but should be *rigid, so that the column of air can vibrate freely, and only this column of air.*

The longer the horn the better, and as the wave length in air of the average voice, such as the *baritone,* is about 4½ feet, the total mean length of the sound chamber from the reproducer should not be less than this value. Providing the sound chamber has at least this length, and that the diafram of the reproducer is large enough, say at least 2½ inches, so as to vibrate at the usual range of frequencies predominant in speech and music reproduction, then you should obtain very good results.

A high authority in the field of acoustics recently mentioned to the Editor of this column that the best phonograph music he ever heard in the laboratory, was that given from a wooden horn seven feet long, which took care of all the longer as well as the shorter wave lengths and frequencies. Very fine results were obtained from a still more rigid horn, constructed of concrete, he stated.

This authority also mentioned that a very slight difference was noted as to whether the sound chamber was made *square* or *round* in cross-section. The lines of its length should expand continually and not be parallel. Furthermore, the general contour or shape of the walls of the horn may be made perfectly straight, and no increased efficiency is obtained by any fancy frills or curves in the horn, as is claimed by many phonograph companies. Also it is a proven fact by laboratory tests, that any form of wooden grill or vane whatsoever placed in the mouth or opening of the sound chamber, only lowers the tonal and acoustic efficiency of the instrument.

With regard to needles, it is also interesting to note that tests have shown where anything softer than a steel, diamond or saffire point is used, that pure and clear sound reproduction is sacrificed, such as when fiber needles are used. Prof. Miller stated the situation very succinctly and correctly, we believe, when he said that "If you use fiber needles and like them, then use them, as they of course effect a saving in the wear on the records." The fact remains however, that any such needle as this absorbs a considerable portion of the vibrations of the music picked up from the record, and dissipates it before it ever reaches the diafram. The same reasoning applies to many other fancy attachments offered to the phonograph public.

A. C. MOTOR STARTING COIL CONNECTIONS.

(1009) G. S. Golden, Harrisburg, Pa., writes:

Q. 1. How do you connect up the starting coils on an A. C. single phase induction motor?

A. 1. We give herewith diagram of connections for the four starting coils on your A. C. motor. The current must flow around the successive poles in an opposite direction,

(*Continued on page* 148)

Advertising Talks
NUMBER 3

LAST month I showed you how necessary it was to the life and growth of a big magazine like the ELECTRICAL EXPERIMENTER to have a large number of satisfied advertisers, and explained how more advertisers meant a bigger magazine for you and more reading matter. This month I want to give you a few more reasons why it is worth your while to patronize firms who advertise, and especially those who advertise in the EXPERIMENTER.

When you pay your good money for some article, no matter what it is, you want to get the very best quality possible for the money. Advertised articles are always of better quality than unknown, unlabeled, and unbranded goods. This is easily proven. Compare such well-known brands as the Sonora Phonographs, Starrett Tools, Brandes or Murdock Receivers, etc., with similar articles put out by firms who have not the ambition or progressiveness to standardize their merchandise. The comparison always proves the superiority of the advertised article.

There is a good reason why this is so. It costs money to advertise. An inch ad in the ELECTRICAL EXPERIMENTER costs $8.40 for one insertion—a page ad $264.60. An advertiser who is using ten or twelve magazines and spending anywhere from $1,000 to $10,000 a month to tell you about the goods he has for sale, must get his money back by keeping you as a steady customer. It costs too much to make the first sale to drop your friendship then and there. He must make you a strong booster of what he has to sell, and keep you a steady customer if he is to make money. The only way he can do it is by giving you better quality and a cheaper price than possible anywhere else. If he doesn't give you a better article and save you money you won't remain a steady customer and he loses.

Therefore, when an advertiser spends a small fortune each year to build up a reputation, don't think for a single moment that he is going to risk that reputation or run the chance of having his money thrown in the gutter by putting out inferior goods. Far from it! The advertiser lays his cards on the table. He says, "Here's who I am, and what I am and what I have to sell you." He is frank with you. He does not try to "stick" you. He cannot afford to.

When you send your orders to any concern which advertises in the ELECTRICAL EXPERIMENTER you know that you are sending them to a reliable firm (we do not accept advertising orders from any concern except those that we know are reliable.) You will know that the goods which you will get are the best that you could buy for the money. You will know that the advertiser stands back of his goods and is willing to make good if any dissatisfaction should arise.

I have given you only a few reasons why it is a business proposition for an advertiser to give better service, put out a better quality of goods, and offer you more for the money than you would get from a non-advertiser. There are many others. Next month I will take up the matter of costs and prices and show you just how the advertiser can sell goods more cheaply than his competitor.

Advertising Manager.

How to Increase Your Will Power In One Hour

Author of This Article Tells How He Quickly Acquired a Dominating Will Power That Earns Him Between $50,000 and $70,000 a Year

FOUR YEARS ago a man offered me a wonderful bargain. He was hard up for money and wanted to sell me some shares in a young, growing company for $1,000. Based on the earnings of the Company the stock offered me was easily worth $5,000—in fact, the man who finally bought the shares sold them again in five months *at a profit of* $4,300.

The reason I didn't buy the shares was that I could no more raise a thousand dollars than I could hop, skip, and jump across the Atlantic Ocean. A thousand dollars! And my income only twenty-five a week.

The second chapter in my life began a few months later, when another opportunity came to me. It required an investment of $20,000 during the first year. I raised the money easily, paid back every penny I borrowed, and had $30,000 left at the end of the first year! To date in less than four years, my business has paid me a clear profit of over $200,000 and is now earning between $50,000 and $70,000 a year. *Yet for twelve years before, the company had been losing money every year!*

The natural question for my reader to ask is, "How could you borrow $20,000 to invest in a business which had previously been a failure, after being unable to borrow $1,000 for an investment that seemed secure?" It is a fair question. And the answer can be given in two little words—*WILL POWER.*

When the first proposition came to me I passed it by simply because I didn't have the money and couldn't borrow it. I went from one friend to the next and all turned me down. Several refused to talk business with me at all. They all liked me personally, and they asked about the kiddies, but when it came to money matters I hadn't a chance. I was scared stiff every time I talked to one of them. I pleaded with them, almost begged them. But everybody had their "money all tied up in other investments." It was an old excuse, but I accepted it meekly. I called it hard luck. But I know today that it was nothing in the world except my lack of Will Power or rather my weak Will Power, which kept me from getting what I wanted.

Partial List of Contents

The Law of Great Thinking.
The Four Factors on which it depends.
How to develop analytical power.
How to think "all around" any subject.
How to throw the mind into deliberate, controlled, productive thinking.
Detailed directions for Perfect Mind Concentration.
How to acquire the power of Consecutive Thinking, Reasoning, Analysis.
How to acquire the skill of Creative Writing.
How to guard against errors in Thought.
How to drive from the mind all unwelcome thoughts.
How to follow any line of thought with keen, concentrated Powers.
How to develop Reasoning Power.
How to handle the mind in Creative Thinking.
The secret of Building Mind Power.
How the Will is made to act.
How to set your Will.
How a strong Will is Master of Body.
What creates Human Power.
The Six Principles of Will Training.
Definite Methods for developing Will.
The NINETY-NINE METHODS for using Will Power in the Conduct of Life.
Seven Principles of drill in Mental, Physical, Personal Power.
FIFTY-ONE MAXIMS for Applied Power of Perception, Memory, Imagination, Self-Analysis, Control.
How to develop a strong, keen gaze.
How to concentrate the eye upon what is before you—object, person, printed page, work.

These are only a few of the many subjects treated.

When I heard that the man sold those shares at a profit of $4,300, it seemed that my sorrow could not be greater. That profit was just about what my salary amounted to for four years! But instead of grieving over my "hard luck," I decided to find out why I was so easily beaten in everything I tried to accomplish. It must be that there was something vital that made the difference between success and failure. It wasn't lack of education, for many illiterate men become wealthy. What was this vital spark? What was this one thing which successful men had and which I did not have?

I began to read books about psychology and mental power. But everything I read was too general. There was nothing definite—nothing that told me *what to do.*

After several months of discouraging effort, I finally encountered a book called "Power of Will," by Prof. Frank Channing Haddock. The very title came to me as a shock. When I opened the book I was amazed. I realized that will power was the vital spark—the one thing that I lacked. And here in this book were the very rules, lessons and exercises through which anyone could increase their will power. Eagerly I read page after page; including such articles as The Law of Great Thinking; How to Develop Analytical Power; How to Concentrate Perfectly; How to Guard Against Errors in Thought; How to Develop Fearlessness; How to Acquire a Dominating Personality.

An hour after I opened the book I felt like a new person. My sluggish will power was beginning to awaken. There was a new light in my eye, a new spring in my step, a new determination in my soul. I began to see, in my past, the many mistakes I had made, and I knew I would never make them again.

I practiced some of the simple exercises. They were more fascinating than any game of cards or any sport.

Then came an opportunity to acquire the business which had lost money for twelve years, and which I turned into a $50,000 a year money maker. Instead of cringing before the moneyed people, I won them over by my sheer force of will. I would not be denied, and my every act and word since then has been the result of my training in will power.

I am convinced that every man has within himself every essential quality of success except a strong will. Any man who doubts that statement need only analyze the successful men he knows, and he will find himself their equal, or their superior, in every way except in will power. Without a strong will, education counts for little, money counts for nothing, opportunities are useless.

I earnestly recommend Prof. Haddock's great work. "Power of Will," to those who feel that success is just out of reach—to those who lack that something which they cannot define, yet which holds them down to the grind of a small salary.

Never before have business men and women needed this help so badly as in these trying times. Hundreds of real and imaginary obstacles confront us every day, and only those who are masters of themselves and who hold their heads up will succeed. "Power of Will" as never before is an absolute necessity—an investment in self-culture which no one can afford to deny himself.

I am authorized to say that any reader who cares to examine "Power of Will" for five days may do so without sending any money in advance. If after one hour you do not feel that your will power has increased, and if after a week's reading you do not feel that this great book supplies that one faculty you need most to win success, return it and you will owe nothing. Otherwise send only $3, the small sum asked.

Some few doubters will scoff at the idea of will power being the fountain head of wealth, position and everything we are striving for, but the great mass of intelligent men and women will at least investigate for themselves by sending for the book at the publisher's risk. I am sure that any book that has done for me—and for thousands of others—what "Power of Will" has done—is well worth investigating. It is interesting to note that among the 250,000 owners of "Power of Will" are such prominent men as Supreme Court Justice Parker; Wu Ting Fang, Ex-U. S. Chinese Ambassador; Gov. McKelvie, of Nebraska; Assistant Posmaster-General Britt; General Manager Christeson, of Wells-Fargo Express Co.; E. St. Elmo Lewis; Senator Arthur Capper of Kansas and thousands of others. In fact, today "Power of Will" is just as important, and as necessary to a man's or woman's equipment for success, as a dictionary. To try to succeed without Power of Will is like trying to do business without a telephone.

As your first step in will training, I suggest immediate action in this matter before you. It is not even necessary to write a letter. Use the form below, if you prefer, addressing it to the Pelton Publishing Company, 30 K Wilcox Block, Meriden, Conn., and the book will come by return mail. You hold in your hand, this very minute, the beginning of a new era in your life. Over a million dollars has been paid for "Power of Will" by people who sent for it on free examination. Can you, in justice to yourself hesitate about sending in the coupon? Can you doubt, blindly, when you can see, without a penny deposit, this wonder-book that will increase your will power in one hour.

The cost of paper, printing and binding has almost doubled during the past three years, in spite of which "Power of Will" has not been increased in price. The publisher feels that so great a work should be kept as low-priced as possible, but in view of the enormous increase in the cost of every manufacturing item, the present edition will be the last sold at the present price. The next edition will cost more. I urge you to send in the coupon now.

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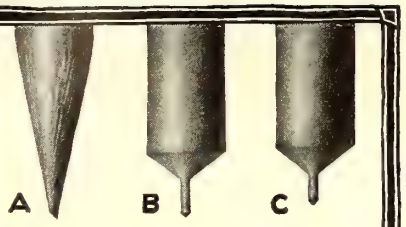
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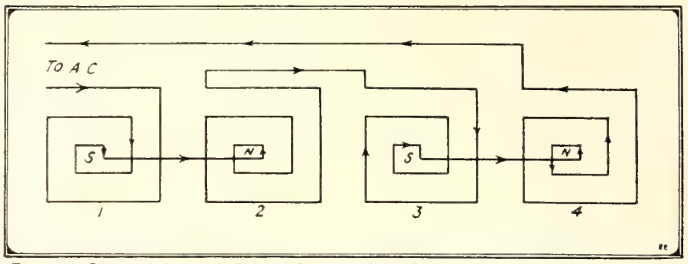


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The Oracle

(*Continued from page* 146)

as the diagram shows. Those you show in your letter are not correct, for they give like polarity on each pole, which is wrong. We have no data on the starting coil dimensions, but you can arrive at this by experiment, or else by getting in touch with the manufacturers of a similar sized motor.



Proper Connection of Poles Composing Starting Winding of Induction Motor.

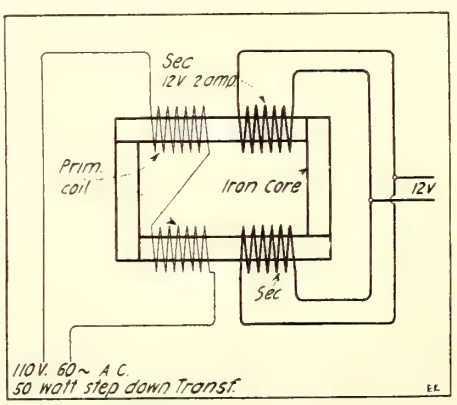
SPECIAL 110 VOLT TO 12 VOLT A. C. TRANSFORMER.

(1010) August Kling, Mobile, Ala., writes:

Q. 1. Asking for data on building a small step-down transformer to give 12 volts at the secondary, which he desires split into two coils. Total output 50 watts.

A. 1. We give herewith data on double wound closed core transformer to step-down 110 volts 60 cycle A. C. to a maximum secondary voltage of 12 volts.

The laminated sheet iron core for this transformer may measure 5 inches wide by 6 inches long, and have a cross-section of 1 inch by ½ inch. At either end of the two longer legs, as the diagram herewith shows, two primary windings may be placed, each of them consisting of 200 turns of No. 18 D. C. C. magnet wire. At either end of the two long legs, the two secondary windings may be placed, as the diagram shows, each of these developing about 12 volts and about 2 amperes, or giving 12 volts and 4 amperes or 50 watts, the total output you request for both secondaries connected in parallel. It is understood that both primaries in this design are to be connected in series on 110 volt 60 cycle A. C. at all times, i.e., whenever the transformer is used. The secondary windings each consist of 45 turns No. 12 B. & S. gage D. C. C. magnet wire, the secondary being wound on either leg beside the primary coil.



Details of 110-Volt to 12-Volt A. C. Transformer. Secondary Coils May Be Connected in Parallel or in Series.

With respect to taking off taps on the secondary for different voltages, you can easily divide up the total number of turns on the secondary yourself by means of a small battery voltmeter. You can readily test the potential by experiment. The voltage in any case is directly proportionate to the number of turns in use.

100-WATT, 32 TO 8-VOLT STEP-DOWN TRANSFORMER.

(1011) Claude Carefoot, Pasqua, Sask., Canada, inquires:

Q. 1. For data on step-down transformer to reduce 32 volts to 8 volts, A. C.

A. 1. We do not of course know how many watts you wish the transformer to carry, but we give you herewith data on a 100-watt transformer. The laminated sheet iron core may be about 8" long by 6" wide and thickness of 1". The core should have a cross-section of 1 square inch. The primary winding, on one leg of the transformer, should consist of 230 turns of No. 11 D.C.C. magnet wire.

The secondary winding should have 58 turns of No. 5 D.C.C. magnet wire.

My Inventions

By Nikola Tesla

(*Continued from page* 112)

any special thought of our far more imperative necessities. The "Magnifying Transmitter" was the product of labors extending through years, having for their chief object the solution of problems which are infinitely more important to mankind than mere industrial development.

If my memory serves me right, it was in November, 1890, that I performed a laboratory experiment which was one of the most extraordinary and spectacular ever recorded in the annals of science. In investigating the behaviour of high frequency currents I had satisfied myself that an electric field of sufficient intensity could be produced in a room to light up electrodeless vacuum tubes. Accordingly, a transformer was built to test the theory and the first trial proved a marvelous success. It is difficult to appreciate what those strange phenomena meant at that time. We crave for new sensations but soon become indifferent to them. The wonders of yesterday are today common occurrences. When my tubes were first publicly exhibited they were viewed with amazement impossible to describe. From all parts of the world I received urgent invitations and numerous honors and other flattering inducements were offered to me, which I declined.

In Faraday's Chair

But in 1892 the demands became irresistible and I went to London where I delivered a lecture before the Institution of Electrical Engineers. It had been my intention to leave immediately for Paris in compliance with a similar obligation, but Sir James Dewar insisted on my appearing before the Royal Institution. I was a man of firm resolve but succumbed easily to the forceful arguments of the great Scotchman. He pushed me into a chair and poured out half a glass of a wonderful brown fluid which sparkled in all sorts of iridescent colors and tasted like nectar. "Now," said he, "you are sitting in Faraday's chair and you are enjoying whiskey he used to drink." In both aspects it was an enviable experience. The next evening I gave a demonstration before that Institution, at the termination of which Lord Rayleigh addressed the audience and his generous words gave me the first start in these endeavors. I fled from London and later from Paris to escape favors

(*Continued on page* 173)



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(See review of this book by Editor in December issue of your Electrical Experimenter, page 568)

I have prepared a pocket-size note book especially for the practical man and those who are taking up the study of electricity. It contains drawings and diagrams of electrical machinery and connections, over two hundred formulas for calculations, and problems worked out showing how the formulas are used. This data is taken from my personal note book, which was made while on different kinds of work, and I am sure it will be found of value to anyone engaged in the electrical business.

The drawings of connections for electrical apparatus include Motor Starters and Starting Boxes, Overload and Underload Release Boxes, Reversible Types, Elevator Controllers, Tank Controllers, Starters for Printing Press Motors, Automatic Controllers, Variable Field Type, Controllers for Mine Locomotives, Street Car Controllers, Connections for reversing Switches, Motor and Dynamo Rules and Rules for Speed Regulation. Also, Connections for Induction Motors and Starters, Delta and Star Connections and Connections for Auto Transformers, and Transformers for Lighting and Power Purposes. The drawings also show all kinds of lighting circuits, including special controls where Three and Four Way Switches are used.

The work on Calculations consists of Simple Electrical Mathematics, Electrical Units, Electrical Connections, Calculating Unknown Resistances, Calculation of Current in Branches of Parallel Circuits, How to Figure Weight of Wire, Wire Gauge Rules, Ohm's Law, Watt's Law, Information regarding Wire used for Electrical Purposes, Wire Calculations, Wiring Calculations, Illumination Calculations, Shunt Instruments and How to Calculate Resistance of Shunts, Power Calculations, Efficiency Calculations, Measuring Unknown Resistances, Dynamo and Dynamo Troubles, Motors and Motor Troubles, and Calculating Size of Pulleys.

Also Alternating Current Calculations in finding Impedance, Reactance, Inductance, Frequency, Alternations, Speed of Alternators and Motors, Number of Poles in Alternators or Motors, Conductance, Susceptance, Admittance, Angle of Lag and Power Factor, and formulas for use with Line Transformers.

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☐ Electric Lighting and Railways	☐ Railway Accountant
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How to Build an Efficient Medical Coil Set

(*Continued from page* 125)

The tin foil and paraffined paper condenser used with this coil for intensifying the current for shocking purposes, etc., may be composed of about forty sheets of tin foil measuring 3x4 inches, each foil leaf separated with a layer of paraffined paper. Alternate sheets are connected together to form a terminal, and the condenser is finally connected up with the switch, as shown in Fig. 1, so that it can be cut in or out of circuit as desired.

Wooden Cabinet.

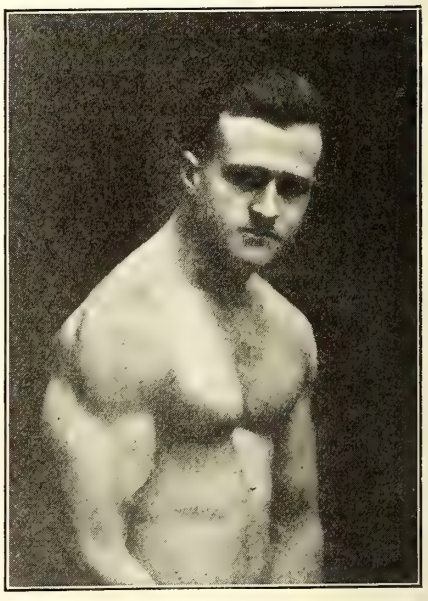
The cabinet proper, housing the two dry cells and the medical coil with control switches, in the case of the writer was made of some ¼-inch pine obtained from some old boxes. To further explain, and after considerable experience in building apparatus of this and kindred sorts, experience dictates that it is best not to bother with any elaborate wooden outer cabinets, but to make it more rugged by housing the apparatus and coils in a small dress-suit case. The author purchased one of these for $2.00, which filled the bill perfectly, the case being made of fiber with a good lock and hasp, reinforced corners and leather handle. The case measured 14 inches long by 8¾ inches in width and 4¾ inches in depth. Before building the cabinet, therefore, and providing you intend to enclose the apparatus in a case of this kind, which may be purchased at any trunk and bag store, you should ascertain the dimensions of the case beforehand, so that the cabinet will fit into it properly. As becomes apparent from Fig. 3, the top of the cabinet is the only part that shows when the case is open, and therefore it will be evident that the bottom can be made of pine and given a coat of black shellac or black coach varnish. The battery cover in the author's instrument is made of polished mahogany, being one-half of a mahogany base which originally belonged to an obsolete wireless instrument and a strip of polished mahogany was used for the central upright alongside the induction coil. The main switch panel which supports the coil of the condenser switch and the twelve points, also the secondary switch, is best made of either black fiber, polished hard rubber or bakelite. As the switch contacts are quite close together, and potentials of several hundred volts are carried thru adjacent contacts.

The battery compartment cover is held in place by means of four eye hooks, which can be purchased for a few cents at any hardware store, and as the experimenter has never yet been born, to the writer's mind, who has not wanted to use the battery which he has just locked up in a cabinet, provision is made so that the battery in this cabinet can be used at any time without having to open the compartment. For this purpose two auxiliary battery terminals or binding posts are placed on the side of the battery switch as Figs. 1 and 2 show.

Miscellaneous.

All of the connections under the panel supporting the apparatus as well as the battery connections are best made with rubber-covered flexible conductor about No. 18 B. & S. gage capacity. At Fig. 6 there are shown details for making the two metal handles, as well as a sponge electrode for treatment with saline solutions (salt water). The handles, if they are to be made instead of purchased, are very well composed of two lengths of brass tubing of about ¾-inch outside diameter by 3½ inches long. Each of these handles should be plugged up by a thick brass washer or a piece of ⅜ brass turned to make a driving fit in the tube, and which may be afterward sweated with solder so as to make a smooth tight joint which cannot be noticed, especially when the handles are afterward nickel plated. Thru the center of the plug a No. 8-32 tap hole should be drilled and threaded, into which a binding post may be secured or else a wooden handle as shown in the detail sketch, Fig. 6, may be utilized. This handle is turned up from some hard wood and given a coat of black shellac, and in the smaller end of the handle there is tightly fitted a piece of No. 8-32 screw. A small hole may be drilled crosswise thru the screw near the wood thru which the cord tip may be placed to make connection when it is used.

This wooden handle is very essential when the sponge electrode is employed, when it is screwed into the threaded shoulder in this electrode. To make the sponge electrode you will require a small piece of soft sponge about ½ inch thick which is sewed or laced with some heavy thread to the brass disc shown at Fig. 6. When using this electrode it is dipt into a salt water solution and applied over the part affected, such as a stiff muscle or cord, the patient holding the other handle in the hand, etc. The positive and negative poles of a faradic current as delivered at the binding post terminals, H and H^1, is readily determined by means of a polarity indicator, and the writer has successfully used very often one of the pole test paper indicators available on the market. This paper is dampened when it is to be used for determining polarity. Some of the papers turn red at the negative pole, and others turn red at the positive pole.



Earle Liederman

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EARLE E. LIEDERMAN
Dept. 209, 203 Broadway, New York City

Paris Letter

(*Continued from page* 119)

tributed and is interrupted in a certain rhythmic manner, which thus gives alternating periods of rest and work to the actuated muscles. The application of the current is made by large metallic surfaces, the electrodes covering the entire muscular region under treatment. The method of application of these electrodes is carefully supervised by the physician in order to get the best results. The large surface electrodes overcome to a great extent the high resistance of the skin, and also renders it certain that the patient does not experience any disagreeable sensation.

There is no nervous fatigue. The patient himself is unconscious of this gymnastic, passive *ergotherapy;* he experiences no shocks nor any disagreeable twitching. There is no muscular fatigue; the muscles are strengthened immediately; particularly the abdominal muscles are greatly benefited. The local circulation is highly stimulated. The motor functions of the muscles rapidly emerge from their impotency.

Our photographs were taken at the Grand-Lebrun Hospital at Bordeaux, Prof. Bergonié himself being in charge of the same. One of the photographs shows one of the electro-therapeutic wards while the faradization is taking place. It is interesting to watch the patients while they undergo the treatment. They seem to be unconscious of the effect of the current, but their muscles are working overtime. Our *Poilus* continue reading their newspapers and magazines as if they were actually enjoying a pleasant rest. The treatment extends for two hours in the morning and two in the evening, but in some cases the treatment is decreased or increased as becomes necessary, all depending on the specific cases. In one of our photographs we see a *poilu,* suffering from a fracture of the leg bones and the loss of his calve muscles, who was enabled to walk again without difficulty within fifteen days.

EXPERIMENTS IN RADIO ACTIVITY.

(*Continued from page* 123)

an undisputed footing to the atomic theory and has helped to solve many problems which have been puzzling the scientists for years.

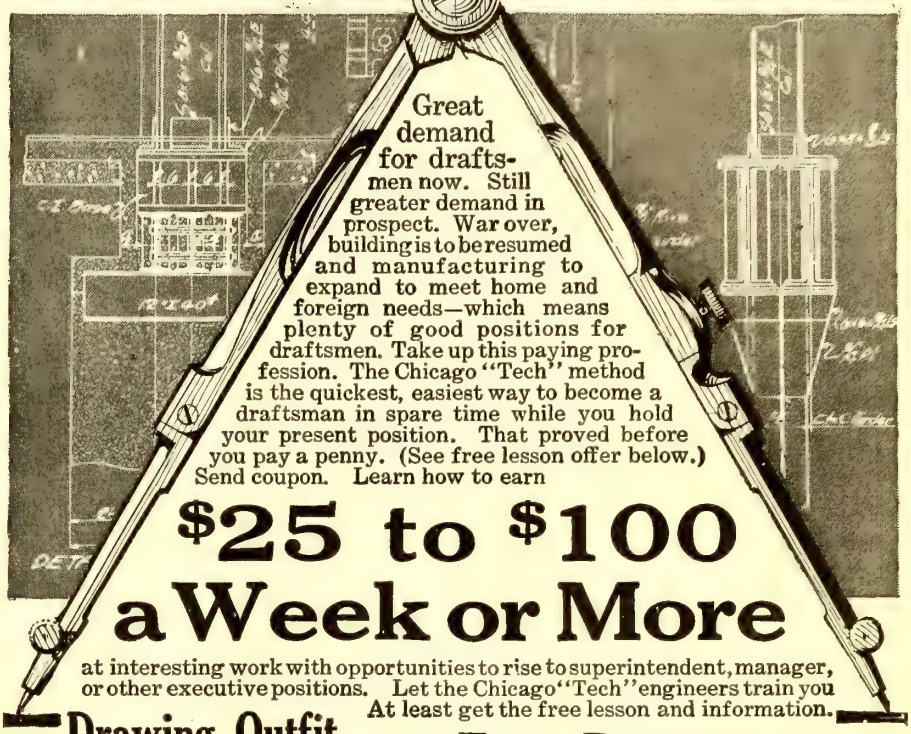
Of course this series is only a beginning and the experimenter wishing to continue should procure a standard work on the subject such as Rutherford's justly famous "Radio-active Substances and Their Radiations." It is hoped by the author that these articles have begot an interest in this far-reaching and fascinating study.

(*Conclusion*)

WIRELESS SIGNALS HEARD THREE-QUARTERS OF A MILE.

As considerable discussion is often heard among radio men, both Professional and Amateur, as to the distance over which an amplified radio signal has been heard, it may be of interest to mention in this connection that Dr. Louis W. Austin of the U. S. Naval Radio-Telegraphic Laboratory states in a recent letter to the Editors that he has often heard incoming radio signals amplified by means of *standard* radio apparatus so as to be audible for from ½ *to* ¾ *mile!* He also states that he believes it possible to amplify phonograph music or speech thru the aid of a standard audion amplifier having several stages and loud talking attachment, so that the music could be heard over a distance of a mile or more.

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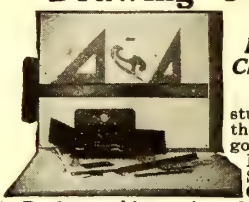


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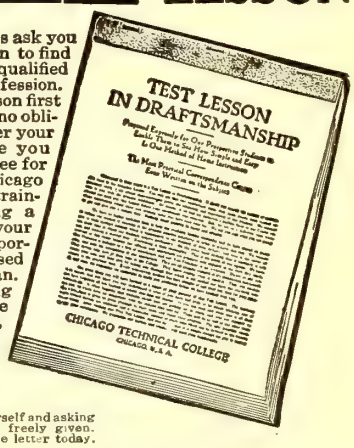
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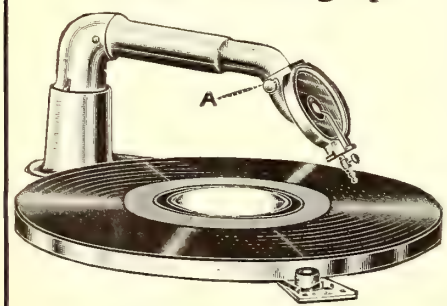
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What's in a Cover?

WHAT we really should say is, "What's ON a cover?"—but you *did* get the meaning after all. There are covers and covers, or to qualify it better, let us say cover illustrations. Tons of reams could be written about them and still the correct answer as to what constitutes a *good* cover would be as nebulous to you as it is to every other magazine editor. To be sure, the "pretty girl" cover has been proven *the* real seller, but so has the homely baby face, and the ugly bulldog, not to speak of Charlie Chaplin or the playful kitten cover. All of these make good covers and the public buys millions of copies of publications every day on account of them.

But the subject on the cover alone does not always mean that it will prove a big seller. Like as not the color scheme plays just as big a rôle. For if the color is not pleasing, the magazine often does not sell, even if the pretty girl *does* adorn its front. Then there is the "teaser," the "wonder-what-it-is" cover. If gotten up correctly, and if it stirs up sufficient curiosity in a man's breast—every copy will be sold as a rule. For after all, man is curiosity incarnate, and is willing to pay for appeasing it!

Our April cover was of this sort, as indeed it was an all-around ideal type. It had the mysterious element in it; it was startling, and the color combination was right and pleasing.

Some one—an authority on magazines—said that if we did get out a thousand covers, we could never hope to beat the April cover! And if the sales of the April issue is an index, his prophecy probably will come true! Indeed, we had to print an extra edition, and that did not cover the demand.

Of course, adverse criticism was not lacking. A few cranks—the usual monthly crop—were on deck, loudly denouncing us. Their virtuous ego had been shocked profoundly because we dared to show a woman unattired, save for her—skeleton!! These "critics" like as not forget that "to the pure everything is pure." They belong to that fanatic category of men who can't bear to look at the naked truth, because it is—naked!

So we were pleasantly surprised when hundreds of readers from all sections of the country began sending us clippings of the editorial which accompanies this article.

This editorial was written by Arthur Brisbane, the highest paid editorial writer in the world. It was publisht in the New York *Evening Journal*, the Chicago *American*, the Washington *Times*, the Boston *American*, the Atlanta *Georgian*, the San Francisco *Examiner*, and the Los Angeles *Examiner*.

Mr. Brisbane seldom uses illustrations in his editorials. That he picked out our April cover illustration proves that it must have been good. Indeed, we may paraphrase Mr. Brisbane's editorial by asking:

"What is a Cover Illustration? A Backbone." And again:

"While there are many *magazines*, so few of them are vertebrate that you can count them on the fingers of your two hands in the United States."

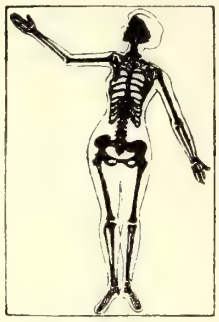
Ask yourself or your friend, "What *magazine* do you know that you can call a vertebrate? What *magazine covers* have you ever heard anybody discuss?" See how many answers you get.

Today the ELECTRICAL EXPERIMENTER is the most widely quoted scientific publication in this country. Within its covers you will find the last word on Radio, Electricity, Aeronautics, Chemistry, Astronomy, Mechanics and all the allied sciences, written so that the layman as well as the most modern theorist may enlarge his fund of knowledge. Therefore do you wonder that hardly a newspaper worth the name fails to quote the EXPERIMENTER several times a month?

What do *you* think is the reason?

EDITORIAL PAGE OF THE NEW YORK
EVENING JOURNAL

What Is an Editorial? A Backbone.



Here, reproduced from that interesting scientific journal The Electrical Experimenter, is a picture showing a lady's skeleton photographed by modern methods. You will see the resemblance between these bones and the editorial.

Copyright 1919 by Star Company

On your knees thank kind Providence that we have not X-ray eyes, but eyes that see the surface, nothing below.

If like the mysterious penetrating rays we could see THROUGH, see the bones, the crinkly skull, with its interesting seams, and all the rest, how gruesome we should look to each other.

Marriages would all be made in heaven, none of them on earth. We should all look too ugly.

But wise Providence limits us in a million directions, giving us what we need to make us useful and efficient here and nothing unnecessary.

We cannot see colors below the red or above the violet. Insects probably see others. We cannot detect sound except within a narrow range. We see the bloom on the cheek, not the bone inside of it. We see the pretty graveyard with the green grass and the flowers, but do not know what happened to the individual who went in there.

We see the baby, just arrived, chewing its fist in the cradle, but don't know whence it came, what it was doing before it got here.

And it is all for the best.

This is written to answer a reader who asks, "What part should you say that the editorial plays in a newspaper?"

This little picture answers the question.

The editorial in a newspaper, if it IS an editorial, which it usually ISN'T, plays in that newspaper the part that the skeleton, and particularly the backbone, plays in the anatomy and the activity of the young lady in this picture.

She doesn't show it, her young man doesn't know it, the world at large doesn't know it, but the most important thing about her, that which makes her stand up and go through life well balanced on her two feet, is the bony structure, and particularly that BACKBONE.

The young man who doesn't know it really admires her for the backbone, admires her because she is a vertebrate; that is to say, one having a spinal column.

Without it she would lie flat on the ground, could not stand up, could not walk, could not even crawl along. Beautiful hair and eyes and color would all go for nothing without the backbone.

So, inquiring reader, it is with the newspaper and the editorial column. The editorial column is the spinal column.

If the newspaper has got it, it is a vertebrate. If it hasn't got it—and newspapers usually haven't—it is a mollusk. The mollusk is good to eat, leads a prosperous, cheerful life quite often. But it is a mollusk.

In the newspaper, as in the human being, the backbone, or editorial column, makes the thing stand up and walk and gives it its power.

In this charming young person, as you can see at a glance, the skeleton is by far the least attractive part. It cannot be compared with long, curly hair, pink cheeks, red lips, sparkling eyes, but it is more necessary than those.

The newspaper's backbone, when it happens to be a newspaper with a backbone, is perhaps the least attractive part, the least pleasing. It does not compare with the woman's page, the continued story, the fashion page, the comic page; but it is THE BACKBONE.

While there are many newspapers, so few of them are vertebrates that you can count them on the fingers of your two hands in the United States.

Ask yourself or your friend, "What newspaper do you know that you can call a vertebrate? What newspaper editorial column have you ever heard anybody discuss?" See how many answers you get.

Making a Practical Electrician

(*Continued from page* 117)

The new student starts at the very beginning, under an instructor that not alone initiates him into the electrical field, but helps to mold the character and general business policy of the future electrician.

In this school no text-books are in evidence! What the student hears and sees, as well as does, is first given to him verbally by his instructor. When he has done the work with his own hands, and made such notes as will be of assistance in the future to refresh his memory, the knowledge he has gained is the only text-book he uses. In the large electrical library of the school the student may at any time refer to any topics that seem hazy or not quite clear to him.

The new man learns the elementaries first, such as the meanings of various symbols and the rudimentary rules applying to electrical calculations, after which he does the practical work at his own table. Next he performs the simple feats of connecting up bells, batteries, telephones, fire-alarms, telegraphs and all sorts of intercommunicating systems.

From here he graduates into the high branch of applied electricity and in a practise building consisting of a ten room apartment he learns how to wire for light, heat and power by all the prevailing systems, such as cleat work, wood and metal moulding, knob and tube work, armored cable, flexible and metallic conduit.

As electrical power is one of the greatest factors of American industry, and its applications many, the electrician finds a great field in his endeavors in this one branch alone. Therefore, at this school every modern power problem is studied minutely. When this part of his course is finished the student is ready to tackle anything that may come his way, be it the installing or building of switchboards to carry enormous currents, the connecting and operating of alternating and direct current motors, dynamos or generators, or the operation or installation of storage battery systems as applied to electrical vehicle propulsion, and every other phase of this branch of electrical science. With his vast storehouse of knowledge gained by actual experience the student is well qualified to enter the field of Electric Traction, the coming achievement of this century, for he will have worked on, installed and run a complete electric trolley and locomotive.

Finally the student learns the biggest bug-a-boo of all, "Armature Winding," which to most people is a science in a class by itself. At this school a complete knowledge is quickly gained in a simple and practical manner. All puzzling details are rapidly grasped and within a short time the student is winding any form of armature, stator, field or motor ever used in actual practise. This and machine shop practise, repairs, electrical drafting, etc., complete the training course.

No specified time is set for a student to complete his studies—everything depends on the individual and the rate at which he can grasp things. No entrance "exams" are needed, one can start at any time. The men hold meetings, at which all new advances in science are discust and many novel features introduced.

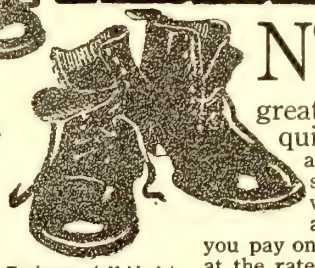
When finally graduated the student, diploma in hand, stands ready to meet any phase of the electrical industry. He is able to undertake any job, for he has the confidence that only comes with the knowledge that he has done with his own hands the things he will have to do in actual practise in the business world. *Photos Courtesy N. Y. Electrical School.*



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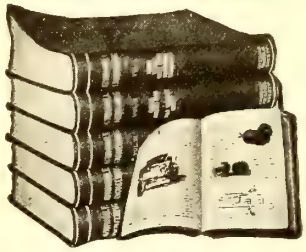
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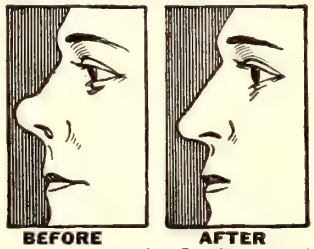
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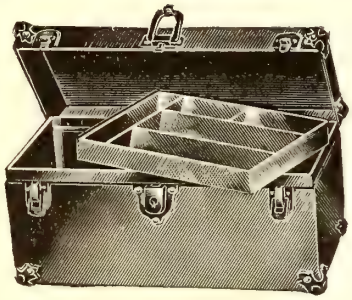


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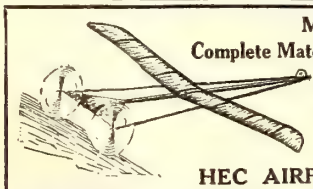
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Practical Chemical Experiments

(*Continued from page* 122)

decay may be at all noticeable.

COOKING OF EGGS. There is a notion prevalent that hard-boiled eggs are not digestible, and experiments made with eggs in the stomach lead to the same conclusion. Thus eggs slightly boiled have left the stomach in 1¾ hours, and raw in 2¼ hours, and hard-boiled in 3 hours. It should be noted, however, that raw eggs are only partially digested in the stomach, perhaps because they do not fully excite the flow of the gastric juice. The complete digestion is accomplished further along in the alimentary canal.

In cooking eggs, they should be placed in water at 170 to 180 degrees Fahrenheit, and allowed to remain for 10 minutes, when the yolk will be found to be more coagulated than the white, the egg albumin beginning to coagulate at 134 deg. Fahr., and it requires some time to heat the egg thruout.

A convenient method for cooking eggs without the use of a thermometer is to pour a quart or so of boiling water into a bowl, and put two or three eggs into this and allow them to remain for 10 or 12 minutes. The yolk actually cooks more readily than the white, and by this process the eggs are cooked uniformly thruout.

QUESTIONS AND ANSWERS

MIXING MILK AND ACID.

Ques. No. 5. A. J. Karlson, Phenix, Ariz., wants to know if it is possible after milk or cream is mixt with Sulfuric acid, to remove the latter and restore the acid to the same strength as before.

Ans. We do not quite understand your object in mixing the acid with the milk, only to revert back to the same original substances. However, this is not possible, as the acid enters into reaction with the formation of new compounds, which reaction is not reversible.

FIRE EXTINGUISHER.

Ques. No. 6. *Fire Extinguishers.* Mr. Kenneth Gordon, Tulsa, Okla., desires information regarding ingredients and operation of fire extinguishers.



Section Thru a Standard Fire Extinguisher.

Answer: A solution of sodium bicarbonat is contained in a metallic cylinder, having a flexible tube at one of the upper sides. Sulfuric acid is kept in a small container above the bicarbonat as shown in the accompanying illustration. When the extinguisher is inverted, the stopper falls out of the bottle, permitting the sulfuric acid to come in contact with the solution of sodium bicarbonat, with the formation of carbon dioxid, thus:—

$$H_2SO_4 + 2NaHCO_3 = 2H_2O + Na_2SO_4$$

The presence of the carbon dioxid gen-

erated forces the solution out thru the hose.

"Pyrene" extinguishers contain carbon tetrachlorid, a highly volatile liquid, whose vapor does not burn.

In either case the gases liberated so envelop the flame that combustion ceases, due to lack of its supporter, oxygen.

RADIOACTIVE GAS MANTLE.

Question 7. *Welsbach Mantle.* Theodore McGowan, Elmira, New York, wants to know how he can conclusively show that the Welsbach gas mantle contains radioactive substances.

Answer: The most simple and conclusive method is to place a gas mantle upon a box which contains an unexposed photographic plate, wrapt in the usual opaque paper. Set these aside for a week or ten days, and develop as usual. The result will be a photographic reproduction of the mantle, exposed by its own light, liberated by the radioactive ingredients.

FULLER'S EARTH.

Question 8. William W. Staley, Portland, Oregon, desires information as follows: Where he can obtain Fuller's earth as mentioned in the April issue, Experiment No. 3 on Butter Tests; and also the composition of the alcoholic potash solution as mentioned in Experiment No. 4 in the same issue.

Answer: (a) *Fuller's Earth* may be obtained from any chemical supply house dealing in chemicals, and may be ordered under that name.

(b) The *Alcoholic Potash Solution* mentioned is prepared by dissolving 28 grams of caustic potash (in stick form) in 1 litre of alcohol.

Science in Slang

(*Continued from page* 143)

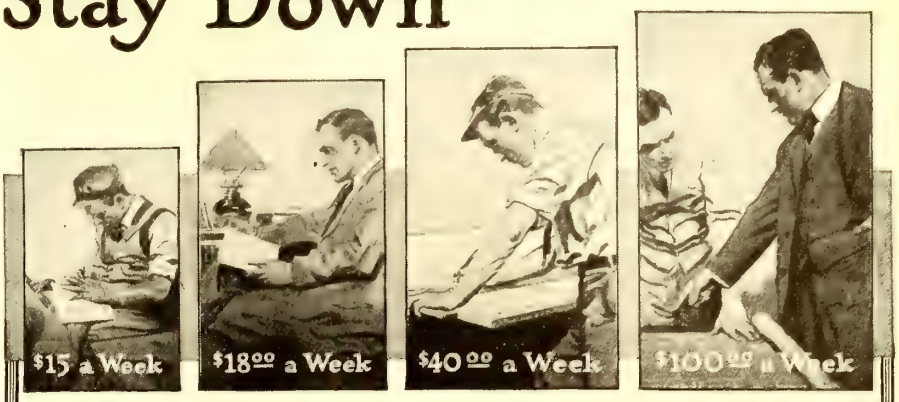
tomers at the same time. At that, the automatic is some little system and the guy who invented it certainly had it thick behind the ears. All you have to do is to move a little disc around the front of the 'phone, having numbers from 1 to 0, and you don't have to wait for a connection, either. If the line is busy you hear the usual busy signal which means, Hang up your receiver.' After a while you try it again and you can cuss and howl all you want if it's still busy. The automatic 'phone exchange doesn't mind it in the least, and take it from me, the system works to a charm."

"That so?" interposed Punk Loomis. "When how comes it that if the system works so charmingly and charmfully, the rest of the universe doesn't adopt it?"

"You see," said Stokes, "it's like this: When a man bumps into you at the corner, almost upsetting you, it does your heart good to come back at him with a long string of verbosity that clears out your venom and makes you feel comfortable again, as soon as it is out of your system. But if you run into a lamp-post, it doesn't do you much good to cuss at it by letting loose a blue streak of hyphenated talk. Same with the automatic outfit. A man wants to have somebody to act as his personal goat once in a while. He wants to tell Central what is the matter with her. Or, if he is not inclined that way and time hangs heavily on his hands, he might want to speak to her about the color of her eyes or the texture of her soul. Never mind if she hangs up on him, that's the complexity of the human mind. So while the automatic is a fine outfit as far as it goes, it is too *inhuman*, for it refuses to be your goat and that is the reason——"

"Stokes!" yelled the steward. "Long distance is answering."

The Man Who *Wouldn't* Stay Down



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Are you satisfied merely to hang on where you are or would you, too, like to have a real job and real money? It's entirely up to you. You don't *have* to stay down. You *can* climb to the position you want in the work you like best. Yes, you can! The I. C. S. are ready and anxious to come to you, wherever you are, with the very help you need.

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Electric Machine Designer	DESIGNER
Telegraph Expert	BOOKKEEPER
Practical Telephony	Stenographer and Typist
MECHANICAL ENGINEER	Cert. Pub. Accountant
Mechanical Draftsman	Traffic Management
Toolmaker	Commercial Law
Ship Draftsman	GOOD ENGLISH
Machine Shop Practice	Common School Subjects
Gas Engineer	CIVIL SERVICE
CIVIL ENGINEER	Railway Mail Clerk
Surveying and Mapping	STATIONARY ENGINEER
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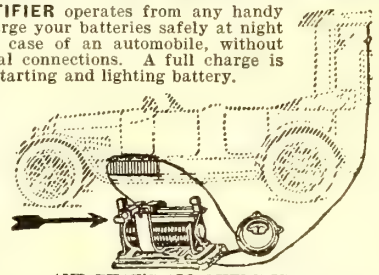
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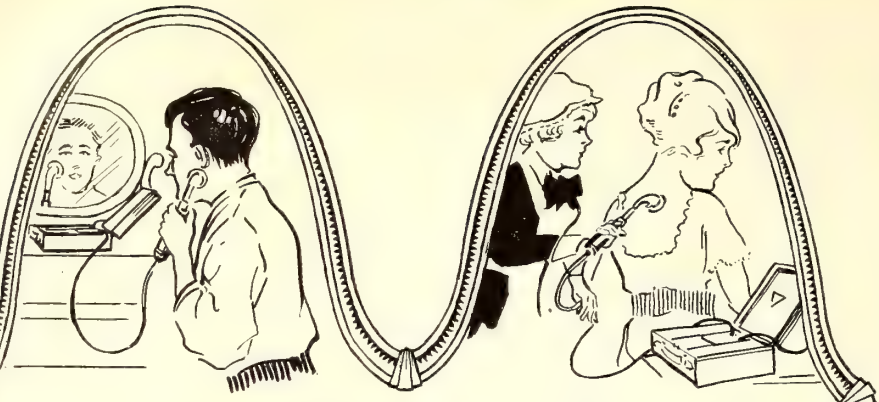
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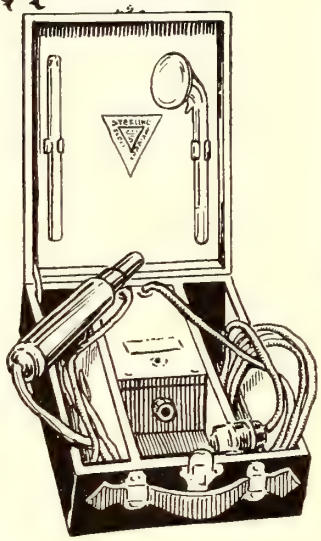
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The Moon's Rotation

By Nikola Tesla

(*Continued from page* 133)

significance of this will be understood by reference to Fig. 7 in which the two masses, condensed into points, are represented as attached to independent weightless strings of lengths R_{g1} and R_{g2} which are purposely shown as displaced but should be imagined as coincident. It will be readily seen that if both strings are cut in the same instant the masses will fly off in tangents to their circular orbits, the angular movement becoming rectilinear without any transformation of energy occurring. Let us now inquire what will happen if the two masses are rigidly joined, the connection being assumed imponderable. *Here we come to the real bug in the question under discussion.* Evidently, so long as the whirling motion continues, and both the masses have precisely the same angular velocity, this connecting link will be of no effect whatever, not the slightest turning effort about the common center of gravity of the masses or tendency of equalization of energy between them will exist. The moment the strings are broken and they are thrown off they will begin to rotate but, as pointed out before, this motion neither adds to or detracts from the energy stored. **The rotation is, however, not due to an exclusive virtue of angular motion, but to the fact that the tangential velocities of the masses or parts of the body thrown off are different.**

To make this clear and to investigate the effects produced, imagine two rifle barrels, as shown in Fig. 8, placed parallel to each other with their axes separated by a distance $R_{g1} - R_{g2}$ and assume that two balls of same diameter, each having mass *m*, are discharged with muzzle velocities V_1 and V_2, respectively equal to $2\pi n R_{g1}$ and $2\pi n R_{g2}$ as in the case just considered. If it be further supposed that at the instant of leaving the barrels the balls are joined by a rigid but weightless link they will rotate about their common center of gravity and in accordance with the statement in my previous article above mentioned, the relation will exist $\frac{V_1 - V_2}{2} = \pi n (R_{g1} - R_{g2})$ n being the number of revolutions per second. The equalization of the speeds and kinetic energies of the balls will be, under these circumstances, very rapid but in two heavenly bodies linked by gravitational attraction, the process might require ages. Now, this whirling movement is real and requires energy which, obviously, must be derived from that originally imparted and, consequently, must reduce the velocity of the balls in the direction of flight by an amount which can be easily calculated. At the moment of discharge the total kinetic energy was $E = \frac{1}{2} m V_1^2 + \frac{1}{2} m V_2^2$ which is evidently equal to $m V_3^2$, V_3 being the effective velocity of the common center of gravity, from which follows that $V_3 = \sqrt{\frac{V_1^2 + V_2^2}{2}}$. The speed of revolution of the masses is, of course, $\frac{V_1 - V_2}{2}$ and the rotational energy of both balls, which must be considered as points, is $e = m\left(\frac{V_1 - V_2}{2}\right)^2$ The kinetic energy of translation in the direction of flight is then $\frac{1}{2} m V_1^2 + \frac{1}{2} m V_2^2 - m\left(\frac{V_1 - V_2}{2}\right)^2 = m\left(\frac{V_1 + V_2}{2}\right)^2 = m V_4^2$, $V_4 = \frac{V_1 + V_2}{2}$ being the speed of the

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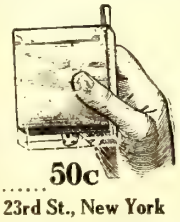
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common center of gravity, so that $V_2 - V_1$ is the loss of velocity in the direction of flight owing to the rotation of the two mass points. If instead of these we would deal with the balls as they are, their rotational energy

$$e_1 = e + i\omega^2 = m\left(\frac{V_1 + V_2}{2}\right)^2 + i(2\pi n)^2$$

i being the moment of inertia of each ball about its axis.

As will be seen, we arrive at precisely the same results whether the movement is rectilinear or in a circle. In both cases the total kinetic energy can be divided into two parts, respectively of the same numerical values, *but there is an essential difference.* In angular motion the axial rotation is nothing more than an *abstract conception;* in rectilinear movement it is a *positive event.*

Virtually all satellites rotate in like manner and the probability, that the acceleration or retardation of their axial motions—if they ever existed—should come to a stop precisely at a definite angular velocity, is infinitesimal while it is almost absolutely certain that all movement of this kind would ultimately cease. The most plausible view is that no true moon has ever rotated on its axis, for at the time of its birth there must have been some deformation and displacement of its center of gravity thru the attractive force of the mother planet so as to make its peculiar position in space, relative to the latter, in which it persists irrespective of distance, more or less stable. In explanation of this, suppose that one of the balls as M in Fig 5 is not of homogenous material and that it is similarly supported but on an axis passing thru its center of gravity instead of form. Then, no matter in what position the ball is fixed on the pivots, its kinetic energy and centrifugal pull will be the same. Nevertheless a directive tendency will exist as the two centers do not coincide and there is, consequently, no *dynamic* balance. When permitted to turn freely on the axis of gravity the body, of whatever shape it may be, will tend to place itself so that the line joining the two centers points to O and there may be two positions of stability but, generally, if the center of gravity is not greatly displaced, the heavier side will swing outwardly. Such condition may obtain in the moon if it had solidified before receding from the earth to great distance, when the

(*Continued on page* 160)

POPULAR ASTRONOMY

The Evolution of the Stars

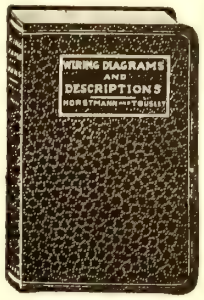
(*Continued from page* 121)

Canopus, one of the giants of the universe. The transition of this type into the solar type stars of class G, to which our sun belongs, occurs when the group of iron lines known as group G begins to appear (see diagram I). The lines of calcium and hydrogen still remain more intense than any other lines in the spectrum, but many fine metallic lines now appear in ever-increasing intensity. The transition of this type into the advanced solar type K occurs when some of the metallic lines surpass the hydrogen lines in intensity. The group of iron lines has also greatly increased in intensity until it becomes one of the most conspicuous features of the K type stars. Stars of the solar type such as Capella and the sun are yellow, and stars of the advanced solar type, such as Arcturus and Aldebaran, are orange colored bordering on red. Their atmospheres are filled with dense metallic vapors. (See photos of solar and advanced solar type spectra.)

Class M is divided into giant and dwarf

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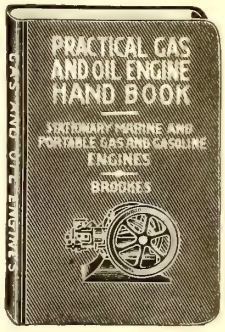


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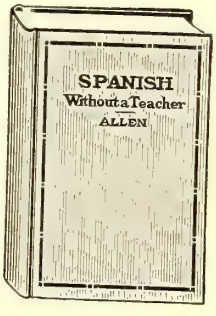
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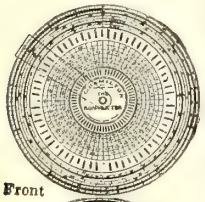
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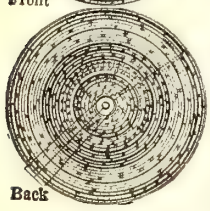
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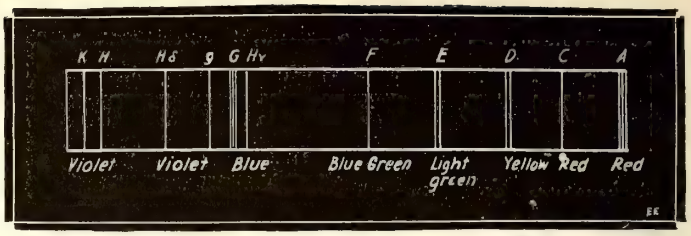
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red stars with banded and fluted spectra corresponding to Secchi's type III. Their dense atmosphere are filled with metallic compounds and they are superficially at least much cooler than stars of the other types outlined above. (See spectrum of typical giant type M star.)

Class N corresponds to Secchi's type IV and its characteristics have been mentioned above.



The Relative Positions of Certain Lines Prominent in Various Stellar Spectra Are Indicated in the Above Diagram of the Visible Spectrum: K and H Are the Absorption Bands of Calcium in the Extreme Violet End of the Spectrum. The Ultra-Violet Lies Beyond to the Left. Hδ, Hγ, F, and C Are the Characteristic Absorption Lines of Hydrogen Prominent in Type I and Type II Stars. g is a Line of Calcium in the Violet. G Is a Group of Lines Due to Iron Prominent in Solar Type Stars. E Is a Second Group of Iron Lines. D Is a Pair of Lines in the Yellow Due to Sodium. A Is a Group of Lines in the Extreme Red Originating in Our Own Atmosphere.

The position of the *Novae* or *Temporary Stars* in this scheme of evolution is somewhat uncertain, if in fact they fit into it at all. At the time of their outburst their spectra are usually rich in violet light and they are therefore to be classed with first type stars. Many sudden and peculiar changes take place in their spectra, but one characteristic is common to all novae, and that is the existence of both bright and dark bands of helium and hydrogen greatly displaced in position, the dark ones being shifted toward the violet and the bright ones toward the red.

Temporary stars usually pass first into bright line stars and later into planetary nebulae, thus reversing the generally accepted order of evolution from nebulas to bright line stars.

Tho a gradual transition from one type of star to the next can be traced, it does not necessarily follow that *all* stars pass from nebula to type M or type N stars thru all the types O, B, A, F, G and K in order and from there on to gradual extinction. It is possible that some stars become extinct or cease to shine without passing thru all of these stages.

The fact that in certain double star systems two stars physically connected and therefore evidently formed at the same time are at different stages of development calls for explanation. Some stars may run thru the course of evolution more rapidly than other stars, and some stars may lose their radiating powers before they have completed the normal course of evolution.

The marked division of the solar and late type stars into dwarf and giant stars also has a direct bearing on the problem of the order of the evolution of the stars. Tho the generally accepted order of evolution is that outlined above, it is possible that the sequence advanced by Prof. H. N. Russell may be the true one in which the evolution begins with giant stars of type M, continues in an order reverse to the one usually accepted thru giants of types K, G and F to the type B helium stars, hence in the normal order thru the *dwarfs* of types F. G, K and M to extinction. This would account for the existence of both giants and dwarfs of the later types. The Orion or Helium stars, which are the hottest of all the stars, would in this case represent the height of stellar development.

Whatever may prove to be the exact sequence in the evolution of the stars, the fact that there is evolution and change going on among the stars is indisputable. Such is the similarity existing among the hundreds of millions of stars of the universe that they can be grouped or classified under one or another of the few distinct types outlined above according to their color and the characteristic lines of their spectra.

(*The next installment will appear in an early issue.*)

TABLE SHOWING THE ORDER OF THE EVOLUTION OF THE STARS ACCORDING TO THE CLASSIFICATIONS OF SECCHI AND THE HARVARD COLLEGE OBSERVATORY

Type of Star Secchi	Type of Star Harvard	Typical 1st Mag. Star	Color	Characteristic Lines of Spectra
.....	Gaseous Nebulae	.....	Green	Bright lines of helium hydrogen and nebulium.
.....	O (Wolf-Rayet)	.....	Blue-White	Bright bands and lines of helium and hydrogen changing later to dark bands and lines.
.....	(Novae)	Nova Persei	.....	Bright and dark bands, greatly displaced, of helium and hydrogen.
Type I	B (Helium)	Rigel	Blue-White	Dark absorption lines of helium and hydrogen, but chiefly of helium and a few faint metallic lines.
Type I	A (Hydrogen)	Sirius	White	Intense absorption lines of hydrogen, reaching maximum. Increasing strength of metallic lines.
Type I-II	F (Calcium)	Canopus	White tinged with yellow	Intense bands and line "g" of calcium in violet. Hydrogen lines of great intensity; many strong metallic lines.
Type II	G (Solar)	Capella	Yellow	Increased intensity and number of metallic lines. Strong hydrogen lines still surpassing metallic lines in intensity. Appearance of Group G lines due to iron.
Type II	K (Advanced Solar)	Arcturus	Orange	Decrease in strength of hydrogen lines. Great increase in number and strength of metallic lines and Group G of iron.
Type III	Ma (banded)	Betelgeuse	Red	Appearance of banded spectra due to compounds of titanium oxide.
Type III	Mb (banded)	.....	.....	Marked faintness of violet end of spectrum.
Type IV	N (Carbon)	.....	Red	Banded spectra due to presence of carbon compounds.

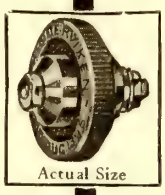
NOTE—This latter type does not follow in order after Type M, but is entirely independent of it in its evolution.

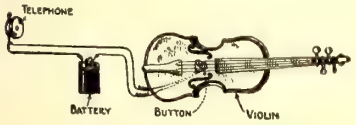
The novae also do not fit into the regular chain of evolution, but are placed after the stars they most closely resemble.

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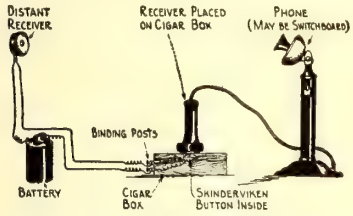
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Full directions for connecting up the button for use as a detectophone are given in booklet No. 4 which is sent with each button.

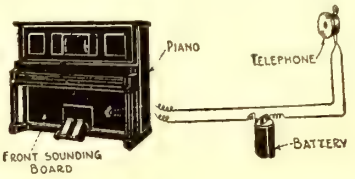
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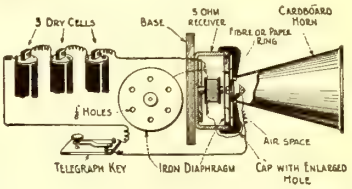
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" " 6 ft. 4 cond.	.28	" 3 oz.
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Transmitters complete with Steco transmitter button	$1.50	12 oz.
Induction coils	.40	6 oz.
Receivers—Watch Case 75 ohms	1.25	1 lb.



AMONG electrical experimenters the button has created a sensation. It is not uncommon to receive unsolicited letters like these: "I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

"I have been using one of your transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimentary." "I have been using one of your transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"



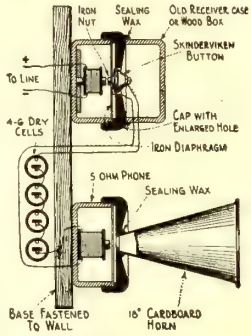
Mr. H. Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In writer's opinion, obtained by actual elaborate tests, your Transmitter Button is probably most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

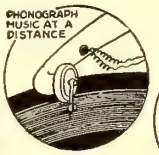
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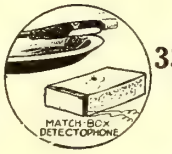
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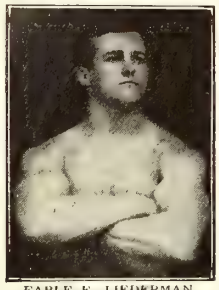
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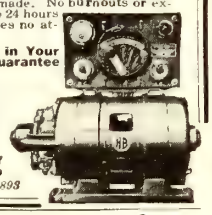
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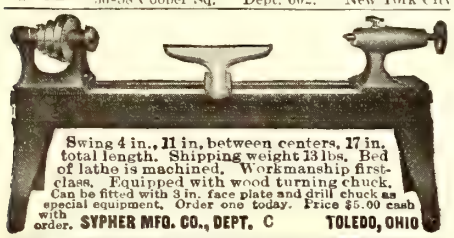
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The Moon's Rotation

By Nikola Tesla

(*Continued from page* 157)

arrangement of the masses in its interior became subject to gravitational forces of its own, vastly greater than the terrestrial. It has been suggested that the planet is egg-shaped or ellipsoidal but the departure from spherical form must be inconsiderable. It may even be a perfect sphere with the centers of gravity and symmetry coinciding and still rotate as it does. Whatever be its origin and past history, the fact is, that at present all its parts have the same angular velocity as though it were rigidly connected with the earth. This state must endure forever unless forces from without the luna-terrestrial system bring about different conditions and thus the hope of the star-gazers that its other side may become visible some day must be indefinitely deferred.

A motion of this character, as I have shown, precludes the possibility of axial rotation. The easiest way to free ourselves of this illusion is to conceive the satellite subdivided into minute and entirely independent parts, as dust particles, which have different orbital, but rigorously the same angular, velocities. One must at once recognize that the kinetic energy of such an agglomeration is solely translational, there being absolutely no tendency to axial rotation. This makes it also perfectly clear why the moon, provided its distance does not greatly increase, *must* always turn the same face to us even *without any inherent directive tendency* nor so much as *the slightest effort from the earth.*

Referring to the librations of longitude, I do not see that they have any bearing on this question. In astronomical treatises the axial rotation of the moon is accepted as a material fact and it is thought that its angular velocity is constant while that of the orbital movement is not, this resulting in an apparent oscillation revealing more of its surface to our view. To a degree this may be true, but I hold that the mere change of orbital velocity, as will be evident from what has been stated before could not produce these phenomena, for no matter how fast or slow the gyration, the position of the body relative to the center of attraction remains the same. The real cause of these axial displacements is the changing distance of the moon from the earth owing to which the tangential components of velocity of its parts are varied. In *apogee,* when the planet recedes, the radial component of velocity decreases while the tangential increases but, as the decrement of the former is the same for all parts, this is more pronounced in the regions facing the earth than in those turned away from it, the consequence being an axial displacement exposing more of the eastern side. In *perigee,* on the contrary, the radial component increases and the effect is just the opposite with the result that more of the western side is seen. The moon actually swings on the axis passing thru its center of gravity on which it is supported like a ball on a string. The forces involved in these pendular movements are incomparably smaller than those required to effect changes in orbital velocity. If we estimate the radius of gyration of the satellite at 600 miles and its mean distance from the earth at 240,000 miles, then the energy necessary to rotate it once in a month would be only

$$\left(\frac{600}{240{,}000}\right)^2 = \frac{1}{160{,}000}$$ of the kinetic energy of the orbital movement.



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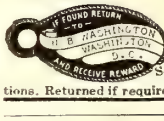
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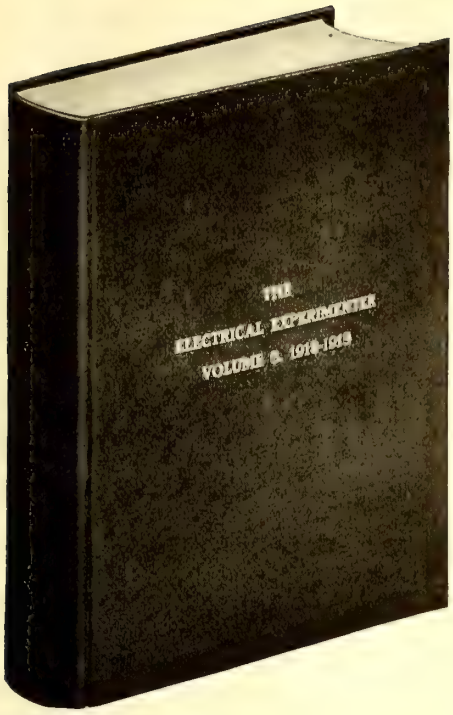
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Close-ups of New Scientific Movies

(Continued from page 118)

play starring May Allison in "The Island of Intrigue."

Lawrence Waring, millionaire oil magnate, compelled to go East on business, worries about leaving his daughter Maida alone. The problem is solved by the arrival of a letter from Mrs. Juliet Smith, an old friend, who invites Maida to spend the summer at her country home on Sunset Island.

A woman, who says she is Mrs. Smith, calls later and Maida, who has never met her father's friend, goes aboard a yacht, en route for the island. She meets Alaric and Lorna, Mrs. Smith's "son" and "daughter," and a "Count" Pellessier.

A few hours later the Waring house is in a state of alarm when the real Mrs. Smith arrives. It is then that Mr. Waring realizes that his daughter has been abducted.

In the meantime the yacht arrives at the island, but Maida, enjoying her holiday, does not realize that she is a captive. On one of her long walks thru the island she comes upon a camp and meets its owner, Gilbert Spear. She does not mention this to the others, but the meetings, begun as a lark, soon become a habit.

In the meantime the Count, by a wireless apparatus cleverly concealed in a piano, sends a message to Waring demanding fifteen thousand dollars as his daughter's ransom. He gets no answer and decides to force Maida to write of her peril to her father. On finding the true standing of the "Smiths," Maida refuses to write the letter and is at once locked in a room. The band have also discovered the friendship which exists between Maida and Gilbert, and after a fierce struggle he is captured, tied and gagged, and placed in a cave.

A second message is sent to Waring, which is also received at a Naval Station, and in this manner the location of the island is disclosed. A submarine chaser, with Waring aboard, goes to the rescue.

In the meantime Maida escapes from the room and flies to the camp. She finds Gilbert gone, but his dog, frantic with delight at her arrival, leads her to the cave. She soon releases him and together they hasten to his motor boat to escape. They are overtaken by the band and are just about to be taken aboard the yacht when the Naval boat comes upon the scene. The swindlers are captured and Maida introduces Gilbert to her father as the man she loves.

"America, First, Last and Always," is the theme of Pathé's new serial, "Wolves of Kultur," abounding in many thrilling radio scenes, underground and cave laboratories, and radio controlled torpedoes. It is the story of Alice Grayson, a cultured young society lady of wealth and refinement, possest of an ardent patriotism which has been stimulated by the completion of the invention by her uncle of an electrically driven wireless controlled torpedo.

Visiting her uncle's laboratory one day Alice finds he has been foully murdered by alien spies, and the plans and model of his invention stolen. Over his dead body Alice vows vengeance for his murder and for this traitorous act to America. She has learned from her uncle before he dies that "Hartman and Zaremba are guilty of this."

Alice, in her rôle of a Secret Service Agent, has finally located the death-dealing torpedo and the operator awaiting orders.

Before she can interfere the torpedo has been launched and is sent on its deadly mission, against a U. S. troop ship, when Alice, in a most superhuman effort, throws a rock at the operator and knocks him out.

She seizes the wireless apparatus and turns the course of the torpedo against the yacht, aboard which are the plotters.



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Don't wait a single day before taking steps to rid yourself of the ailments or bad habits that will be millstones about your neck as long as you live, if you don't free yourself from them. When a man is on the limited for the scrap heap, every day counts; what is easy today will be a heap harder tomorrow, almost impossible if you wait too long.

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..Headache	..Constipation	..Poor Circulation
..Thinness	..Biliousness	..Skin Disorders
..Rupture	..Torpid Liver	..Despondency
..Lumbago	..Indigestion	..Round Shoulders
..Neuritis	..Nervousness	..Lung Troubles
..Neuralgia	..Poor Memory	..Increased Height
..Flat Chest	..Rheumatism	..Stoop Shoulders
..Deformity (describe)	..Youthful Errors	..Muscular Development

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AGE .....OCCUPATION .....

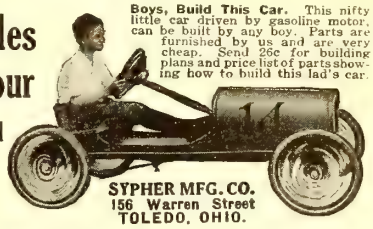
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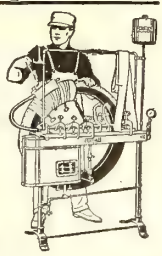
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Listening to Theater Critics

(*Continued from page* 105)

are usually well patronized, by "between the acts" smokers and thirsty box holders, then phonograph selections are played thru the loud-talking telephones in the horns, and the public generally is pleased—both those that like music and the others, who will enjoy it anyhow. But the psychological moment always arrives, and we have our turn after the show when the horns are "unsuspiciously silent," while the audience files out, homeward bound, chatting among one another about the show, and incidentally handing out several hundred dollars' worth of valuable criticism and suggestions, which any theater manager would almost break his neck to overhear. But even tho his office has a screen door, or if he happens to adorn the passageway with his own graceful and frock-tailed form, he hears but little of real value.

Now, all is changed, however, for, thanks to the dictograph installation, our friend the theater manager can appease his heretofore unsatiated thirst for a knowledge of "what his patrons actually think of the performance" by simply manipulating a switch at his desk, which causes the voices, no matter how low they may be, to be picked up by the respective microphones switched into circuit, and reproduce loudly and clearly thru the loud-talking telephone in his office. In the summer when naturally the office would not be closed up so tightly, the regular head phones, which resemble the telephone operator's headgear or that of the wireless operator, may be used with exactly the same results. The advantage of the loud-speaking telephone for reproducing the conversations is that everyone does not care to be inconvenienced by placing a telephone receiver band on the head, especially when we think of some of our old-time friends—the theater managers, that we have met here and there, who like to, and mostly do, resemble some of our Fifth Avenue millionaires with their sporty neck-ties, spats and a one dollar Perfecto sticking nonchalantly in the southeast corner of their jibs; and then again, who in his wildest theatrical moments can even imagine a "regular" honest-to-goodness theater manager appearing *without* his silk hat, once he has left his hotel. Well, for these poor souls we will suggest that they have available a first-rate secretary who can record the conversation, or better yet, hook up an Edison dictaphone (phonograph) to the horn of the loud-talker and record the various criticisms, so that they can be reproduced later and studied more closely at leisure.

We should imagine that such an arrangement as this will be very valuable indeed to the modern theater, where the movement toward establishing desirable plays, etc., is being brought to more nearly meet the exact wants of the theater-going public. In other words, the American theater manager has for a long time been seeking for every possible opening to gain a more perfect relation between the box office and the patron of the theater, and well this might be so, for if a performance is such that it does not suit the people at the time the play is produced, then there is no use expending additional sums in trying to foist the unwanted play on the theater-going public. Sometimes, however, in the past, and, in fact, it may be said in most cases, one of the chief reasons for the failure of a dramatic or other play, has been that the manager and producers could not quickly enough ascertain the exact feeling or obtain a comprehensive survey of the collective ideas of the audiences viewing the first performance of the play until it was too late.

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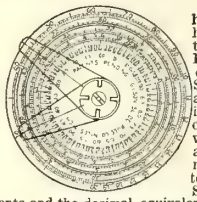
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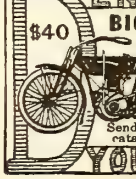
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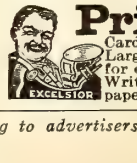
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Experimental Mechanics. Twist Drills

(*Continued from page* 127)

With this information on hand and a little practical experience on the subject, there should be no difficulty for the novice to become thoroly familiar with the handling of twist drills.

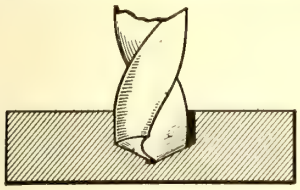


Fig. 4

If the Cutting Lips of the Twist Drill Are Ground of Uneven Length, the Hole Will Be Enlarged Over the Diameter of the Drill.

Average Cutting Speed for Drills In Revolutions Per Minute.

The following table represents the most approved practise in rate of cutting speed for drills ranging from $\frac{1}{16}$ inch to 2 inches in diameter:

Diameter of Drills	Speed on Steel	Speed on Cast Iron	Speed on Brass
1/16	1,712	2,383	3,544
1/8	855	1,191	1,772
3/16	571	794	1,181
1/4	397	565	855
5/16	318	452	684
3/8	265	377	570
7/16	227	323	489
1/2	183	267	412
9/16	163	238	367
5/8	147	214	330
11/16	133	194	300
3/4	112	168	265
13/16	103	155	244
7/8	96	144	227
15/16	89	134	212
1	76	115	191
1 1/16	72	106	180
1 1/8	68	102	170
1 3/16	64	97	161
1 1/4	58	89	150
1 5/16	55	84	143
1 3/8	53	81	136
1 7/16	50	77	130
1 1/2	46	74	122
1 9/16	44	71	117
1 5/8	40	66	113
1 11/16	38	63	109
1 3/4	37	61	105
1 13/16	36	59	101
1 7/8	33	55	98
1 15/16	32	53	95
2	31	51	92

(*The next article of "Experimental Mechanics" will appear in the July issue*)

FRANCE BUYS BIG U. S. BORDEAUX RADIO STATION

Virtual demobilization of all the United States naval establishments in European waters, the sale of the great Lafayette wireless station at Bordeaux to the French government at a price of approximately $4,000,000 and many hitherto unpublished facts of American naval activities in the war, were announced recently by Assistant Secretary Roosevelt.

"The great Lafayette radio station near Bordeaux was intended to insure communication between Washington and the army and navy in case the cable systems were put out of commission or interfered with by German submarines. It has eight towers and could communicate with the United States day and night. It was built by the navy. I arranged with the French government that we shall complete the station, which is two-thirds finished, and they will take it over at what it cost us, about 22,000,000 francs," said Mr. Roosevelt.



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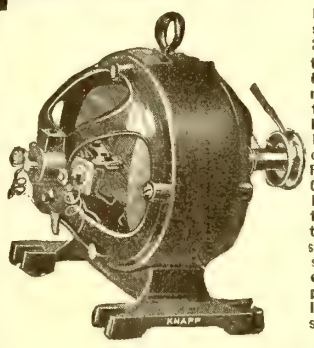
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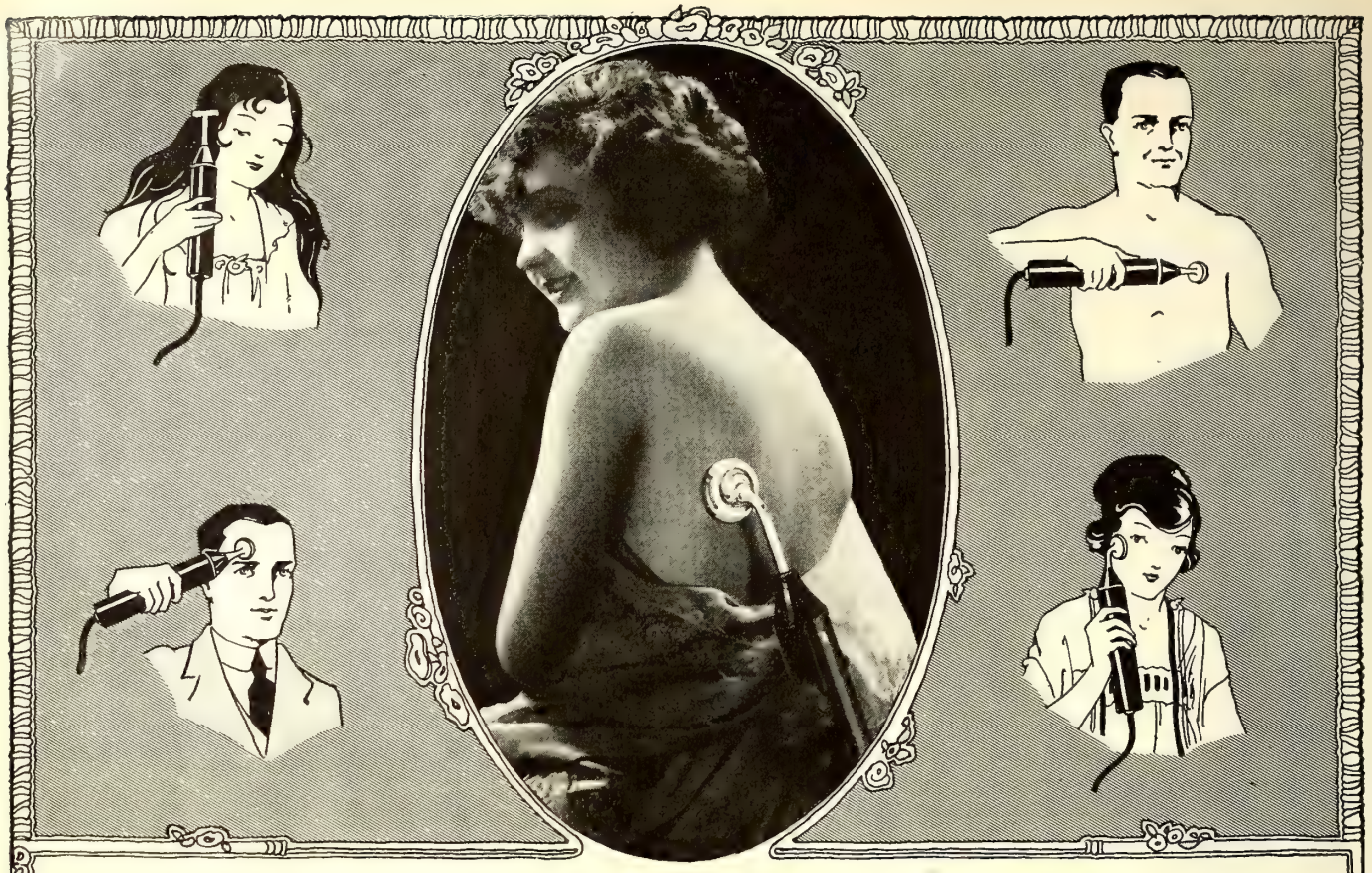
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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

How to Finance and Manufacture a Patent*

By Jay G. Hobson

This article is dedicated to the interest of inventors and people with commercial ideas who are inexperienced in the financing and marketing of commercial products. It tells of a practical plan that made one invention successful. It is written with the intention that it will benefit each reader financially, and will assist him in avoiding the many pitfalls encountered along the road to success.—THE AUTHOR.

MOST people think of inventors as geniuses parturient to some brilliant idea suddenly caught from the air and patent it in workable form. However, this is not the case, for as Thomas Alva Edison, the great inventor, declares: "Genius is one per cent inspiration and ninety-nine per cent perspiration," and "The three essentials to secure anything worth while are, first, hard work; second, stick-to-it-iveness; and, third, common sense."

Edison's inventions have been the result of many experiments, and exacting judgment. He has always sought to produce things that were necessities, which would benefit the masses; consequently, his wonderful success.

The first important step in financing and marketing an invention is, positive conviction that you have discovered something that is practical, not only from a manufacturing point of view, but also from the public's point of view—for it is the co-operation of the public (your eventual customers) that will insure your success. To secure the co-operation of the public, and to sell your invention, be positive you have something to offer that the public needs and demands. Then, after you have made your article commercially practical, prepare it for the market in a convenient form, that will offer the least resistance to the consummation of a sale.

Investors or people with capital (who want to assist you financially in marketing your product) observe your invention and are of the same frame of mind toward it as the public—your ultimate customers. Investors scrutinize the practicability of the commercial side, as well as the production or manufacturing side; however, they are generally more interested in the commercial side of an article, for there is the source of large profits.

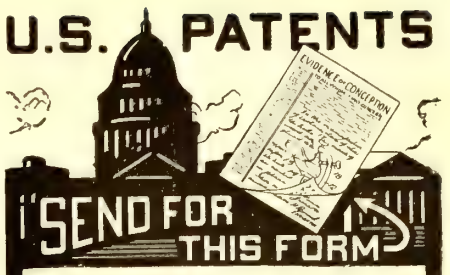
Obtaining financial backing for your invention is a serious undertaking. Investors demand facts, proof, conviction, before they will take the business venture necessary for the success of a new idea. Investors are the pessimists, so to speak, while inventors are the optimists. The inventors who succeed with their figments are greater optimists than men with money are pessimists. Conviction, confidence and enthusiasm will convert the most skeptical. Get the confidence of men with money and you will get their assistance.

Men who are successful say that the shortest route to commercial success is thru the example proven by those who have gone before. While modern business necessitates individual plans of operations, yet what one man or firm did to succeed others can duplicate. Therefore, the plan employed to finance and market one invention should help finance another. Experience proves that a patent is as valuable as the inventor or his associates make it—that completing a working model of an invention and securing the patent rights upon same are only the preliminary steps to success. The greatest obstacles lie ahead in the financing, manufacturing and marketing of a new article. It is the commercial wilderness that every new manufactured product must cross before reaching that summit of success desired by all.

It matters not how wonderful or unique an invention may be, it must be serviceably made, intelligently financed and greatly ad-

* **Owing to the publication this month of the promised article—"How to Finance and Manufacture a Patent" by Mr. Hobson, the Questions and Answers on Patent Advice are omitted.**

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vertised to make the inventor money. The public must be educated to the need of a new article before they will buy it. Few inventors appreciate these facts, and are of the opinion that all they need do is to conceive some new, useful improvement, patent it, and their fortune is made; but unfortunately this is not true. It is only the beginning of a difficult undertaking. An inventor should be as good a salesman as he is a mechanic. The public must be convinced before they will invest. The better the salesman, the greater the financial backing. Inventors should sell themselves the merits of their invention before attempting to sell others. With the backing of the convictions that you have a good thing—it will make the convincing of others an easy matter. Confidence and credit in the commercial world are more valuable than gold itself.

Only one who has gone thru a successful patent experience can adequately advise others how to succeed. For the benefit of my readers who may desire to finance a new proposition, I will enumerate the steps thru which I brought my first invention to success. It may help point the way for others.

After I had been granted full protection on my invention for a period of seventeen years, and had settled with my patent attorney for his services, it suddenly dawned upon my elated conscience that my patent certificate, with its big red seal, was not cashable like a Government bond; but, that it was only the foundation and beginning of a steep, rocky road to fame and fortune. I had spent most every cent for my patent rights and a demonstrating model of my invention. I had no money to promote the sale or manufacture of same, but I did possess an abundant confidence in its usefulness and ultimate success, if only I could secure financial backing to put it on the market before the buying public.

As it stood it was absolutely valueless to me. One of two things was necessary for its success. Either I must sell it to some one with money, or raise the capital to manufacture it myself. My friends urgently advised me to sell for any fair profit above my actual cost, saying: "It was better to accept a profit regardless of size than possibly fail in securing sufficient capital for marketing it."

Thru courtesy I listened to all this sincere advice, but was of the same opinion still—that my invention filled a long-felt public want. It was a necessity that could be made easily and profitably. I determined to stick to the first meritorious product of my brain and if possible raise the money that would enable me to place it for sale before the world. I knew that success only waited upon the introduction of my discovery to those for whom it was intended. But how best to accomplish this seemingly impossible task and overcome the colossal obstacles that were in evidence, forced me into quite a quandary.

However, remembering the old adage, "Where there is a will, there is a way," spurred me on to greater hopes for the success of my invention. I decided to tackle this proposition for all it was worth, and reap the benefits that were justly mine.

At that time I was a typical amateur in the mysteries of finances. I could not afford to make mistakes and knew few plans to pursue in obtaining the required finances for marketing my invention. Several plans came to my mind, such as borrowing the capital from relatives or friends, giving my patent as security for the loan; organizing a stock company and selling shares of stock to raise the money; or, advertise and sell part interest in my patent to some one, honest and reliable, who would agree to buy only a minority interest, thereby giving me control and protection against loss—for I was determined that I would not be frozen out by a partner.

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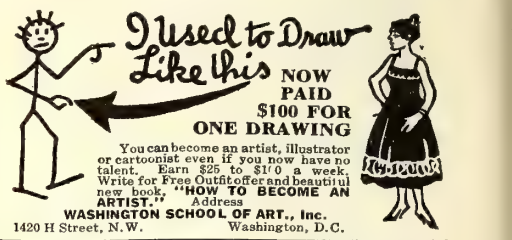
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The first plan had its precipitous faults. Relatives as a rule do not make good creditors and seldom appreciate their kin's abilities in business. The second plan meant immediate cash for incorporation of a company, as well as a long drawn out, expensive stock selling campaign, with capital possibly coming in by dribbles. The third plan appealed to me more favorably. I decided to put forth my best efforts toward this method of placing my invention on the market. How and where to find the investor with the cash who would be willing to invest under the above conditions proved to be my greatest problem. After considerable deliberation, after several demonstrations and interviews with business men whom I knew, I was convinced that the quickest and cheapest way to find *that* person with the idle cash and confident enough to take a legitimate business chance with me, was to advertise in some good newspaper or magazine, under "Business Chance." This I forthwith started and used the following advertisement:

"Wanted, a capable business man with capital to take substantial interest in patented meritorious invention. This is a public necessity that should make fortune for manufacturers. If qualified, address ———, etc."

The above advertisement cost about $1.00 per issue under classified position in a paper having a weekly circulation of upwards of five hundred thousand copies. The first replies were somewhat disappointing. But, believing I was headed right, I continued the advertisement for a few weeks, and one day I received an inquiry from a man who had ready cash, and sufficient optimism to back me up in my great ambition. For $2,000 cash I sold him forty-five per cent interest in my patent right (leaving me fifty-five per cent. or control). With this nest egg in the company's treasury we proceeded to gather all the information that we might need in the manufacturing and marketing of our invention.

First, we decided upon a firm name suitable to the article. Then we arranged with a machinery company to construct the machinery needed for quantity production. We called on the supply houses and secured their lowest prices on material for making our product. We arranged for the printing of circulars, letterheads, envelopes, bill heads, statements, etc., that would be needed for our office. From a bookkeeper friend we learned books required for our business and how to keep them correctly. We called on the wholesale and retail deal-

(*Continued on page* 181)

Hunting Submarines by Sound

(*Continued from page* 111)

"Ship ahoy!" came from the masthead.

"Where away?"

"Two points on the starboard bow, sir. Looks like she was heading this way."

The Ear Beats the Eye.

This vessel had been detected by sound waves traveling thru the water, her course and speed had been accurately charted *and her exact position* within one point of the compass had been determined *more than an hour before the vessel itself had become visible over the horizon.*

"It's almost perfect," said one of the naval engineers in an undertone. The tension under which they had worked for hours suddenly relaxed. The ship's crew gathered in groups to talk it over. There was not a dissenting opinion. The secret of detecting the presence of an unseen vessel had been solved!

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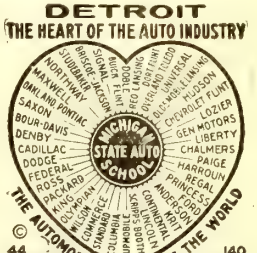
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The ships steered back to Nahant. A long-distance call was put in for the Navy Submarine Base at New London.

"Rush three submarine chasers to Nahant at once."

In due time they appeared. The party started out again, were joined by submarines from the Boston Navy Yard, and anchored off the Massachusetts coast line.

One submarine at a time submerged. The subchasers equipt with detectors followed her every movement, charted her position, reported to each other by special signal devices, and when everything was in readiness rushed to a spot just over the "sub." Dummy depth bombs were dropt. The submarine rose to the surface. *She had been within a few feet of her charted position.*

And now the apparatus was about to demonstrate its most valuable service. A series of practical tests proved beyond the possibility of a doubt that the detector could successfully differentiate between the sounds made by surface craft and the sub. The submarine's noises were distinctly peculiar to itself and the instrument translating this sound to the trained ear brought home the message just as you, when you pick up the long-distance telephone receiver, can identify the voice at the other end of the wire.

The Submarines On the Phonograph.

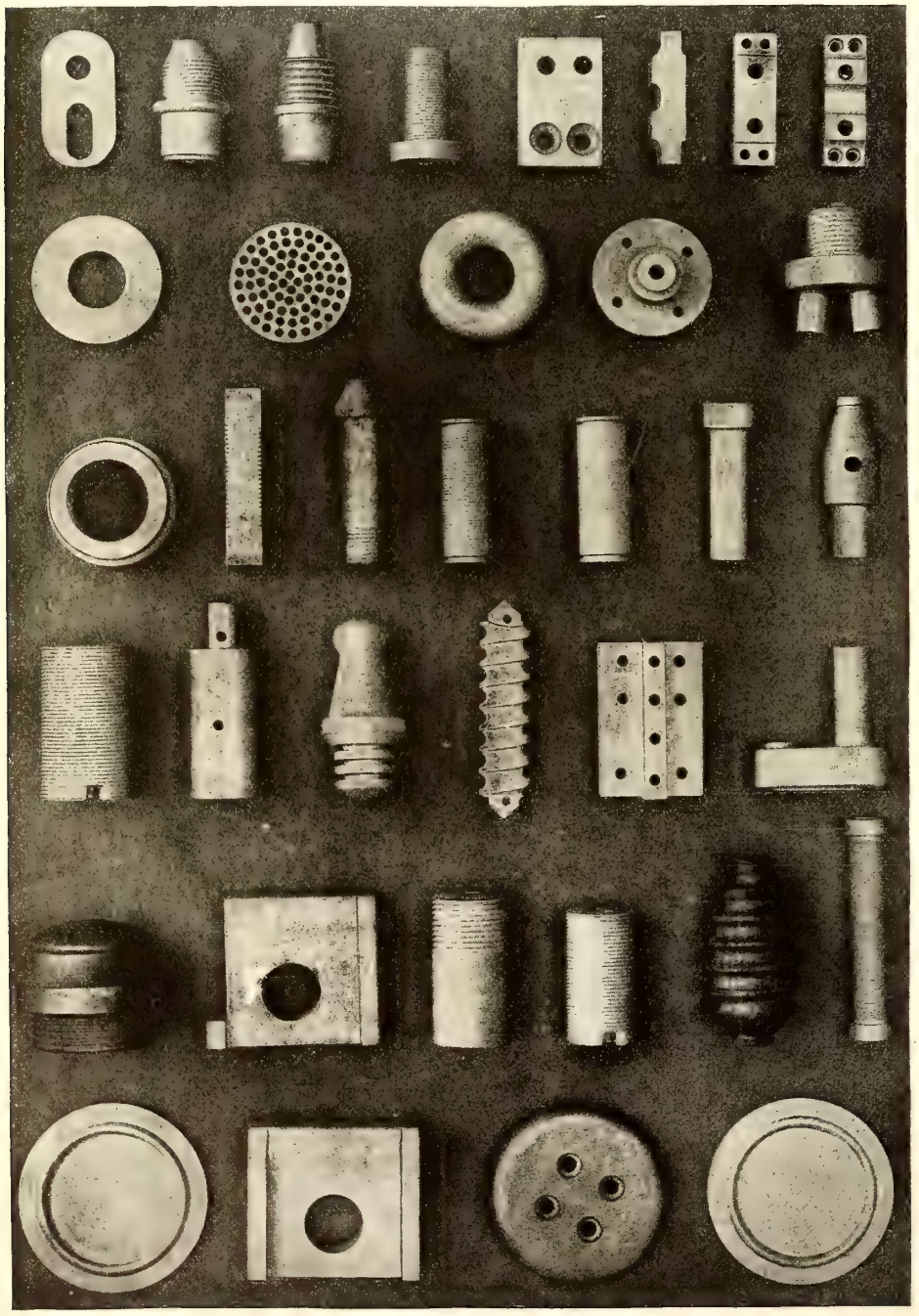
The Victor Talking Machine Company was now called upon for its contribution to the invention. *Phonograph records of the various sounds heard by the observer were made and catalogued,* thus presenting a complete record of the accomplishment of the device. The records were used principally in training students to identify the submarine noises and detect the difference between submarine and surface craft.

Further tests were made. Shore listening stations were set up. During the night trained men sat and listened to vessels going in and out of Boston harbor. The Navy attempted to slip a submarine thru the harbor entrance one night, but the craft was detected at once and a full report of her activities was sent to headquarters a few hours later. Not a ship could enter or leave Boston without being heard. In fact, so sensitive was the instrument that *trained listeners could accurately identify a ship by name,* once having heard her, the engine characteristics of different ships being plainly audible and distinctive.

It was estimated that in December, 1917, *two to five enemy submarines past thru the English Channel daily.* After July 1, 1918, only *one* submarine is known to have done so. In June the Admiralty estimated that *one out of every four submarines was destroyed.* In October the ratio had been increased to five out of every twelve. By this summer British and American naval officers believe three out of every four submarines would have been destroyed. These results were largely due to the perfection of "listening devices."

Hundreds of British craft and most of the American forces were now equipt with the submarine detector. Many French and Italian vessels were also using it. The "submarine hunt" was on in earnest.

About May, 1918, the American ships



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began to go across with all these devices installed.

Hearing Subs 25 Miles.

Here are some of the outstanding features of the American submarine sound detector:

Under ideal conditions with extraneous noises reduced to a minimum or entirely eliminated *the device was effective at a range of from fifteen to twenty-five miles.*

Trained operators could clearly and invariably distinguish between the sounds made by approaching surface craft and under-water vessels (submarines).

Under average circumstances, the device was good for a range of between *three and eight miles.*

Within five miles the engine characteristics of different vessels was clearly marked even to the point of *identifying by name* certain (unseen) vessels after they had been observed previously for more than one time. (This test was substantiated by a series of night-time experiments at the entrance to Boston harbor in September and October, 1917.)

It was found practical to tell when a submarine changed from her oil engines to electrical drive, which was necessary every time she submerged.

The direction of sound could usually be computed within a very few degrees of its actual location and a good judgment of the distance could generally be made. This was proved to the satisfaction of all concerned following a number of practical tests off Cape Cod, Mass., in the late summer of 1917, in waters adjacent to Boston and in Long Island Sound.

The addition of these listening devices to submarines added the heretofore lacking *sense of hearing* to all the underwater craft and made them at once a much more effective weapon of offense.

An allied submarine on one occasion chased a German U-boat for four hours, while both craft were submerged, without once losing sound contact with the enemy.

The graphic chart publisht herewith will indicate to the reader the ability of submarine chasers to maintain "sound contact" with the enemy and the efficiency of the direction qualities of the device when used in this manner.

The actual battle engagement which it illustrates occurred one early morning in the English Channel. A small squadron of sub-chasers discovered an enemy craft moving slowly up the channel submerged. Forming for the attack they rushed over the spot where their listeners indicated the U-boat to be, dropt a pattern of depth bombs and then withdrew to take observations.

Feverish activity and the sound of hammers ringing against the ship's side was heard. The submarine engines would then start up and stop, start and stop again.

25 Germans Commit Suicide.

Further attacks were delivered and more noise came to the listeners from the hold of the submarine. Evidently the first depth charge had taken good effect and the enemy's crew was making a last desperate effort to reach the surface. Suddenly there was dead silence—then 25 revolver shots rang out—3 followed by 22. *The crew giving up in despair, had committed suicide.* The loss of this submarine was later substantiated by the British Intelligence Department.

When Capt. Leigh and his party went abroad in November, 1917, he requested the Admiralty to loan him two high-speed chasers in which operations could be begun in English waters, but was finally obliged to accept 3 trawlers of 9 to 10 knots speed, because of the then scarcity of higher speed craft.

Equipping these vessels with all of the anti-submarine detecting apparatus they went out in the English Channel on New Year's Day, 1918. Shortly afterwards a wireless message was picked up from an airship giving the position of a submarine which had just been seen to submerge. The channel had been laid out in numbered squares to facilitate the immediate location of enemy craft and the little squadron steamed over, got their devices out and picked up the submarine course.

When believing themselves about over the enemy, depth bombs were discharged and later a trawling instrument was used, **which indicated that the submarine had been destroyed.** Great quantities of oil rising to the surface also substantiated the success of the attack.

Remaining in English and French waters for several months, where the American devices proved of great value and were highly complimented both by Admiral Sims and British naval officers, another squadron was equipt and sent into the Mediterranean and Adriatic, where at this time submarine activity was at its height.

Because of the deeper water and less interference from surface traffic, listening conditions were unusually good. A "barrage" line of boats was organized across Otranto Straits, between the mainland and the Island of Corfu, to effectively put a stop to the enemy's free entrance to the Mediterranean.

Three of the chasers patrolling in formation abreast one dark night heard a "sub" approaching. The bearings obtained by the two beam vessels pointed directly toward the center boat. The middle boat now heard the submarine approaching from a position dead astern. The enemy came nearer and nearer and finally past right under the sub-chaser so close to the surface that those on board felt a wave of water along the keel of their ship.

When the German had past on and out in front the attack was made in unison, a *pattern** of depth bombs was "let go" and the little fleet halted for further observations. Pretty soon the whirl of the submarine's electric motors was heard—evidently in an effort to reach the surface.

The Germans "Cash In."

Then came a crunching noise not unlike the popping in of a blown-up paper bag. It was apparent that the submarine had been damaged—put out of control—and sunk, and that she had collapsed from the tremendous water pressure at these depths.

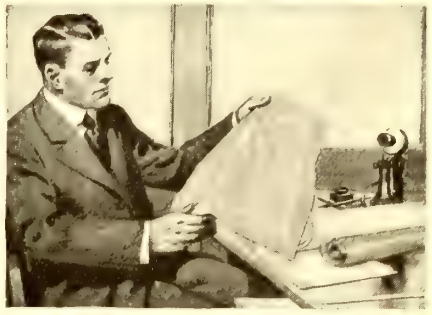
Many incidents of this kind occurred during the subsequent operations in foreign waters and several submarines were accounted for thru the direct aid of the American listening devices.

In fact, naval experts who were closely in touch with submarine detection development during the war period state with conviction that if the conflict had continued thru another summer the submarine would literally have been driven from the ocean, the promise of a condition due in a large measure to the perfection of submarine detecting apparatus.

It has also been stated that the noticeable change in naval tactics—from defensive to offensive—which marked this country's entrance into the war was largely caused by the application of American principles to the pursuit and attack of the U-boat, something made possible by the practical use to which it was found the American submarine detector could be put.

* A pattern of depth bombs refers to the plan of dropping them simultaneously in certain prearranged figures, such as squares, circles, etc. The chart herewith shows the pattern scheme quite clearly—notice the black dots at points marked "attack."

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By the addition of a loud talking telephone he is able to hear the messages many feet away from the instrument. He is also able to demonstrate the operation of his wireless apparatus to his friends.

The super-sensitive DETECTAGRAPH-TRANSMITTER herewith shown is two and three-eighths inches in diameter, five-eighths of an inch thick and weighs less than three ounces. It is the most sensitive sound detecting device ever brought before the public.

The manner in which the amplifying process is attained is by attaching with tape the DETECTAGRAPH - TRANSMITTER to the regular wireless receiver as indicated in the diagram.

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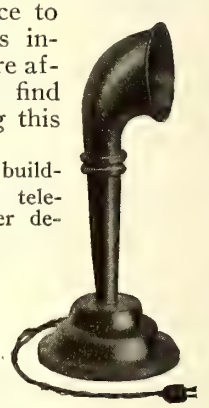


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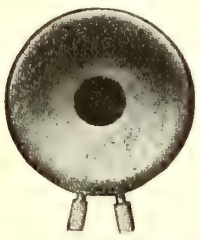
Other Uses

Not only is this instrument applicable for amplifying radio signals, but it can be used with equal satisfaction for magnifying other sounds. Phonograph music can be transmitted from one place to another by means of this instrument, and those who are afflicted with deafness will find enormous benefit by using this transmitter.

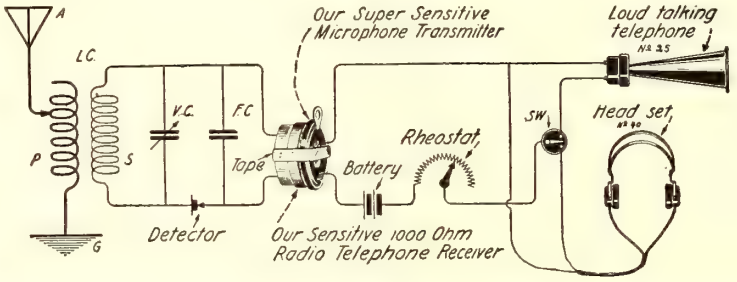
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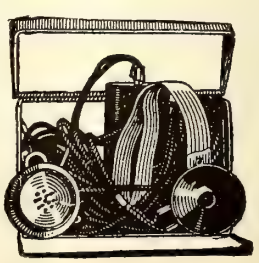
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Alexanderson's "Barrage" Receiver

(*Continued from page* 135)

ing which has become so familiar, but also the original meaning of toll or stoppage prevention. Thus the barrage receiver may be used not only in time of war to counteract the offensive barrage of an enemy radio station, but it may be used to multiply the number of peaceful communications that may be carried on simultaneously without disturbing each other.

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NEUTRALIZED RECEIVING ANTENNA MOUNTED ON THE SAME MAST AS THE SENDING ANTENNA

If two sets of wires are mounted on the same masts, the radiation from one set to the other is obviously so strong that the overpowering of an ordinary receiving set by the transmitted energy would be almost of the same order of magnitude as if the identical wires were used. The quantitative relations may be better appreciated by mentioning specific figures. In the tests made in Schenectady, the receiving antenna consists of five wires mounted as an umbrella

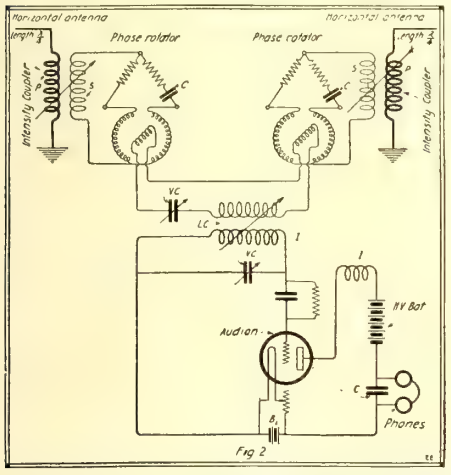


Fig. 2. Duplex Antenna Used with Phase Rotator Units and Regular Receiving Instruments in Alexanderson "Barrage" Receiving Set.

around the main mast, while the sending antenna consists of two wires extending from this mast to another building. The capacity to ground of the sending antenna is 0.003 microfarad, the receiving antenna 0.0011 microfarad, and the mutual capacity such that 10,000 volts on the sending antenna produces 500 volts on the receiving antenna when it is disconnected. While it is obvious that an antenna oscillating with 500 volts continuous waves could not be used with ordinary methods of reception, the system for neutralization which will be described has proven so effective that an ordinary receiving set can be used for receiving signals from such distances as the Pacific coast (2,500 miles or 4,000 km.) without any appreciable interference from continuous wave radiation from the main antenna of 20 amperes and 10,000 volts!

Two methods of neutralization have been used: *inductive* neutralization and *static* (*capacitive*) neutralization. While both methods have been used successfully, the capacitive neutralization is much preferable both on account of accuracy of adjustment and simplicity. A diagram of inductive neutralization is shown at Figure 1. The transformer *T* is used to create a potential of opposite phase to the potential of the sending antenna. The negative potential thus created is transferred to the receiving antenna thru the exposure condenser *E*. The negative potential thus imprest upon the receiving antenna thru the transformer and the exposure condenser is adjusted so as to counterbalance exactly the direct exposure from antenna to antenna, thus leaving the receiving antenna at ground potential. The phase relation of the transformer is, however, not exactly 180°, and a residual potential is left on the receiving antenna which is sufficient in most cases to interfere with reception unless further precautions are taken. If, however, a frequency trap *F* is introduced the neutralization becomes good enough so that an ordinary receiving set can be used.

The arrangement shown in Figure 1 was used to demonstrate duplex radio telephone conversation between Pittsfield and Schenectady (50 miles or 80 km.)

The "Barrage" Radio Receiver.

The barrage receiver is fundamentally a *uni-directional receiver*. The principle of uni-directional reception was first developed by Bellini and Tosi. While the uni-directional Bellini-Tosi receiver has been used as a direction finder, it has, to the knowledge of the author, not been used to any extent for reception of long distance signals. The Bellini-Tosi receiver is based on the principle of receiving the signal thru two antennas of different characteristics and neutralizes the signals received from one direction by a system of balancing.

The uni-directional Bellini-Tosi receiver works on the principle that the *electromagnetic* and *electrostatic* exposures are 90° out of phase. The *barrage receiver* takes advantage of the geographic phase *displacement* in the wave as it travels over the surface of the earth. In the first barrage receivers which have been installed the antennas consist of two insulated wires laid on the ground a distance of two miles (3.2 km.) in each direction from the receiving station. It was originally intended by the author to mount the wires on poles, but the easier procedure of laying the wires on the ground was adopted at the suggestion of Lieutenant-Commander A. Hoyt Taylor, and the arrangement has proven entirely satisfactory. The barrage receiving set, photograph of which is shown herewith, consists of a standard receiving set, combined with a *phase rotator* set. When used as a barrage receiver, a condenser is used in place of the antenna and the standard receiving set is coupled to the aperiodic antenna by the phase rotator set. The diagram of the phase rotator set is shown at Fig. 2. Each antenna is connected to ground thru an intensity coupler, the secondaries of the intensity couplers are connected to the primary of the phase rotators. Each phase rotator is built on the principle of a split phase induction motor or induction regulator. A single phase current introduced in the primary is split into a quarter-phase current which produces the equivalent of a rotating magnetic field inductively related to the secondary. By adjusting the position of the secondary coil the electromotive force induced in it may be made to assume any desired phase relation to the primary voltage. The receiving set proper when used with the barrage receiver has all the normal characteristics of a standard receiving set. A signal originating in any direction whatever may be neutralized by adjustment of the intensity couplers and phase rotators. This adjustment is very easy to perform, even by an inexperienced operator, and is perfectly stable after it has been made.

An experimental barrage receiving set was operated for several months of the

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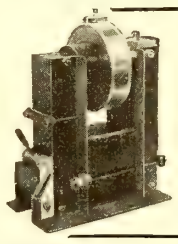
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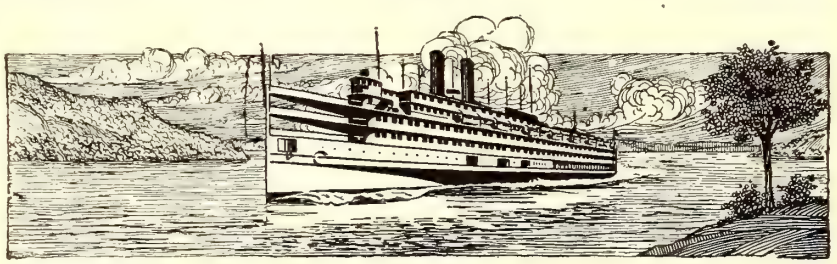
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summer and fall of 1918, about three miles from the New Brunswick, N. J., radio station. Records were kept on the reception of European stations during the operation of the New Brunswick station. As the New Brunswick wave is 13,600 meters and the Carnarvon, Wales, wave is 14,200 meters, the reception of Carnarvon was the hardest test to which the set could be put. It was found that in spite of the overwhelming intensity of the New Brunswick signals on an unbalanced receiver, the barrage receiver could be adjusted so that the transmitted wave not only did not interfere with the Carnarvon signals, but the New Brunswick signals could be made entirely inaudible. During these tests it was found that the directive characteristics of the barrage receiver was a material help in reduction of interference by static and strays, as it was found very frequently that solid copy could be obtained by proper directive adjustment, while the signals were practically unreadable with ordinary methods.

The improvement of reception of signals by the use of the barrage receiver depends upon the highly directive qualities of this receiving system. For comparison with other methods of directive reception, a tabulation of directiveness is given in Fig. 3. In this comparison the symmetrical elevated antenna which receives equally from all directions is designated at 100 per cent. The percentages of directivity are calculated from the areas of the corresponding horizontal plane intensity diagrams here shown. If the directivity represented by the intensity diagrams can be taken as relative measure of the average stray-to-signal ratio, we find that the magnetic loop should have 50 per cent. as much strays as the elevated antenna, the differential horizontal antenna (Sayville, Long Island), probably about the same as the magnetic loop, and the barrage receiver 22 per cent. Statistics of reception indicate that these figures are reasonably in agreement with facts, when the strays are evenly distributed. When the strays are directive the improvement is much greater.

A rather surprising characteristic was discovered by the use of the barrage receiver. It was expected that this receiver could be used to neutralize signals from all directions except the direction close to the signal to be received. As a matter of fact it was found that interference could be neutralized by originating in the same direction as the signal. This was first discovered in the New Brunswick installation. Signals from San Diego, Cal., right in line with the transmitting station, could be received without great reduction in intensity, while the set was adjusted so as to neutralize the transmitting station. The explanation for this is the fact that in the case of the nearby station the wave front is curved and the radiation diverging, whereas in the case of the far-away station the radiation is parallel. The receiving antenna covers a space of four miles (6.4 km.), and in this space there is sufficient divergence of the radiation from the nearby station so that an adjustment can be made whereby the diverging and parallel radiation have different effect upon the receiving set. The phenomenon is comparable to the focusing of a field glass on nearby and distant objects. In this case we have a radio field glass of four miles (6.4 km.) in diameter; and, for such dimensions, the focusing effect is sufficient, even at considerable distances, to produce an effective discrimination.

While the barrage receiver was worked out primarily to avoid interference in transoceanic communication, it may be found useful also for the purposes for which the bridge receiver was developed—that is, simultaneous sending and receiving from small shore stations or ship stations. In such cases it has the advantage over the bridge receiver that it can be used not only to neutralize the transmitting station to which it belongs, but can neutralize interference from any other ship or shore station.

My Inventions

By Nikola Tesla

(*Continued from page* 148)

showered upon me, and journeyed to my home where I passed through a most painful ordeal and illness. Upon regaining my health I began to formulate plans for the resumption of work in America. Up to that time I never realized that I possessed any particular gift of discovery but Lord Rayleigh, whom I always considered as an ideal man of science, had said so and if that was the case I felt that I should concentrate on some big idea.

Nature's Trigger.

One day, as I was roaming in the mountains, I sought shelter from an approaching storm. The sky became overhung with heavy clouds but somehow the rain was delayed until, all of a sudden, there was a lightning flash and a few moments after a deluge. This observation set me thinking. It was manifest that the two phenomena were closely related, as cause and effect, and a little reflection led me to the conclusion that the electrical energy involved in the precipitation of the water was inconsiderable, the function of lightning being much like that of a sensitive trigger. Here was a stupendous possibility of achievement. If we could produce electric effects of the required quality, this whole planet and the conditions of existence on it could be transformed. The sun raises the water of the oceans and winds drive it to distant regions where it remains in a state of most delicate balance. If it were in our power to upset it when and wherever desired, this mighty life-sustaining stream could be at will controlled. We could irrigate arid deserts, create lakes and rivers and provide motive power in unlimited amounts. This would be the most efficient way of harnessing the sun to the uses of man. The consummation depended on our ability to develop electric forces of the order of those in nature. It seemed a hopeless undertaking, but I made up my mind to try it and immediately on my return to the United States, in the summer of 1892, work was begun which was to me all the more attractive, because a means of the same kind was necessary for the successful transmission of energy without wires.

Four Million Volts.

The first gratifying result was obtained in the spring of the succeeding year when I reached tensions of about 1,000,000 volts with my conical coil. That was not much in the light of the present art, but it was then considered a feat. Steady progress was made until the destruction of my laboratory by fire in 1895, as may be judged from an article by T. C. Martin which appeared in the April number of the *Century Magazine*. This calamity set me back in many ways and most of that year had to be devoted to planning and reconstruction. However, as soon as circumstances permitted, I returned to the task. Although I knew that higher electro-motive forces were attainable with apparatus of larger dimensions, I had an instinctive perception that the object could be accomplished by the proper design of a comparatively small and compact transformer. In carrying on tests with a *secondary in the form of a flat spiral*, as illustrated in my patents, the absence of streamers surprised me, and it was not long before I discovered that this was due to the position of the turns and their mutual action. Profiting from this observation I resorted to the use of a high tension conductor with turns of considerable diameter sufficiently separated to keep down the distributed capacity, while at the

(*Continued on page* 176)



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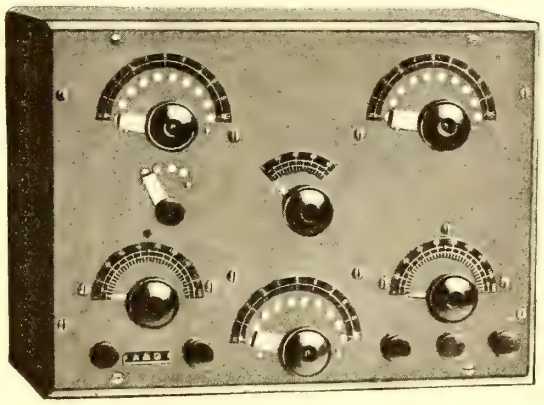
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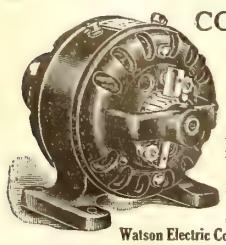
WIRELESS operators are in demand owing to the expansion of our Merchant Marine. Pay has increased to $110 per month plus all expenses.

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for our line of
Electric Farm Lighting Plants
Good money-making proposition, liberal commission. $300 required. Write for terms.
We also sell **Garage Equipment, Storage Batteries, Battery Charging Generators, Motors, Tungar Rectifiers,** etc. Catalog free.
Watson Electric Co. Dept. 16, 122 Michigan Av. Chicago

Amateur Radio Restored

(*Continued from page* 131)

plaything only or just a mere hobby.

The ELECTRICAL EXPERIMENTER thru the RADIO LEAGUE OF AMERICA shall be only too glad to publish letters from amateurs suggesting new ways and means to benefit the cause of Radio Amateurism, our columns being open to all worthy suggestions.

While for the present there is nothing to be feared of adverse legislation, still it is impossible to forecast that such legislation will not be attempted in the future. We have won the freedom of the ether due to the splendid coöperation of Radio Amateurs in this country, and if we have won once we will win again.

The RADIO LEAGUE OF AMERICA is a clearing house for all Radio Amateurs in the United States, and today has more members than any other league, but it has not enough members. It wishes to have every amateur as an enrolled member. The membership of the Radio League, established in 1915, is gratuitous. There are no dues or fees to be paid. All the League wants is the name of every amateur and his address, so that first of all, if a national emergency arises, the Government can rely on the amateurs for quick communication. Also in case adverse legislation should be attempted, the League wishes to notify every member immediately, as it did last December when the freedom of the ether was threatened.

We ask every amateur who is not a member of the League to sign the blank appended herewith. It costs nothing but a 3-cent stamp to do so. Every enrolled amateur is entitled to the membership certificate free of charge which is mailed to all members. The membership of the Radio League of America now comprises 21,309 members. If you are not a member at the present time, you should enroll at once by all means.

LONG LIVE THE RADIO AMATEUR!

Application for Membership in the Radio League of America

I, THE UNDERSIGNED, a Radio Amateur, am the owner of a Wireless Station. My station has been in use since....., and I herewith desire to apply for membership in the RADIO LEAGUE OF AMERICA. I understand that the Radio League of America is a National Scientific Organization for the pursuit of the Radio Arts. I will not be called upon to pay membership fees, or dues, and once enrolled I am to share in all the privileges of a regular member.

Upon receipt of this form properly filled out you are to send me your eight-page booklet describing the purpose of the League, rules, etc.

Name.....

City.....

State.....

Date.....191

Mail this blank to Radio League of America, 231 Fulton St., New York City.
6-19

A NEW TYPE OF TRANSFORMER

(*Continued from page* 139)

(Nos. 20 to 30 gage), and is twelve inches long. The exact diameter cannot be given, but it must be slightly smaller than the inside diameter of the secondaries, usually from one to one and one-half inches.

The primary can consist of three pounds No. 16 D. C. C., which when connected in series with an adjustable reactance or rheostat, will give a power range of approximately two to six amperes.

The core is wound with two or three layers of Empire cloth, and then the primary wire is wound on. Between the primary and each secondary should be placed a hard rubber disc about an inch wider than the secondaries, and then the secondaries, covered with Empire cloth, are slipt in place. If a hard rubber disc is not available, three or four layers of the Empire cloth may be used. Great care must be taken with the insulation on account of the peculiar construction, and it is especially necessary that the insulation along the core, between primary and secondaries, be well taken care of. Connections for the secondaries are shown in the diagram (2).

When properly constructed, a thick spark, the length depending on the secondaries used, will be obtained. The transformer has proved especially good in use with a rotary gap.

A transformer constructed along similar lines, using two secondaries from a three-inch spark coil, has been giving me excellent service, and I hope other amateurs will have a similar experience.

Contributed by WM. HOLLADAY.

GERMANS' WIRELESS CODE

Dr. J. A. Fleming, in a lecture on "Electric Wave Telegraphy" at the British Royal Institution, revealed the fact that the Germans had, during the war, conveyed much important information from Tuckerton radio station in America by a code which was dependent on a certain method of "spacing," being otherwise harmless.

"I Would Not Part with it for $10,000"

So writes an enthusiastic, grateful customer. In like manner testify over 100,000 people who have worn it. Conserve your body and life *first.*

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Overcomes **WEAKNESS** and **ORGANIC AILMENTS** of **WOMEN AND MEN.** Develops erect, graceful figure.

Brings restful relief, comfort, ability to do things, health and strength.

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Does away with the strain and pain of standing and walking; replaces and supports misplaced internal organs; reduces enlarged abdomen; straightens and strengthens the back; corrects stooping shoulders; develops lungs, chest and bust; relieves backache, curvatures, nervousness, ruptures, constipation. Comfortable and easy to wear.

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Learn WIRELESS —NOW—

Enter This New Field of Greatest Opportunity



NOW that peace is here wireless offers the greatest opportunity of the day to the young men of America. The experimental stage has passed. Wireless now equals in importance telegraphy and telephony, and if the present commercial wireless program is carried out, it may supplant them by the end of 1919. It has earned its place among the great commercial industries of the earth. So great has been the development and growth of Wireless in recent years that there is now a tremendous shortage of operators.

Peace Increases Demand For Wireless Operators

Actually thousands upon thousands of Wireless Operators, Inspectors, Mechanics, Electricians, and Radio Draftsmen will be needed for permanent "peace time" wireless positions at bigger salaries than have ever before been paid.

Peace means a bigger demand for men in every branch of wireless and is opening up new fields of Commercial Wireless activity which will fairly revolutionize present methods of communication.

No Previous Experience Necessary

You Can Learn Wireless In Ten Weeks In Your Own Home, through our practical home study wireless course. No previous experience or training is necessary in order to become a Successful Wireless Expert With our help you can quickly qualify for a good position at big pay. Many of our students have secured positions before completing the course. You will make rapid progress from the start because our course is based on actual practice and teaches you what you will need to know to make a big success of Wireless work.

Get Your Instructions From the Nation's Capital

(Our Course is endorsed by U. S. Government Officials.)

The National Radio Institute headed by authorities who have been closely allied with government training of students, was established in 1914 and is the first school in America to successfully teach Wireless by Mail. The work is under the direction of J. E. Smith, E. E., director of the Radio Department, Howard University, and E. R. Haas, formerly of the Radio Division of Yale University.

We now have students throughout the world. Our location in the Nation's Capital together with the standing of our officers and their wide acquaintance among government officials, connected with Wireless activities, place us in position to give our students the best instruction obtainable and to be of the utmost help in assisting them to secure good paying positions.

Travel and See the World

If you want to travel and see the world—go to foreign countries, and increase your knowledge of world affairs, Wireless offers you the chance of a lifetime. However, you are not obliged to travel, but may secure a permanent position at one of the big Land Stations, Railroad, Telegraph, or Steamship companies, if preferred.

Pay as You Go Along With Your Lessons

Our plans of payment bring a wireless education within the reach of anyone who desires to learn. A small payment down on our convenient payment plan, and small following payments, enables you to earn the cost of your tuition while actually learning to be a wireless operator.

Earn up to $250.00 per Month

In the short period of ten weeks we can make of you a wireless operator, a man with a profession, independent, and not subject to the rise and fall of wages in the labor market. Salaries are as high as $250.00 per month. We give you this training at home, by mail, in your spare time. It is not necessary for you to lose any time from your work to take the course. Then when you have received your diploma from us, we help you find a good position.

FREE INSTRUMENTS TO EVERY STUDENT

In addition to text books, lessons and personal instruction, we send you, while taking our course, a Home Practice Set consisting of a standard sending key and buzzer, and a Universal automatic wireless transmitting and receiving set. These instruments are free to every student. No other school can offer you what we do.

Announcement - - Opening of Norfolk School

The demand for our Course has grown to such an extent that we are now preparing to open a school in Norfolk, Va., which will be under the management of Mr. A. H. Van Nostand, Radio Inspector of the Third Radio District.

FREE Our booklet, "WIRELESS, the Opportunity of Today", gives you complete information in regard to our course, the quick and easy methods by which you can master wireless and other important facts you should know. It is free. Just mail the coupon. No obligation whatever on your part.

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Department 74, Washington, D. C.

Send me, free of charge, your booklet, "Wireless, the Opportunity of Today," with full particulars regarding your famous 10 weeks Home Study Course, and your Special Free Instrument Offer.

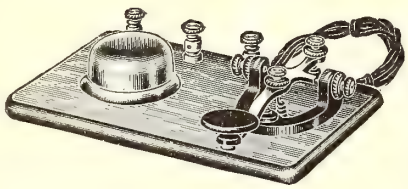
Name .....

Address .....

Town .....

Wireless Receiving Ban Raised

MESCO WIRELESS PRACTICE SET



The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

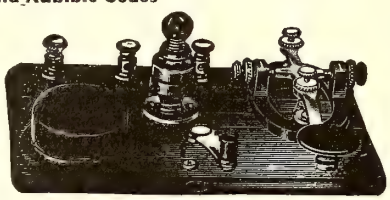
The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

List No.		Price
342	Telegraph Practice Set, with Battery and Cord	$3.24

Weighs 4 lbs. packed.
Price does not include postage.

MESCO **Combination Practice Set for Learning the Morse and Continental Visual and Aubible Codes**

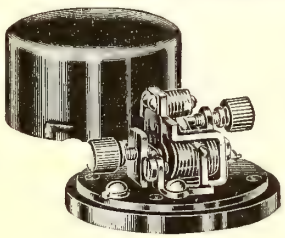
This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.



List No. 52—Practice Set with Red Seal Battery and Cord $4.05

Weighs 4 lbs. packed. Price does not include postage.

MESCO RADIO BUZZER



This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

It consists of practically a closed circuit field of low reluctance, having a steel armature to which is riveted a strap supporting a movable contact. The armature tension is adjustable by means of a screw with a milled head large enough to be easily and permanently adjusted with the fingers. The stationary contact is adjusted by means of a similar screw. The magnet coils are connected in series with a total D. C. resistance of 3.9 ohms. Shunted across these coils is a resistance having a D. C. value of 3 ohms. This shunt eliminates all sparking such as occurs at the break on ordinary radio buzzers and the energy saved thereby is transferred into any oscillating circuit connected to it, the result being that this buzzer as constructed radiates five times more energy than any other existing type. All connecting wires liable to be broken are eliminated. Contacts are of genuine platinum, which is essential in order to maintain a constant note. The parts are mounted on a Condensate base to insure constancy in operation.

Diameter 2 in., height 1¼ in. The cap is attached to the base by a bayonet joint.

List No.		Price
55	Mesco Radio Buzzer	$2.05

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My Inventions

By Nikola Tesla

(*Continued from page* 173)

same time preventing undue accumulation of the charge at any point. The application of this principle enabled me to produce pressures of 4,000,000 volts, which was about the limit obtainable in my new laboratory at Houston Street, as the discharges extended through a distance of 16 feet. A photograph of this transmitter was published in the *Electrical Review* of November, 1898. In order to advance further along this line I had to go into the open, and in the spring of 1899, having completed preparations for the erection of a wireless plant, I went to Colorado where I remained for more than one year. Here I introduced other improvements and refinements which made it possible to generate currents of any tension that may be desired. Those who are interested will find some information in regard to the experiments I conducted there in my article, "The Problem of Increasing Human Energy" in the *Century Magazine* of June, 1900, to which I have referred on a previous occasion.

The Magnifying Transmitter.

I have been asked by the ELECTRICAL EXPERIMENTER to be quite explicit on this subject so that my young friends among the readers of the magazine will clearly understand the construction and operation of my "Magnifying Transmitter" and the purposes for which it is intended. Well, then, in the first place, it is a *resonant transformer* with a secondary in which the parts, charged to a high potential, are of considerable area and arranged in space along ideal enveloping surfaces of very large radii of curvature, and at proper distances from one another thereby insuring a *small electric surface density everywhere* so that *no leak can occur even if the conductor is bare.* It is suitable for any frequency, from a few to many thousands of cycles per second, and can be used in the production of currents of tremendous volume and moderate pressure, or of smaller amperage and immense electro-motive force. The maximum electric *tension is merely dependent on the curvature of the surfaces* on which the charged elements are situated and the area of the latter.

100 Million Volts Possible.

Judging from my past experience, as much as 100,000,000 volts are perfectly practicable. On the other hand currents of many thousands of amperes may be obtained in the antenna. A plant of but very moderate dimensions is required for such performances. Theoretically, a terminal of less than 90 feet in diameter is sufficient to develop an electro-motive force of that magnitude while for antenna currents of from 2,000-4,000 amperes at the usual frequencies it need not be larger than 30 feet in diameter.

In a more restricted meaning this wireless transmitter is one in which the Hertz-wave radiation is an entirely negligible quantity as compared with the whole energy, under which condition the damping factor is extremely small and an enormous charge is stored in the elevated capacity. Such a circuit may then be excited with impulses of any kind, even of low frequency and it will yield sinusoidal and continuous oscillations like those of an alternator.

Taken in the narrowest significance of the term, however, it is a resonant transformer which, besides possessing these qualities, is accurately proportioned to fit the globe and its electrical constants and properties, by virtue of which design it becomes highly efficient and effective in the

wireless transmission of energy. Distance is then absolutely eliminated, there being *no diminution in the intensity of the transmitted impulses.* It is even possible to make the actions *increase with the distance from the plant* according to an exact mathematical law.

This invention was one of a number comprised in my "World-System" of wireless transmission which I undertook to commercialize on my return to New York in 1900. As to the immediate purposes of my enterprise, they were clearly outlined in a technical statement of that period from which I quote:

"The 'World-System' has resulted from a combination of several original discoveries made by the inventor in the course of long continued research and experimentation. It makes possible not only the instantaneous and precise wireless transmission of any kind of signals, messages or characters, to all parts of the world, but also the inter-connection of the existing telegraph, telephone, and other signal stations without any change in their present equipment. By its means, for instance, a telephone subscriber here may call up and talk to any other subscriber on the Globe. An inexpensive receiver, not bigger than a watch, will enable him to listen anywhere, on land or sea, to a speech delivered or music played in some other place, however distant. These examples are cited merely to give an idea of the possibilities of this great scientific advance, which annihilates distance and makes that perfect natural conductor, the Earth, available for all the innumerable purposes which human ingenuity has found for a line-wire. One far-reaching result of this is that any device capable of being operated thru one or more wires (at a distance obviously restricted) can likewise be actuated, without artificial conductors and with the same facility and accuracy, at distances to which there are no limits other than those imposed by the physical dimensions of the Globe. Thus, not only will entirely new fields for commercial exploitation be opened up by this ideal method of transmission but the old ones vastly extended.

"The 'World-System' is based on the application of the following important inventions and discoveries:

"1. *The 'Tesla Transformer.'* This apparatus is in the production of electrical vibrations as revolutionary as gunpowder was in warfare. Currents many times stronger than any ever generated in the usual ways, and sparks over one hundred feet long, have been produced by the inventor with an instrument of this kind.

"2. *The 'Magnifying Transmitter.'* This is Tesla's best invention—a peculiar transformer specially adapted to excite the Earth, which is in the transmission of electrical energy what the telescope is in astronomical observation. By the use of this marvelous device he has already set up electrical movements of greater intensity than those of lightning and passed a current, sufficient to light more than two hundred incandescent lamps, around the Globe.

"3. *The 'Tesla Wireless System.'* This system comprises a number of improvements and is the only means known for transmitting economically electrical energy to a distance without wires. Careful tests and measurements in connection with an experimental station of great activity, erected by the inventor in Colorado, have demonstrated that power in any desired amount can be conveyed, clear across the Globe if necessary, with a loss not exceeding a few per cent.

"4. *The 'Art of Individualization.'* This invention of Tesla is to primitive 'tuning' what refined language is to unarticulated expression. It makes possible the transmission of signals or messages absolutely secret and exclusive both in the active and passive aspect, that is, non-interfering as well as non-interferable. Each signal is like an individual of unmistakable identity and there is virtually no limit to the number of stations or instruments which can be simultaneously operated without the slightest mutual disturbance.

"5. *The terrestial Stationary Waves."* This wonderful discovery, popularly explained, means that the Earth is responsive to electrical vibrations of definite pitch just as a tuning fork to certain waves of sound. These particular electrical vibrations, capable of powerfully exciting the Globe, lend themselves to innumerable uses of great importance commercially and in many other respects.

"The first 'World-System' power plant can be put in operation in nine months. With this power plant it will be practicable to attain electrical activities up to ten million horsepower and it is designed to serve for as many technical achievements as are possible without due expense. Among these the following may be mentioned:

"(1) The inter-connection of the existing telegraph exchanges or offices all over the world;

"(2) The establishment of a secret and non-interferable government telegraph service;

"(3) The inter-connection of all the present telephone exchanges or offices on the Globe;

"(4) The universal distribution of general news, by telegraph or telephone, in connection with the Press;

"(5) The establishment of such a 'World-System' of intelligence transmission for exclusive private use;

"(6) The inter-connection and operation of all stock tickers of the world;

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General Description

15 KVA Motor Generator set. Motor is 440 volt, 120 cycle, 4000 R P M type, built to stand heavy overloads for indefinite lengths of time. Generator same specifications. Set is No. 3 phase, complete with all controls, starters, meters, etc.

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Induction transformer of sufficient size to be used on any wave length up to 2000 meters with a 650 foot antennae.

Capacity of apparatus without extending:—

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Installed at a cost of over $15,000.00

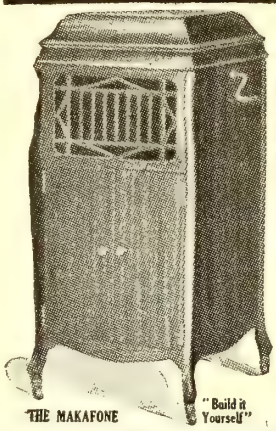
The equipment comprising this outfit was the very highest type that could be bought; it is complete—ready to erect and operate without the purchase of other apparatus. Was in daily use when ordered sealed for the duration of the war. The outfit has been completely overhauled and is guaranteed to be in first class operating condition.

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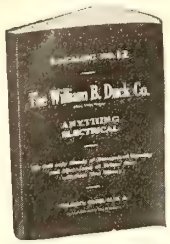
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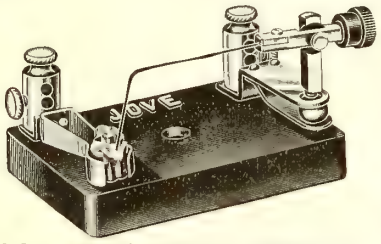
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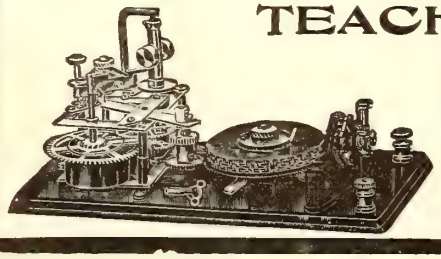
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"(8) The universal registration of time by cheap clocks indicating the hour with astronomical precision and requiring no attention whatever;

"(9) The world transmission of typed or hand-written characters, letters, checks, etc.;

"(10) The establishment of a universal marine service enabling the navigators of all ships to steer perfectly without compass, to determine the exact location, hour and speed, to prevent collisions and disasters, etc.;

"(11) The inauguration of a system of world-printing on land and sea;

"(12) The world reproduction of photographic pictures and all kinds of drawings or records."

I also proposed to make demonstrations in the wireless transmission of power on a small scale but sufficient to carry conviction. Besides these I referred to other and incomparably more important applications of my discoveries which will be disclosed at some future date.

A plant was built on Long Island with a tower 187 feet high, having a spherical terminal about 68 feet in diameter. These dimensions were adequate for the transmission of virtually any amount of energy. Originally only from 200 to 300 K.W. were provided but I intended to employ later several thousand horsepower. The transmitter was to emit a wave-complex of special characteristics and I had devised a unique method of telephonic control of any amount of energy.

The tower was destroyed two years ago but my projects are being developed and another one, improved in some features, will be constructed. On this occasion I would contradict the widely circulated report that the structure was demolished by the Government which owing to war conditions, might have created prejudice in the minds of those who may not know that the papers, which thirty years ago conferred upon me the honor of American citizenship, are always kept in a safe, while my orders, diplomas, degrees, gold medals and other distinctions are packed away in old trunks. If this report had a foundation I would have been refunded a large sum of money which I expended in the construction of the tower. On the contrary it was in the interest of the Government to preserve it, particularly as it would have made possible—to mention just one valuable result—the location of a submarine in any part of the world. My plant, services, and all my improvements have always been at the disposal of the officials and ever since the outbreak of the European conflict I have been working at a sacrifice on several inventions of mine relating to aerial navigation, ship propulsion and wireless transmission which are of the greatest importance to the country. Those who are well informed know that my ideas have revolutionized the industries of the United States and I am not aware that there lives an inventor who has been, in this respect, as fortunate as myself especially as regards the use of his improvements in the war. I have refrained from publicly expressing myself on this subject before as it seemed improper to dwell on personal matters while all the world was in dire trouble. I would add further, in view of various rumors which have reached me, that Mr. J. Pierpont Morgan did not interest himself with me in a business way but in the same large spirit in which he has assisted many other pioneers. He carried out his generous promise to the letter and it would have been most unreasonable to expect from him anything more. He had the highest regard for my attainments and gave me every evidence of his complete faith in my ability to ultimately achieve what I had set out to do. I am unwilling to accord to some small-minded and jealous individuals the satisfaction of having thwarted my efforts. These men are to me nothing more than microbes of a nasty disease. My project was retarded by laws of nature. The world was not prepared for it. It was too far ahead of time. But the same laws will prevail in the end and make it a triumphal success.

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Tesla Bulbs

(*Continued from page* 134)

scription of the phenomenon, as seen in a bulb without conducting electrode. It is observed under the following conditions:

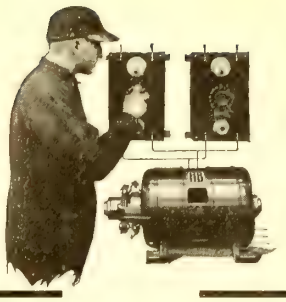
"When the globe L (Figs. 1 and 2) is exhausted to a very high degree, generally the bulb is not excited upon connecting the wire *w* (Fig. 1), or the tinfoil coating of the bulb (Fig. 2) to the terminal of the induction coil. To excite it, it is usually sufficient to grasp the globe L with the hand. An intense phosphorescence then spreads at first over the globe, but soon gives place to *a white, misty light.* Shortly afterward one may notice that the luminosity is unevenly distributed in the globe, and after passing the current for some time the bulb appears as in Fig. 4. From this stage the phenomenon will gradually pass to that indicated in Fig. 5, after some minutes, hours, days or weeks, according as the bulb is worked. Warming the bulb or increasing the potential hastens the transit.

"When the brush assumes the form indicated in Fig. 5, it may be brought to a state of *extreme sensitiveness to electrostatic and magnetic influence.* The bulb hanging straight down from a wire, and all objects being remote from it, *the approach of the observer at a few paces from the bulb will cause the brush to fly to the opposite side, and if he walks around the bulb it will always keep on the opposite side.* It may begin to spin around the terminal long before it reaches the sensitive stage. *When it begins to turn around, principally, but also before, it is affected by a magnet,* and at a certain stage it is susceptible to magnetic influence to an astonishing degree. A small permanent magnet, with its poles at a distance of no more than two centimeters, will affect it visibly at a distance of two meters, slowing down or accelerating the rotation according to how it is held relatively to the brush. I think I have observed that at the stage when it is most sensitive to magnetic, it is not most sensitive to electrostatic, influence.

"When the bulb hangs with the globe L down, the rotation is always clockwise. In the southern hemisphere it would occur in the opposite direction, and on the equator the brush should not turn at all. The rotation may be reversed by a magnet kept at some distance. The brush rotates best, seemingly, when it is at right angles to the lines of force of the earth. It very likely rotates, when at its maximum speed, in synchronism with the alternations, say, 10,000 times a second. The rotation can be slowed down or accelerated by the approach or receding of the observer, or any conducting body, but it cannot be reversed by putting the bulb in any position. When it is in the state of the highest sensitiveness and the potential or frequency be varied, the sensitiveness is rapidly diminished. Changing either of these but little will generally stop the rotation. The sensitiveness is likewise affected by the variations of temperature. To attain great sensitiveness it is necessary to have the small sphere *s* in the center of the globe *L*, as otherwise the electrostatic action of the glass of the globe will tend to stop the rotation. The sphere *s* should be small and of uniform thickness; any dissymmetry of course has the effect to diminish the sensitiveness.

"The fact that the brush rotates in a definite direction in a permanent magnetic field seems to show that in alternating currents of very high frequency the positive and negative impulses are *not* equal, but that one always preponderates over the other.

"Of course, this rotation in one direction may be due to the action of the two elements of the same current upon each other, or to the action of the field produced by one of the elements upon the other, as in a



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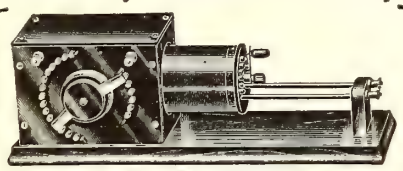
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series motor, without necessarily one impulse being stronger than the other. The fact that the brush turns, as far as I could observe, in any position, would account for this theory. In such case it would turn at any point of the earth's surface. But, on the other hand, it is then hard to explain why a permanent magnet should reverse the rotation, and one must assume the preponderance of impulses of one kind.

"As to the causes of the formation of the brush or stream, I think it is due to the electrostatic action of the globe and the dissymmetry of the parts. If the small bulb *s* and the globe L were perfect concentric spheres, and the glass thruout of the same thickness and quality, I think the brush would not form, as the tendency to pass would be equal on all sides. That the formation of the stream is due to an irregularity is apparent from the fact that it has the tendency to remain in one position, and rotation occurs most generally only when it is brought out of this position by electrostatic or magnetic influence. When in an extremely sensitive state it rests in one position, and most curious experiments may be performed with it. For instance, the experimenter may, by selecting a proper position, approach the hand at a certain considerable distance to the bulb, and he may cause the brush to pass off by merely stiffening the muscles of the arm. When it begins to rotate slowly, and the hands are held at a proper distance, it is impossible to make even the slightest motion without producing a visible effect upon the brush. A metal plate connected to the other terminal of the coil affects it at a great distance, slowing down the rotation often to one turn a second.

"I am firmly convinced that such a brush, when we learn how to produce it properly, will prove a valuable aid in the investigation of the nature of the forces acting in an electrostatic or magnetic field. If there is any motion which is measurable going on in the space, such a brush ought to reveal it. It is, so to speak, a beam of light—frictionless, devoid of inertia.

"I think that it may find practical applications in telegraphy. With such a brush it would be possible to send dispatches across the Atlantic, for instance, with any speed, since its sensitiveness may be so great that the slightest changes will affect it. If it were possible to make the stream more intense and very narrow, its deflections could be easily photographed.

"I have been interested to find whether there is a rotation of the stream itself, or whether there is simply a stress traveling around the bulb. For this purpose I mounted a light mica fan so that its vanes were in the path of the brush. If the stream itself was rotating the fan would be spun around. I could produce no distinct rotation of the fan, altho I tried the experiment repeatedly; but as the fan exerted a noticeable influence on the stream, and the apparent rotation of the latter was, in this case, never quite satisfactory, the experiment did not appear to be conclusive.

"I have been unable to produce the phenomenon with the disruptive discharge coil, altho every other form of these phenomena can be well produced by it—many, in fact, much better than with coils operated from an alternator.

"It may be possible to produce the brush by impulses of one direction, or even by a steady potential, in which case it would be still more sensitive to magnetic influence."

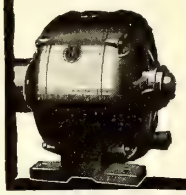
Fig. 6 shows a practical application of the Tesla bulb. The bulb itself, as will be seen, is excited by means of a Tesla high frequency alternator which, in turn, is connected to the primary of a transformer. The secondary of the transformer is grounded at one end, while the other end of the transformer connects with the Tesla bulb.

Dr. Tesla, in an interview, stated that

(*Continued on page* 184)

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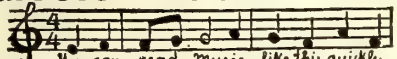
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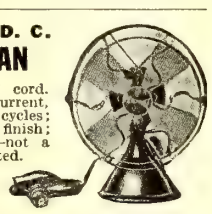
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How to Finance and Manufacture a Patent

(*Continued from page* 167)

ers in reference to handling and pushing our goods, when ready for the market (using models of our invention for demonstration) and secured several substantial orders for future delivery. We also consulted an advertising agency about the future advertising of our product.

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In conclusion, I wish to suggest the following: If your invention has merit, is a public benefit or necessity, or an attractive novelty, do not sell out for "Whatever you can get," unless it is mighty good. If it is worth your best efforts to originate and perfect, it is also worth further efforts to raise the capital to manufacture it yourself. You might as well receive its full value instead of allowing some one else to do so. However, if you are forced to sell, and feel you cannot command the ability and persistence required to finance it yourself—don't be too anxious to close the deal. Don't accept the first offer made you. Of course, you should not turn it down entirely, consider them all, then decide and you will be sure of getting a fair price.

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.....Building Contractor	.....Master Plumber
.....Civil Engineer	.....Heating & Vent. Engineer
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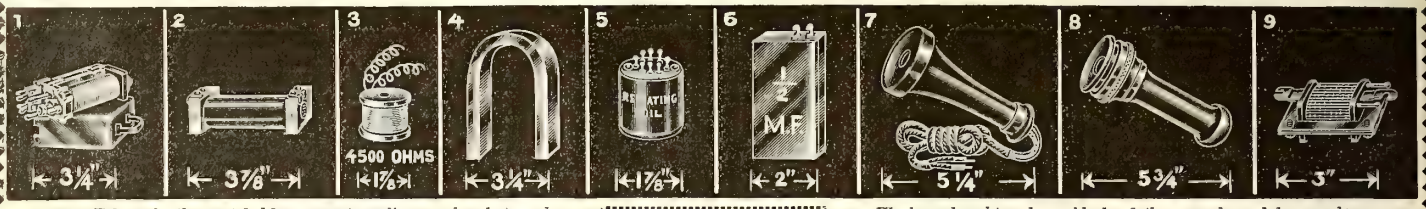
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No. 1 Relay—shipping weight, 2 lbs. Price..... **$1.50**

NO. 2 STANDARD TELEPHONE Induction Coil, primary 1 ohm, secondary 55 ohms. Used wherever you need a good induction coil. Has primary and secondary and iron wire core; fibre heads.
No. 2 Induction Coil as described—shipping weight, 2 lbs. Price..... **$0.50**

NO. 3 STANDARD RESISTANCE wound with German silver wire—4,500 ohms, can be used as a choke or plain resistance, and has many other uses that readily suggest themselves to the experimenter.
No. 3 Standard Resistance as described—shipping weight, 4 oz. Price..... **$0.40**

NO. 4 HORSESHOE MAGNET, size 3¼ inches wide x 5 inches high. Will lift about 1 lb. Quality such as used on magnetos, which means the best.
No. 4 Horseshoe Magnet — shipping weight, 2 lbs. Price..... **$0.30**

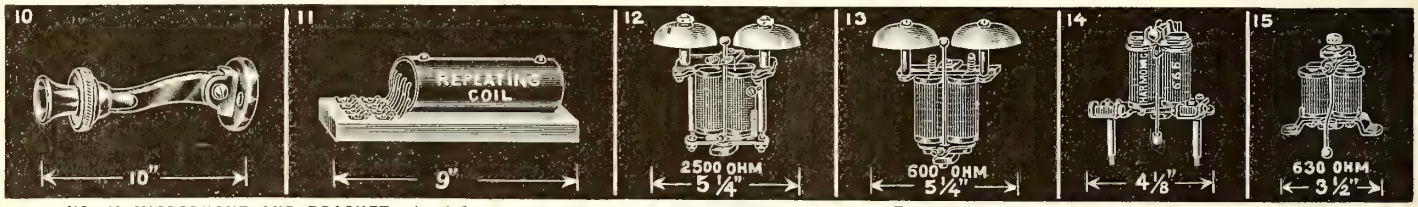
NO. 5 REPEATING COIL (Transformer). This is a standard small repeating coil and is used by all telephone companies. It has 4 different windings and eight contacts. Entirely enclosed in iron. The resistance being respectively 72 and 120 ohms, and 90 and 100 ohms. Diagram is furnished. Can be used for wireless, for boosting signals, etc.
No. 5 Repeating Coil—shipping weight, 2 lbs. Price..... **$0.50**

NO. 6 ½ M.F. CONDENSER. This is a standard telephone condenser and has ½ microfarads. Condenser comes in neat metal casing. This condenser is used in connection with spark coils to absorb the vibrator spark. Invaluable for test buzzers to absorb spark and make the sound of buzzer more steady. Is also used by every experimenter in connection with wireless where a fixed capacity is needed. Several of these condensers should be in every experimenter's laboratory.
No. 6 Condenser, ½ M.F.—shipping weight, 1 lb. Price..... **$0.50**

NO. 7 DOUBLE POLE BELL TELEPHONE RECEIVER—hard rubber casing with 4 ft. cord and tips. Standard 75 ohms—very powerful magnets. This receiver can be used in connection with any ordinary telephone work, and you will even find it sensitive enough for short distance wireless work.
No. 7 Bell Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.80**

NO. 8 STANDARD TELEPHONE RECEIVER with Metal Head. This receiver is made by Stromberg Carlson Co., with genuine hard rubber handle and ear cap. A very good fool-proof as well as sensitive receiver that cannot be put out of order if you try. Used for the same purpose as No. 7 Telephone Receiver.
No. 8 Standard Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.75**

No. 9 IMPEDANCE COIL (Close Core Transformer). This is a very fine little transformer and is used extensively in connection with telephone work. It is in reality an A.C. transformer for which you would pay $5.00 if you had it made to order. The primary has 0.15 ohms, secondary 2000 ohms. It can be used for a variety of purposes that will suggest themselves to every experimenter. Can be used successfully to boost wireless signals. Also in connection with audions, etc. An A-1 instrument. Size 3 x 3 inches.
No. 9 Impedance Coil—shipping weight, 2 lbs. Price..... **$0.65**



NO. 10 MICROPHONE AND BRACKET. An A-1 sensitive microphone of the carbon grain type. Has hard rubber mouthpiece and enamel steel bracket, the instrument being 10 inches long. This microphone, in connection with our No. 7 or 8 Receiver, will constitute a complete telephone outfit, good to speak 50 miles or more, at a remarkably low price.
No. 10 Microphone and Bracket—shipping weight, 5 lbs. Price..... **$1.00**

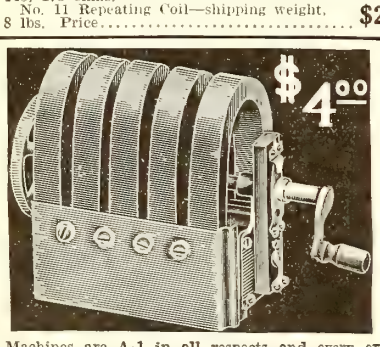
NO. 11 REPEATING COIL (Transformer). A standard repeating coil used for telephonic work. The coil windings are encased in an iron tube 2¼ inches in diameter. There are eight terminals for the four windings to connect to and the instrument is invaluable in connection with radio work to boost up signals, audion work, etc. Many interesting uses will be found for this coil. Resistances are: 100, 120, 145, 175 ohms.
No. 11 Repeating Coil—shipping weight, 8 lbs. Price..... **$2.00**

NO. 12 POLARIZED RINGER with Bells. The resistance of the two coils is 1250 ohms each. The armature is perfectly adjustable. Bell will work on any magneto. We also furnish blue print with ringer showing how *a first class polarized relay* can be made by anyone using only a few pieces of metal and screws.
No. 12 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.50**

NO. 13 POLARIZED RINGER with Bells. This is the same kind of ringer as the No. 12, except that it is not adjustable and that the resistance is less. First class in all respects. Blue print furnished with this to *make polarized relay* same as with No. 12. Solenoids on this ringer are worth more than the price we ask for the entire ringer, and do not forget a powerful magnet that goes with it.
No. 13 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.00**

NO. 14 HARMONIC RINGER. This ringer is also polarized and has a powerful magnet. It works on 66.6 cycles and any magneto will operate it if run at a certain speed. A very finely built instrument. Resistance of each coil being 200 ohms. Can be converted into a polarized relay by substituting a very fine leaf spring instead of the heavy one furnished. A most interesting instrument with which to experiment.
No. 14 Harmonic Ringer — shipping weight, 4 lbs. Price..... **$1.60**

NO. 15 RINGER without Bells—630 ohms. This also is a polarized ringer and has an adjustable armature. The adjustment is done by means of the top screw. A beautiful little instrument. With this instrument, too, we furnish a blue print showing how a *polarized relay can be built.* You should have several of these beautiful little instruments. They are worth their weight in gold; the powerful magnet alone being worth more than the price we ask for the entire instrument.
No. 15 Ringer—shipping weight, 2 lbs. Price..... **$0.80**



No. 55 5-bar magneto, 110 Volt A. C. Generator

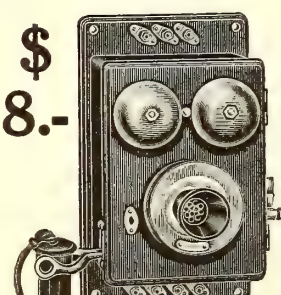
This is one of the most powerful magnetos ever built, when manufacturers could afford to put good stuff into them; equipt with transmission, make and break, etc. Transmission wheels are all brass, crank handle furnished. This magneto, as well as the other ones listed below, will light a 110-volt lamp merely by turning the crank handle slowly. While this magneto gives alternating current only, it can be rewound so it will light up a number of four, six and 10-volt lamps, all depending upon the thickness of the wire you wind on the armature. As we furnish these magnetos, they will give a powerful alternating current and you will not be able to stand the current when grasping hold of the terminals. This makes an ideal shocking machine. All our generators can be transformed into a direct current machine by equipping it with a home-made commutator. Machines are A-1 in all respects and every experimenter should have one of them in his shop. Many other experiments which can be performed with this machine will readily suggest themselves to any experimenter. The magnets furnished with these generators are very powerful, each one being able to lift one pound easily.

NO. 55 5-BAR MAGNETO GENERATOR as described—shipping weight, 25 lbs. Price..... **$4.00**

NO. 33 3-BAR GENERATOR, same as described above except that it has only 3 bars, and is somewhat smaller.
No. 33 3-bar Generator—shipping weight, 10 lbs. Price..... **$2.00**

NO. 44 4-BAR GENERATOR, same as No. 55 except that it has 4 bars, and is somewhat smaller.
No. 44 4-bar Generator—shipping weight, 15 lbs. Price..... **$3.00**

NO. 66 6-BAR GENERATOR, same as No. 55 except that it has one more magnet and the armature is somewhat larger and more powerful. This is the biggest type made and is extremely powerful.
No. 66 6-bar Generator—shipping weight, 30 lbs. Price..... **$4.50**



Complete Wall Set

This is a complete commercial telephone station. The cabinet is of polished oak, piano finish, within which is contained the powerful magneto, the 300 Ohm polarized ringer, and induction coil. The magneto is exceptionally efficient, being of the two bar type with brass gear transmission. The extra sensitive microphone, mouthpiece and two gongs are mounted on the front of the cabinet, giving the entire instrument that desirable appearance of compactness and efficiency. Guaranteed to work over 20 miles. The telephone receiver is a double poled one, and has a hard rubber case. Seven binding posts are provided for connections. The instrument is one which we can offer with pride to our patrons at a ridiculously low price. It is unobtainable anywhere else at less than $15.00 and is an instrument unequaled in value for the price we ask. Size over all 11" x 10" x 8". Shipping weight, 15 lbs.
No. 26 Long Distance Telephone Set..... $8.00

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Electric Drive on U. S. S. "New Mexico"

(*Continued from page* 106)

structions from the captain, sent either by loud speaking telephones, by indicators, by lights, or by messenger. Following these instructions, the engineers standing at the switchboard can start the vessel forward, or start it backwards; they can make it go many different speeds in either direction; they can run all four of the motors from one of the power plants, or from the other power plant; they can even split up the load so that one power plant will run two of the motors forward and the other power plant will run the other two "astern." Another combination they can effect is that both power plants can equally share the load of driving the four motors—one to each propeller.

If one of the propellers becomes foul the engineer can disconnect this motor from the circuit, and then all of the power in the two power plants is available for the three remaining motors.

Giant Motor for Each Screw.

Can you imagine a motor twice as high as a six-foot man? Can you imagine *one motor capable of doing the work of* 30,000 *horses working at three eight-hour shifts?* If so, then you can appreciate the picture which these made in their steel compartments. One of these giant motors is provided for each of the four propeller shafts. The screw is at one end of the shaft in the water, and the motor is at the other end of the shaft inside the ship. One reason for their efficiency is the fact that the shaft can be short as the motor can be close to the propeller. There is an additional advantage also, because the turbine generators can be located near the boilers, and this permits of a short steam pipe. These very desirable features are a result of electric drive, because it doesn't make any difference what is located between the power plant and the motors.

No Reversing Turbines.

With electric drive, no reversing turbines are necessary, *the reversing is done electrically.* So with the electric drive, the turbine in the power plant always runs in the *same direction* and at highest efficiency.

Electrical propulsion not only does away with reversing turbines, but also does away with reduction gears. The wonderful simplicity of the arrangement can be appreciated also when you remember that the battleship *Pennsylvania* has ten turbines and the *New Mexico* only two.

Propeller More Efficient.

Electric propulsion has another advantage in making the propeller more efficient. This is because, within limits, the faster a propeller turns, the less efficient it becomes. If it turns too rapidly, it merely churns the water, and therefore does not effectively drive the ship ahead. When turbines are directly connected to the propeller shaft, the turbine rotates too slowly to be at its best efficiency, and the propeller shaft rotates too rapidly to operate at its maximum efficiency. So you can look at electric propulsion as a means of speed reduction; for it permits the turbines to rotate at their normally high speed, where they show the best fuel economy, and also permits the propeller to operate at comparatively low speed, where it gives the best driving economy. Without electric propulsion, there were at many different speeds practically "compromise" arrangements, by which either the turbine was rotating too slowly or the propeller too fast. This is obviated in the *New Mexico*, which is one reason why, with one filling of her oil tanks, she can cruise over 50 per cent. further than with any other equipment. In fact, she can go 7,500 knots at 12 knots speed before it will be necessary to take on any more fuel.

Nearly 100,000 Horse Power.

The *New Mexico* is practically the only 100 per cent. electric boat. This will be seen by glancing over, or, better yet, carefully reading the following table, showing her electrical equipment.

Particular attention is called to the loud speaking telephones, 104 in number, located all over the ship. From three different transmitting stations the bugle calls or other instructions can be sent to all or any one of five different groups of these telephones.

Electrical Equipment

2	main generators	33,000 h.p.
4	motors for propelling	33,000 h.p.
6	dynamos	3,000 h.p.
6	air compressors	400 h.p.
2	vacuum pumps	80 h.p.
20	motor generator sets totaling almost	100 h.p.
4	boat crane motors	220 h.p.
2	anchor motors	250 h.p.
4	winch motors totaling	200 h.p.
20	turret motors	1,300 h.p.
10	ammunition hoists	500 h.p.
2	refrigerator motors	40 h.p.
8	motors in kitchen (Peel potatoes, mix dough and cake, and wash dishes, cut butter, make ice cream, meat grinder, all bread and cakes baked electrically.)	15 h.p.
6	in carpenter shop	20 h.p.
10	in machine shop	30 h.p.
6	in laundry (5 machines use electric heat)	10 h.p.
5	motors in print shop totaling	6 h.p.
14	pumps water	140 h.p.
4	oil pumps	8 h.p.
50	electric air heaters	30 h.p.
12	searchlights	300 h.p.
160	fans, 60 blowers, 6 electric toasters, 1 electric percolator, 15 electric irons, 104 loud speaking telephones, 176 ship service telephones, 170 fire control telephones, 2 Sperry electric gyroscopic compasses, 7 portable electric drills, 2 electric glue pots, 6 electric soldering irons.	

Airplane Speeds 300 Miles an Hour

An airplane with a speed of from 200 to 300 miles an hour which will bring America within a short day's journey of Europe, is the prospect held out by the invention of a French engineer, Auguste Rateau.

At the present time without the invention the higher an airplane mounts the less power does its engine develop on account of the rarefying of the air. The loss at 15,000 feet, for instance, is 50 per cent.

M. Rateau's device is said to be very simple. It consists of an arrangement by which the exhaust from the engine works a small turbine, which compresses the air drawn into the engine to normal pressure so that the engine develops full power no matter what the altitude. As the resistance of an airplane decreases enormously at high altitudes, it follows that the higher a machine fitted with the new device mounts the greater will be its speed. This fact, it is declared, was demonstrated by the famous German long-range gun.

It has been found that a heavy day bombing machine whose speed at 15,000 feet ordinarily did not exceed 80 miles an hour, made 140 miles an hour when fitted with this invention, an increase of 75%.

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When the typewriter arrives deposit with the express agent $9.15 and take the machine for five days' trial. If you are convinced that it is the best typewriter you ever saw, keep it and send me $4.00 a month until our bargain price of $53.15 is paid. If you don't want it, return it to the express agent, receive your $9.15 and return the machine to me. I will pay the return express charges. This machine is guaranteed just as if you paid $100.00 for it. It is standard. Over one hundred thousand people own and use these typewriters and think them the best ever manufactured.

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H. A. SMITH, 738, 218 N. Wells St., Chicago, Ill.

Ship me a No. 10 Smith Premier F.O.B. Chicago, as described in this advertisement. I will pay you the $44.00 balance of the special $53.15 purchase price, at the rate of $4.00 per month. The title to remain in you until fully paid for. It is understood that I have five days in which to examine and try the typewriter. If I choose not to keep it I will carefully repack it and return it to the express agent. It is understood that you give the standard guarantee for one year.

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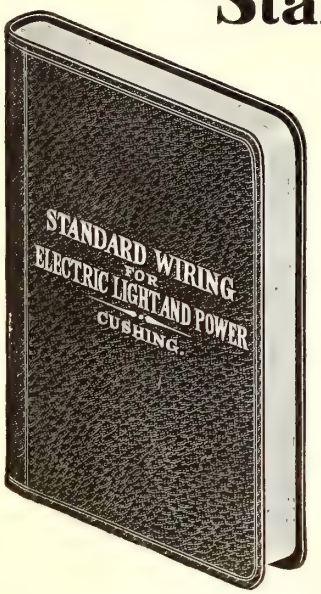
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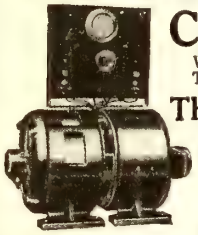
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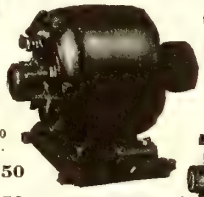
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Tesla Bulbs

(*Continued from page* 180)

the best way to use the bulb for such experiments is when the shaft of light is in the position as shown in Figs. 5 and 6, at rest, but in a state of equilibrium inconceivably delicate. This is fully described above in Dr. Tesla's lecture. The inventor states that in such a condition, the shaft of light is marvelously sensitive to magnetic disturbances. Dr. Tesla informs us that a toy permanent horseshoe magnet not longer than ½" and with its poles ⅛" apart could with ease throw the shaft of light out of its normal direction across the whole room. In our illustration, an electromagnet is shown a few inches away from light ray, and we can imagine a slot in a screen in such a way that normally no light falls thru it. If, however, very faint radio-telegraphic impulses surge thru the electromagnet, the light ray will immediately become displaced, and will fall into the slot. Inasmuch as this shaft of light has no inertia, it will follow exactly the dot and dash impulses surging thru the electromagnet, no matter how rapidly they take place. They can then either be read off by the eye, or if desired, can be registered upon a fast moving film. This method will, of course, only be used where the transmission is made at high speed, and where it would be impossible for an operator at the receiving end to follow the dots and dashes with the eye.

The method shown by us in Fig. 6, of course, represents only one. Many others can undoubtedly be evolved to use the Tesla bulb to advantage.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of Electrical Experimenter, published monthly at New York, N. Y., for April 1, 1919.

State of New York, County of New York—ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the Editor of the Electrical Experimenter, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, The Experimenter Publishing Co., 233 Fulton Street, New York City; Editor, Hugo Gernsback, 233 Fulton Street, New York City; Managing Editor, Harry Winfield Secor, 233 Fulton Street, New York City; Business Manager, Hugo Gernsback, 233 Fulton Street, New York City.

2. That the owners are: Experimenter Publishing Co., 233 Fulton Street, New York City; Hugo Gernsback, 233 Fulton Street, New York City; Sidney Gernsback, 233 Fulton Street, New York City; Mrs. K. Hymes, 233 Fulton Street, New York City; Harry Winfield Secor, 233 Fulton Street, New York City.

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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is —(Required only of daily publications.)

(SEAL) H. GERNSBACK.

Sworn to and subscribed before me this 4th day of April, 1919.

BEATRICE K. OWEN.

(My commission expires March 30, 1921.)

Choke Coils: Theory and Design

by Prof. F. E. Austin

(*Continued from page* 140)

It is evident that with a current of 13.9 amperes in a resistance of 2.9 ohms, there will be considerable heating effect, denoted by $R_x I^2_{dc} = 2.9 \times 13.9^2 = 560.3$ watts. If the current passes thru the circuit for one hour, about one-half kilowatt hour of energy will be paid for, which is simply a *heat waste* in the auxiliary resistance R_x.

When connected with a 110 volt alternating current circuit, the current of 13.9 amperes was maintained without this heat loss, simply because of the counter-electromotive-force of induction of the coil itself.

The financial saving effected by the use of a choke coil is therefore very apparent, since the coil reduces the current in the circuit from 22 to 13.9 or 8.1 amperes, at no operating expense for power.

The usual condition governing the use of a choke coil is either the amount of current to be past thru the coil is known, or the amount of pressure reduction is known.

The size of the wire constituting the coil must be large enough to carry the desired current without overheating the coil. The choking effect of any coil depends upon the *square of the number of turns* of wire composing the coil. That is, if the *number of turns* on a coil are *doubled*, its choking effect is increased *four* times.

A very serviceable choke coil for a wide range of choking effect may be made by winding ten pounds of No. 14 double cotton covered copper wire in two sections on a hard fiber tube, measuring 2 inches in outside diameter, and 9½ inches long. The tube should be provided with wooden ends about 4½ inches square and ¾ inch thick, with a middle partition of wood ¾ inch thick. It will be advisable to shellac the insulated wire very thoroly and allow it to dry before using the coil.

An iron core should be made up of about No. 18 iron wire stock, carefully varnished with shellac varnish, and measuring about 14 inches long by 1¼ inches in diameter.

Such a coil will carry as high as 15 amperes for a short time and as high as 5 amperes for a long period without seriously heating.

With both sections in series, without an iron core and with an applied pressure of 110 volts at 60 cycles, the current in the coil will be about 6 amperes. The insertion of an iron core such as described above will reduce the current to less than ½ ampere.

With one section of such a coil, connected across 110 volts at 60 cycles, with no iron core, the current will be nearly 12 amperes, and by inserting the iron core may be gradually reduced from 12 amperes to less than one ampere.

Such a coil may be connected in series with other coils or lamps such as an arc lamp and the desired pressure applied to the apparatus. In using a choke coil always have the iron core inserted in the coil before closing the circuit, so as to have *maximum* choking effect in operation at the *start*.

The effect of the iron core is to greatly increase the coefficient of inductance L, thus increasing the numerical value of the term $2 \pi f L$. The iron core takes the place of a very large number of turns of wire, greatly reducing the expense of construction.

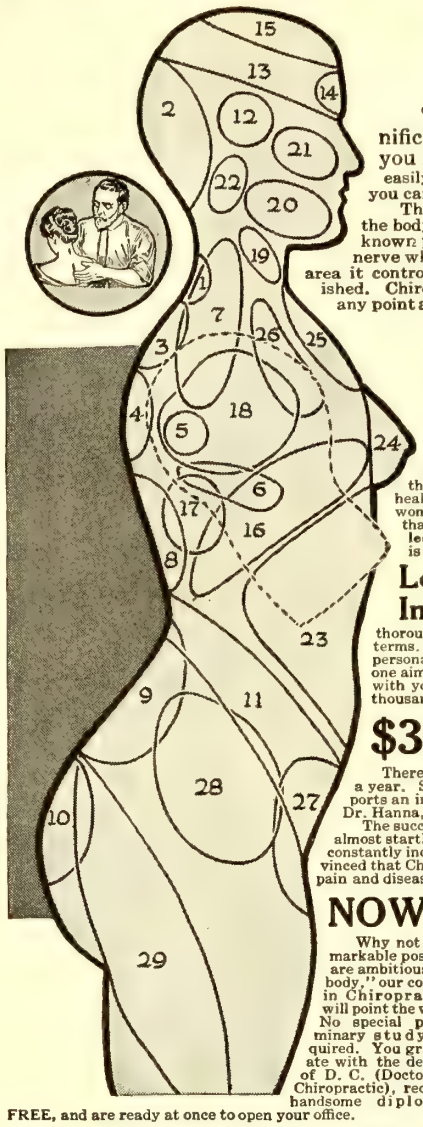
A very useful equation by which choke coils may be designed is as follows:

$$L = \frac{4 \pi n^2 \mu A}{10^9 b};$$

in which L denotes the inductance of a coil in *henries;* n denotes the number of turns on the coil, μ denotes the so-called magnetic permeability of the medium (iron, etc.), in-

(*Continued on page* 187)

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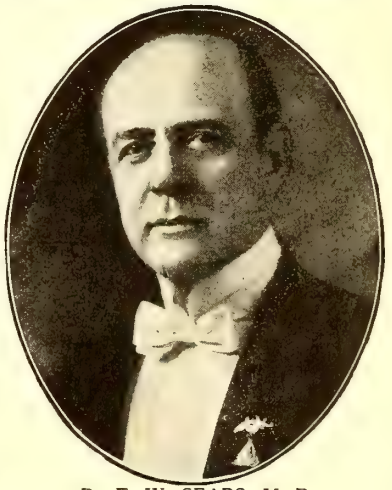
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The Rogers' Underground Aërial for Amateurs

(*Continued from page* 137)

specified, where the transmitting set is one employing an audion oscillation generator. The voltage in this case will not be extremely high, and special precautions need not be taken to provide extra heavy insulation on the buried antenna. Official tests by the U. S. Navy have shown transmission by radio over 50 miles with the Rogers underground antenna. *The wire in such a case, however, should be especially well insulated* to stand the higher voltage.

Regarding loop aërials in general, it would appear that we can expect a great deal from them, as some of the really remarkable results achieved during the war would seem to point out. The number of turns and the amount of wire to be used in a spiral antenna, such as shown at Figs. 7 and 8, will vary of course for different wave lengths, etc., and here is where the Radio Amateur will have a chance to carry out some original experiments, which may net him some real knowledge, fame and money. Another form of loop antenna, so-called, and which has been tried out several years ago with such success that European stations could be copied in a laboratory located in Florida, is one composing a square form, several feet in height. This was used, as just mentioned, to receive stations using fairly long wave lengths, say from 8,000 to 12,000 meters, W. L. Here the insulating form was wound with a layer comprising several hundred turns of insulated wire, such as ordinary annunciator wire. This antenna was successfully used in some tests made by the Marconi radio engineers at a laboratory in Florida several years ago. Trans-Atlantic radio reception was effected at the radio laboratory of Union College, Schenectady, N. Y., just prior to America's entrance into the world war. This aërial comprised about two dozen turns of No. 14 or 12 bare or R.C. wire, mounted on porcelain knob insulators screwed on the inside wall of the laboratory. The turns were spaced about 3 inches apart. The inside turn was 3 feet square. Flexible leads, fitted with clips, serve to connect as many turns as desired.

Choke Coils: Theory and Design

By Prof. F. E. Austin

(*Continued from page* 185)

side the coil, A denotes the cross-sectional area in square centimeters of the central hole thru the coil, and b denotes the length of the *coil* (not of the wire) in centimeters. For air the magnetic permeability μ is 1. For an iron core μ varies considerably, according to the kind of iron used. For ordinary iron μ will be between 1,500 and 2,000 which shows how L increases from an air core to an iron core value. Consult any text-book containing a magnetization table, which gives the various permeability values for different flux densities. The flux density in each case depends upon the ampere-turns produced by the coil; this value is found by multiplying the amperes by the number of turns in the coil. Thus it is seen how the value L constantly varies as the core is moved in and out of the coil, or the number of turns varied, as well as any variations of the amperage, which would change the flux and in turn the permeability. It is usual to allow 1,000 circular mils per ampere in designing choke coil or transformer windings; a common core flux density is 25,000 to 30,000 lines per square inch of cross-section.



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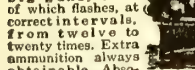
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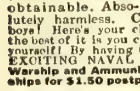
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SIMPLEX TYPEWRITER ONLY $2.50



Cheap But Good. So Simple a Child Can Use It. We Guarantee the Writing.

Though so marvelously cheap, this machine is a thoroughly practical Typewriter. We positively guarantee it to produce writing equa in every respect to that of any $1.00 machine. It does not seem possible at the price, but we send you a specimen of its work and you will be convinced. Wide reasonable carriage. Writes a line 6 inches wide. Speed unlimited. It is so simple that a child just able to read can write with it. You can learn all there is to know about it in five minutes, and an hour's practice will make you an expert operator. Every business man must have a typewriter. Illegible pen writing is unbusinesslike and creates the impression that the firm is a no-account and slow-going concern. Have your typewriter do the work. It will faithfully deserves its name as it is fit to do the correspondence of any business or profession, and to do it well, or you should not miss this chance of securing a bargain. The letters of the alphabet, the numerals 1 to 10, and punctuation marks are so grouped that the letters most used are before the fingers most of the time, enabling him to write rapidly. The rollers hold the paper in positi n while writing and at the end of each line a slight turn of the roller moves the racket which makes a click and the paper forward, giving the proper line spacing, so that the lines are all an equal distance from each other, so desirable in letter writing. Each typewriter packed in a strong box, with full printed instructions for use. Price complete, $2.50 sent by mail postpaid.

Johnson Smith & Co., Dept. E 8, 3224 N. Halsted St., Chicago

MysteriousGhost



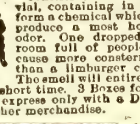
This is not a pretty object, but there is fun in it for people who like practical jokes. The Ghost, when displayed in a perfectly dark place, glows with a ghastly cold bluish radiance, very much like a "creepy" sensation, even when you know all about it, but a regular stunner for those who come upon it unexpectedly. A great joke to play on your mother-in-law. Price only 15 cents each, or three for 40 cents.

INKLESS PEN



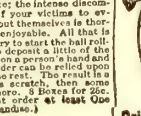
WRITES with WATER 600 words every time you dip. Makes its own ink. Writes fashionable violet color. Better and cheaper than fountain pens. Writes a long letter with one dip in plain water. No trouble—no bother—no muss. A pleasure to use. With Nickel Plated Reversible Holder 10 CENTS, 3 for 25c

INVISIBLE INK



The most confidential messages can be written with this ink, for the writing MAKES NO MARK. Cannot be seen unless you know the secret. Invaluable for many reasons. Keep your postals and other private memorandums away from prying eyes. Great fun for playing practical jokes. Only 15c Bottle

LOVE LETTER INK



Writing written with this remarkable ink vanishes entirely in a few weeks (sooner if desired), leaving the paper QUITE BLANK. 15c p. pd.

LUMINOUS INK Writing can be READ ONLY IN A DARK ROOM; writing shines like fire. Quite invisible at daytime. Very remarkable. 15c bottle; 3 for 40c postpaid.

JOHNSON SMITH & CO.

MULTIPLYING BILLIARD BALLS
The Best Feat of its Kind



This trick is an effective and surprising one. The performer hands around the ball for examination, and immediately it is returned to him he seizes it by the tips of his thumbs and fingers and a second ball mysteriously appears. These are held in full view of the audience by the tips of the fingers of the left hand, and even while being placed in position, another ball unexpectedly makes its appearance, and the magician apparently suffers from some kind of spasm and yet another ball is the result. The balls can then be reversed, the balls disappearing one after another until none remains. It is a very interesting trick that is quite easily performed by following the directions that accompany the apparatus PRICE, 25 CENTS, POSTPAID. JOHNSON SMITH & CO.

GOOD LUCK RING
Quaint and Novel Design



A VERY striking and unconventional ring, made of gunmetal finish, with elaborate design, with two brilliant flashing gems sparkling out of the eyes. A never failing object of interest. It is said by Good Luck to the wearer, hence its name Good Luck Ring, and whilst we will not positively guarantee that, it is certainly a conversation piece that you will take a pride in wearing. They were made to sell at 50 cents, but as a special bargain we will supply them to customers interesting this paper, at HALF PRICE, viz., ONLY 25 CENTS, POSTPAID. JOHNSON SMITH & CO.

LOADED CIGARETTES
Just Like Ordinary Cigarettes, But Such Real Starters!

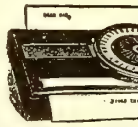


A box containing ten apparently genuine Cigarettes. They contain a charge which explodes when about one-third is smoked.

They appear so real, and afford a good smoke while they last that the victim is taken entirely by surprise. A great trick producer, entirely harmless. Price, box of ten, 25 cents, postpaid.

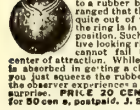
Johnson Smith & Co., Dept. E-8

THE "LITTLE GIANT" TYPEWRITER
A First Class Writing Machine For $1.25



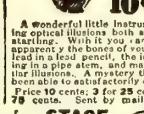
A per cent little typewriter for $1.25. There are thousands of businesses who would like to use a typewriter but these machines are not necessa ro not warrant the expense at sched to the purchase and there are many persons we confidently recommend our Little Giant. It is strong and durable, simple in construction, so that any one can quickly learn to operate it, and they will write as rapidly as they would with pen and ink. The letters of the alphabet most frequent y used being so grouped as to enable one to write rapidly, the numerals 1 to 10, and the punctuation marks being together. With this machine you can send your best girl typewri ten love letters, address envelopes, make out bills, and almost any kind of work not requiring a large machine. With each typewriter we send a tube of ink and full printed instructions for using the machine. Price complete $1.25 by mail postpaid.

SQUIRT RING



You may have a lot of fun with this sparkling Gem Squirt Ring. It consists of a handsomely plated ring, attached to a rubber ball, so arranged that the latter is quite out of view when the ring is in proper position. Such an attractive looking ring as this cannot fail to be the center of attraction. While the victim is absorbed in admiring it you just squeeze the rubber ball and the observer experiences very great surprise. PRICE 20 CENTS, three for 50 cen s, postpaid. J. S. & CO

Wonderful X-Ray Tube



A wonderful little instrument producing optical illusions both surprising and amazing. With it you can see the bones apparent y the bones of your fingers, the lead in a lead pencil, the inside of an opening in a pipe stem, and many other similar illusions. A mystery that no one has been able to satisfactorily explain.

Price 10 cents; 3 for 25 cents; 1 dozen, 75 cents. Sent by mail, postpaid.

Sneezing Powder



Place a very smallamount of this powder, on the back of your hand and blow it into the air, and everyone in the room or within a radius of a few feet will commence to sneeze without knowing the reason why. It is most amusing to hear their remarks, as they never suspect the real source, but think they have caught it one from the other. Between the laughing and sneezing you yourself will be having the time of your life. For parties, political meetings, car rides, or any place at all where there is a crowd of people, it is the greatest joke out. Price 12 cents or 3 for 30c.

By Express Only

STAGE MONEY



With a bunch of these bills, it is easy for each person of limited means to appear prosperous. By flashing a roll of these bills at the proper time and peeling off a genuine bill or two from the outside of the roll, the effect created will be found to be all that can be desired. Prices, postpaid: 15 Bills 10c, 50 Bills 25c, 125 for 50c, or $3.50 thousand

NEW BOOK ON ROPE SPLICING
USEFUL KNOTS, HITCHES, SPLICES, ETC.

How Different Knots Are Made and What They Are Used For. Knots to Use and Knots to Avoid.

A most practical handbook giving complete and simple direction for making all the most useful knots, hitches, rigging, splices, etc. Over 100 illustrations. All about wire rope attachments, lashing, blocks, tackles, etc. 37 Heraldic Knots illustrated. Of great value to mechanics, riggers, campers, boatmen Price 20c p. pd.

Johnson Smith & Co., Dept. E8, CHICAGO

LUMINOUS PAINT
Make Your Watches, Clocks, Etc, Visible by Night

The very latest discovery in the scientific world. Hitherto, practically unobtainable except at an exorbitant price, we have at last succeeded in producing this remarkable LUMINOUS PAINT, which, applied to the surface of any article, emits rays of white light, rendering it perfectly visible in the dark. THE DARKER THE NIGHT, THE MORE BRILLIANT IT SHINES. Quite simple to use. Anyone—you can do it. A little applied to the dial of your watch or clock will enable you to tell the time by night. You can coat the push buttons or switch plates of your electric lights, match boxes, and innumerable other articles; make your own Luminous Crucifixes, Lominous Rosaries, etc. Prices 30c and $1 postpaid. Johnson Smith & Co., Dept. E8.

MUSICAL KAZOO



With the Musical Kazoo you can, without previous practice whatsoever, play any tune right off, imitate any bird or animal, bagpipe, snare drum, Punch and Judy, etc. No holes to finger. It is simplicity itself. Produces excellent music. You do not blow into it, but sing, speak, laugh or make any desired imitation. Used with astonishing results at society meetings, home, club or church entertainments, dances, serenades, picnics, outings, excursions. Just the thing for choruses and shows, bicycle and marching clubs, etc. Excellent for vocal or instrumental accompaniments, either with or without other musical instruments. Price 15c. p. pd.

MAGIC FLUTE



Wonderfully Sweet Toned and Musical

A marvelous musical instrument. No other instrument produces sweeter music. With it be the joyous notes of a quickstep or even strains of a church hymn—in fact, any piece of music can be played upon the Humanatone without practice, as it is almost a self-playing instrument. When played with a piano accompaniment, or any other musical instrument, the effect is charming. Full printed instructions for playing sent with each instrument.

Post Paid 15c

All the Latest Surprising and Joke Novelties

Pharo's Serpents Eggs, box	10c	Cover the Spot Trick, a selen.nov.	10c
Miniature Water Pistol	10c	X Ray Novelty	10c
Cleopatra's Snake (very lifelike)	15c	Trick Pencil	10c
False Mustache (fool your friends)	6c	Rubber Tacks (a good joke)	10c
Ford Auto Puzzle (Latest)	10c	Mesmerized Penny (defies the law of gravitation)	20c
Mysterious Thumb Tube	10c	Mysterious Tumbler and Vanishing Coin Trick	25c
Rubber Razor (very formidable)	20c	Magic Mirror (take one peep)	10c
Rubber Dagger (sensational)	20c	Magic Plate Lifter	20c
Window Smasher (great joke)	25c	Imitation Gold Teeth	5 for 10c
Lookbackroscope (see behind you)	15c	Great Surprise Puzzle	10c
Great Mind Reading Mystery Cds.	10c	Wire Puzzles, 10c. 22 different, $1.95	
Thurston's Mysterious Trick Cds.	10c		
Fighting Roosters, pair	10c		

JOHNSON SMITH & CO. 3224, N. Halsted St. CHICAG

Boys, you can have Movies at your own home with this latest model

MOVING PICTURE MACHINE

Uses Standard Films same as the larger machines. Very easily managed. Simply turn the handle. Good Variety of Films always obtainable

PRICE Complete ONLY **$2.50** Postpaid anywhere Including Two Films

Extra Films, 15c each postpaid



THIS IS A GENUINE MOVING PICTURE MACHINE and the motion pictures are clear, sharp and distinct. The Moving Picture Machine is finely constructed, and is carefully put together by skilled workmen. It is made of Russian Metal, has a beautiful finish, and is operated by a finely constructed mechanism. The projecting lenses are carefully ground and adjusted, triple polished, standard double extra reflector, throwing a ray of light many feet, and enlarging the picture on the screen up to three or four feet in area. The light is produced by powerful gasoline generator, such as is used on the largest automobiles. This throws a dazzling white light on the screen.

It is a solidly constructed and durable Moving Picture Machine. The mechanism is exceedingly simple and is readily operated by the most inexperienced. The pictures shown by this marvelous Moving Picture Machine are not the common, crude and lifeless Magic Lantern variety, but are life-like photographic reproductions of actual scenes, places, and people which never tire its audiences. This Moving Picture Machine has caused a rousing enthusiasm wherever it was used.



JOHNSON SMITH & CO.

Dept. E 8 3224 N. HALSTED ST., CHICAGO

ANARCHIST BOMBS



Consists of a little glass vial, containing in liquid form a chemical which will produce a most horrible odor. One dropped in a room full of people will cause more consternation than a limburger cheese. The smell will certainly disappear in a short time. 3 Boxes for 25c, shipped by express only with a Dollar's worth of other merchandise.

ITCHING POWDER



This is another good practical joke; the intense discomfiture of your victims to everyone but themselves is truly enjoyable. All that is necessary to start the ball rolling is to deposit a little of the powder on a person's hand and the powder can be relied upon to do the rest. The result is a vigorous scratch, then some more scratch, and still some more. 3 Boxes for 25c. Sent only by express. (Must order at least One Dollar's worth of other merchandise.)

"The Baby" Double Action Hammerless Revolver
A HANDSOME AND MOST EFFECTIVE WEAPON

$5.50

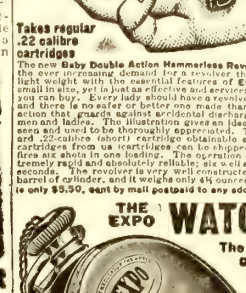
Measures but 4¼ inches long



Takes regular .22 calibre cartridges

The new Baby Double Action Hammerless Revolver has been produced to meet the ever increasing demand for a revolver that would combine small size and light weight with the essential features of Efficiency and Practicability. It is small in size, yet is just as effective and serviceable as the more expensive weapons you can buy. Every lady should have a revolver and should know how to use it, and there is no safer or better one made than this. A great feature is its safety action that guards against accidental discharge, making it quite safe for young men and ladies. The illustration gives an idea of its appearance, but it must be seen and tested to be thoroughly appreciated. The ammunition used is the standard .22-calibre (short) cartridge obtainable anywhere, or you may obtain the cartridges from us (certificates can be shipped only by express). The revolver fires six shots in one loading. The operation of the chambering mechanism is extremely rapid and absolutely reliable; six solid-drawn shots can be fired in as many seconds. The revolver is very well constructed, with finely nickel plated fluted barrel of cylinder, and it weighs only 4¾ ounces. The Price of the Baby Revolver is only $5.50, sent by mail postpaid to any address. JOHNSON SMITH & CO.

THE EXPO WATCH CAMERA
The most wonderful and ingenious Camera made



Price **$2.50**

Is but little larger than a watch, which it closely resembles. You can carry the Expo about in your pocket and take pictures without any one being the wiser.

One Cent a Picture

The Expo loads in daylight with 25 Exposure Films, costing 25c, thus the picture taking part of a whole day at nothing may be had for the nominal sum of 25c—one cent a picture. 10 Exposure Films also obtainable. It is simplicity itself to operate. Takes pictures through the stem, where the Rapid Fire Lens is located. The photos (0/8 x 7/8) may be enlarged to any size.

QUICK AS A FLASH



Time and Instantaneous shutters; weighs but 8 ounces; nickel plated. Endorsed by amateurs and professionals the world over. Thoroughly practical—printing and developing of films just the same as ordinary cameras—in daily use by the police, newspaper reporters, detectives, and the general public. Important beats have been secured with the Watch Camera by enterprising reporters. Produces clear, sharp negatives indoors or outdoors equal to any camera on the market, else or price notwithstanding.

Expo Watch Camera Postage 10c Anywhere **$2.50** FILMS, 10 Exposures 15c, 25 Exposures, 25c Leather Pocket Carrying Case, 35c

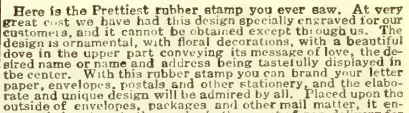
Johnson Smith & Co., Dept. E 8, 3224 N. Halsted St., Chicago

This Pretty WITH PAD — RUBBER STAMP AND INK, 75c



Here is the Prettiest rubber stamp you ever saw. At very great cost we have had this design specially engraved for our customers, and it cannot be obtained except through us. The design is ornamental, with floral decorations, and a beautiful stove in the upper part conveying its message of love, the desired name or name and address being tastefully displayed in the center. With this rubber stamp you can brand your letter paper, envelopes, postals and other stationery, and the elaborate and unique design will be admired by all. Placed upon the outside of envelopes, packages and other mail matter, it ensures their return to the sender in the event of non-delivery for any reason. It boils very pretty stamped on books, music, photographs, etc. With each stamp we include a self-inking stamp pad and a bottle of ink for re-inking the pad, and the PRICE of the COMPLETE OUTFIT, in box, is ONLY 75 CENTS, POSTPAID.

New Vamping Card



No Teacher Needed Surprisingly Simple System

Persons having neglected their Musical Education need not despair, for with the aid of our new VAMPING CARD (placing the card upright over the piano keys), you can at once Vamp away to thousands of Songs, Ballads, Waltzes, Rag Time, etc., etc., equal to a Professional Musician. No knowledge of music is required. After using it a few times, you will be able to dispense with the aid of the Vamping Card entirely. Only 15 cts. p.pd. Johnson Smith & Co., Dept E8

Gigantic New Guinea Butter Beans



The New Edible Vegetable Wonder

Grows to an astonishing size, the Beans measuring from 3 to 6 feet long and weighing anything from 10 to 16 lbs. and even more. One bean is sufficient for a family for several meals. Very palatable and rich in nutritious materials. The delicate Buttery Flavor is much appreciated. The Vines are easily grown, ornamental and most welcome and valuable adjunct to your garden. Try them; you will find them the most delicious vegetable you ever tasted. Imported direct. Unobtainable elsewhere. Sample package of Seeds with full direction for cultivating and cooking. 25c, postpaid.

JOHNSON SMITH & CO. DEPT E8 3224 N. HALSTED STREET CHICAGO

SHARPEN-M-ALL SAFETY RAZOR STROPPER

SHARPENS EVERY KIND OF SAFETY RAZOR BLADE

Sharpens the Gillette and Durham Duplex both edges at one time

ALSO SHARPENS THE GEM JUNIOR, EVER READY, KEEN-KUTTER, MARK CROSS, CLARK, AUTOSTROP, STAR, CRESCENT, AND ALL OTHERS



By using the SHARP-N-ALL STROPPER, you will not only get BETTER SHAVES but you will SAVE MONEY on blades as you will be able to get 100 to 200 shaves from a blade and the last shave will be as good as the first. The construction is simple and cannot get out of order. There are no parts that can possibly get out of order and the user is just as safe as in the most expert barber. It is operated by simply turning the lever or handle as shown in the illustration. It has two spiral rollers that travel from heel to point as they are revolved, giving the CORRECT DIAGONAL STROKE. There are no screws adjustments, or any kind of tinkering necessary to operate the machine. The rollers are made of a special material that STROPS AND HONES the blade at the same time. The rollers turn only one way, so there is no fear of damaging the blade or the stropper. The SHARPEN M ALL is packed in a handsome case, and with it is sent full instructions. The weight of the complete machine is but eight ounces. Price, only $1.00 postpaid.

JOHNSON SMITH & CO., DEPT E8 3224 N. HALSTED STREET CHICAGO

Potmend Stops a leak in a minute



The finest repairer for Ironware, Agateware, Enamelware, etc. Good for kettles, pots, pans, boilers, and every kind of ironware, also for tin, copper, aluminum, ice boxes, iron pipes, cracks in stoves, broken china, porcelain, bric-a-brac, bisque, crockery, woodenware, marble, etc. Will not chip, fly, burn, bake or boil out. THE MEND IS THE STRONGEST SPOT IN THE POT. Could not be simpler; just mix the powder with water. HARDENS LIKE IRON. Fire-proof, Water-proof. You can fill a big hole or a small crack. Mended place stronger than new. Replaces chipped enamel. Anyone can do it: FAILURE IS IMPOSSIBLE. Better and easier than solder. Three sizes, 15 cents, 25 cents and 50 cents.

Johnson Smith & Co., Dept. E8 3224 N. Halsted St., Chicago

SERPENT'S EGGS



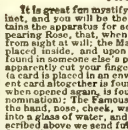
Each box contains 12 Eggs, which are no larger than a grain of oats. When lit with a match, however, each one gradually hatches itself into a Snake several feet long, which curls and twists about in a most lifelike manner. Price per box 10c, postpaid. Johnson Smith & Co.

MYSTIC SKELETON



A jointed figure of a skeleton 14 inches in height, will dance to music and perform various gyrations and movements while the operator may be any distance from it. The figure may be examined by the spectators. When handed back to the operator it is simply placed on a chair or table, when it will seemingly become endowed with life, and begin to move. At the command of the operator it will lie down, stand up, dance, etc. We guarantee satisfaction with each Skeleton, try the aid of which anyone can readily make it perform. 10c postpaid.

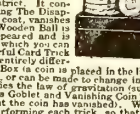
CIGARETTE ROLLER



Very neat and handy. Weighs less than one dram. Capacity of an ounce. It makes better cigarettes than you can buy and makes them easily and quickly. You can use just the tobacco you prefer and thus have a nicer "smoke" than costly brands, and more of them besides saving about half of your money. Just try one and make your cigarettes just to your own liking. Price only 30c or 3 for 25c postpaid, with full instructions for use. JOHNSON SMITH & CO.

MIDGET ILLUSTRATED BIBLE
A Great Curiosity

The Smallest Bible in the World

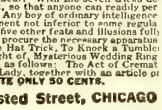


The Midget Bible is a perfect gem, and a work of art. It is about the size of a postage stamp and contains TWO HUNDRED AND FIFTY PAGES of the NEW TESTAMENT, beautifully illustrated. This little Bible is a wonder. It is said to bring good luck to the owner. Must be seen to be appreciated. Price, only 12 cents. Extra Special: 30 cents; one dozen Bibles for $1.00 or 100 for $6.00. Good money can be made selling these Midget Bibles for curiosities, church and Sunday school, Sunday schools, bazaars, etc. Send for a few and try it.

The CONJURER'S CASKET

Apparatus and Directions for a Number of Mysterious Tricks Enough for an Entire Evening's Entertainment

ANYONE CAN DO THEM



50c

It is great fun mystifying your friends. Get this Conjurer's Cabinet, and you will follow in the footsteps of the great. It contains the apparatus for seven first-rate tricks, including The Disappearing Rose, that, when placed in the hand of your self, vanishes from sight at will; the Magic Vase and Ball Trick (a Wooden Ball is placed inside, and upon replacing the lid has disappeared and is found in someone's pocket); The Magic Hat with which you perform apparently cut your finger almost in two; the Wonderful Card Trick (a card is placed in an envelope, and when opened an entirely different card altogether is found); The Disappearing Coin Box (a coin is placed in the little wooden barrel, and when opened again, is found to have vanished entirely, or can be made to change into a coin of another denomination); The Famous Mesmerized Penny that defies the law of gravitation suspends from the palm of the hand, nose, cheek, wall, clothing, etc.); The Glass Goblet and Vanishing Coin Trick (a coin is dropped into a glass of water, and when the water is poured out the coin has vanished). With the seven tricks described above we send full printed instructions for performing each trick, so that anyone can readily perform all the tricks to the great amusement of their friends or the public. Any boy of ordinary intelligence with this Cabinet of Tricks in his possession, can prove a perfect entertainment not inferior to some regular magicians. Besides the tricks contained in the Cabinet, there are twenty-five other feats and illusions fully explained with full printed instructions, for which you can easily make or procure the necessary apparatus. Among them are The Mouse in a Pack of Cards, The Drawn Card, The Hat Trick, To Knock a Tumbler Through a Table, One Cent Robbed into Two, To Find the Number Thought of, Mysterious Wedding Ring, and a Question and Answer Trick. The Art of Cremating a Woman, Walking on the Ceiling of a Room, and the Disappearing Lady, together with an article pertaining to gentlemen and valuable hints to amateur conjurers. PRICE COMPLETE ONLY 50 CENTS.

JOHNSON SMITH & CO., Dept. E 8, 3224 N. Halsted Street, CHICAGO

The Newest Novelty Aerial Balloon



Flies gracefully in or outdoors. This is the VERY LATEST SENSATION IN BALLOONS. A brightly colored balloon that measures sixteen inches long is blown up in the usual way, and when released, the air pressure sends the balloon SOARING UPWARD, the 24-inch propeller SPINNING AROUND AT A LIVELY RATE. The effect is startling. It is a graceful flier that makes the youngsters go WILD WITH JOY. May be used repeatedly indoors or outdoors. An immensely interesting toy. Price 10c each, 3 for 25c psd.

JOHNSON SMITH & CO., Dept. E 8, 3224 N. Halsted Street, CHICAGO

SAVE 1/2 - INSTALL YOUR OWN PLUMBING AND HEATING

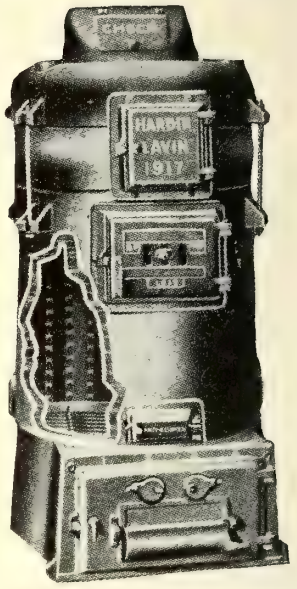
NEW HARDIN EASY WAY HARDIN-LAVIN CO CHICAGO



Reduce the High Cost of Building

Plan and Install Your Own Plumbing and Heating System

Our new HARDIN EASY WAY enables any electrician, carpenter, contractor, builder, or farmer to easily install a complete, highest-grade plumbing system. Forty years' experience selling plumbing and heating goods direct has qualified us to supply material equipped with patented, easily-adjustable connections that any handy man can install himself. Our method is perfect, simple and easy. It will enable you to save on time, labor and materials. It will reduce your installation expense ONE-HALF.



Hardin-Lavin Hot Water Boiler

Send for Handy-Man Book

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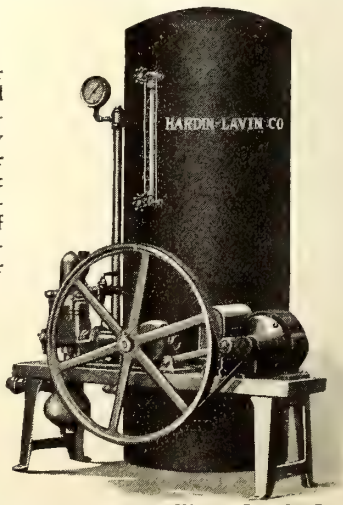


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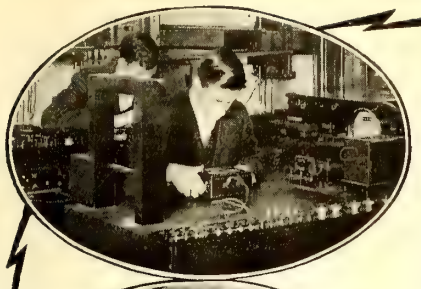


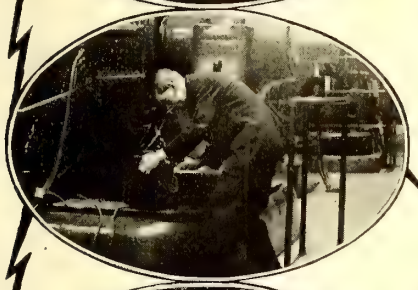
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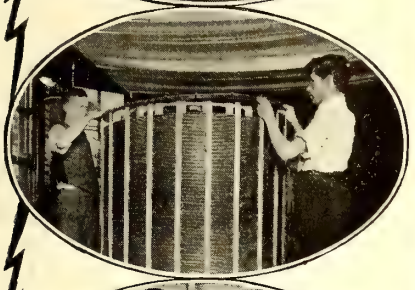
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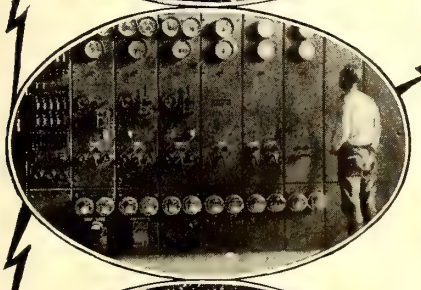


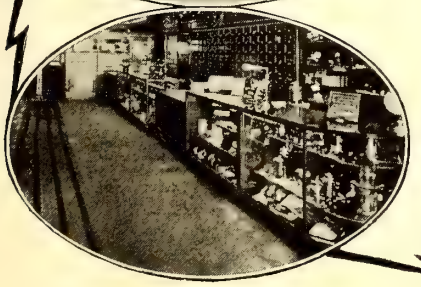












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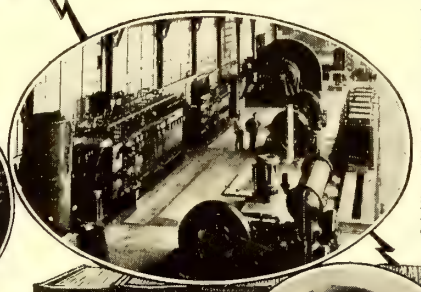
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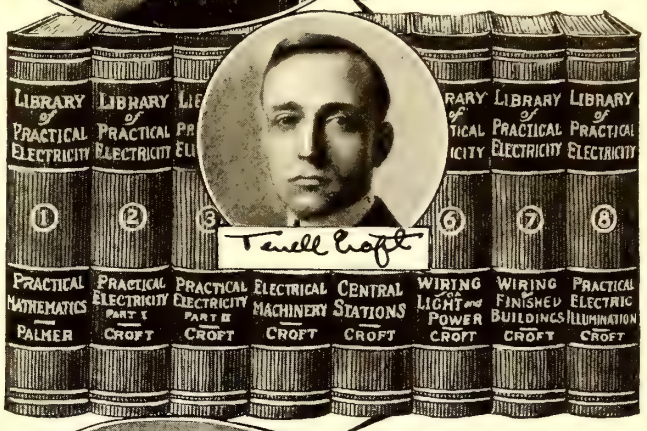
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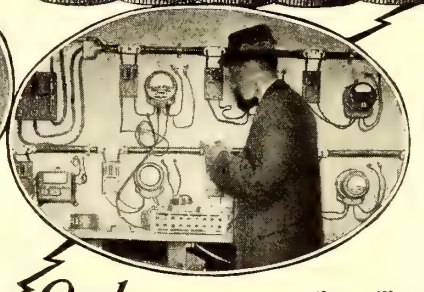
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EDITORIAL

Piped Cold

ONE of the most profound annual summer mysteries of the twentieth century—at least to the writer—is our hot office or our hot home. We would not think of an unheated house or office in the dead of winter with the temperature near the zero point, but curiously enough we allow ourselves to suffer cruelly from the heat in the summer time when the temperature rages up in the nineties. Is it not a most curious world in which we live?

We think nothing of spending fabulous sums in the winter for our coal supply in order to keep warm and comfortable. But in the summer we prefer to spend nothing and suffer untold misery in consequence. Babies and grown up sick folk die like flies by the thousands on account of the heat, while we stand by helpless, or rather as if we were devoid of all intelligence, while the totally unnecessary slaughter goes on incessantly. How our grandchildren will read with astonishment that for decades human beings had their houses piped for heat, but had not enough sense to run a freezing solution or other freezing agent thru the self-same pipes in the torrid summer days!

There might be an excuse for our criminal negligence if we had not the means at hand to keep us cool and comfortable in summer. But we really have all the means, all the apparatus; in fact, everything—including our radiators and pipes. But we prefer not only to let our babies and our feeble old folk die unnecessarily every summer, but we actually lose untold millions of dollars thru non-production when the "dog-days" are upon us. No one can work at his best when the mercury climbs to dizzy heights. Production, whether mental or physical, slows down anywhere between forty and eighty per cent. Statistics prove it. Factories as well as offices slow down and just barely creep along. Think of this enormous, incalculable loss alone, not to mention all the physical suffering due to the heat.

Ah, yes, we *do* have our brave fans—which, however, do not cool at all, but only remind us how hot our bodies are the minute we are not in the immediate vicinity of one of these spinning monuments to our stupidity.

For our dear fans only stir up the hot air *and* the dust. Our skin, wet or moist from perspiration, meets this stirred up air and due to a well known physical phenomenon, *surface evaporation,* we experience a *sense of coolness,* but the air itself is *not* cooled. It is true that surface evaporation produces cold, but in order to have it, it is necessary to let the fans blow upon us, or nearly so, and everyone knows this is far from healthy, frequently producing severe colds. Besides, as soon as we leave the fan our suffering from the heat is all the more acute.

Where is the practical genius who will "study up" on refrigeration and sell us a cheap refrigerating machine which we can connect to our already existing steam or hot water radiators? For the same money which we now spend on fans we ought to be able to buy the machine. And for the money it costs to run the fans we can run the refrigerator, too.

Hundreds of refrigerators have been invented, but the simplest and best no doubt for our purpose is the *cold-air process.* It is based on the principle that the compression of air generates heat and in its subsequent expansion absorbs heat. The air is first comprest, is then past thru a cooler under pressure, after which it is expanded in a cylinder. No chemicals are used with this system and it possesses the very distinct advantage that extremely low temperatures are readily obtainable.

H. GERNSBACK.

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which can unlock the secret chambers of success and throw wide the doors which seem to bar men and women from the Treasure House of Nature.

El Paso, Texas, Oct. 1, 1917.
MR. CHARLES F. HAANEL, St. Louis, Mo.
In Re "The Master Key."

My Dear Mr. Haanel: The value of an idea is determined by its application. Pragmatism has long since spread beyond the confines of Missouri. The world to-day insists on being shown.

The lash of circumstances and the logic of events are, more than ever, impelling men to think. Whether an idea be a new process for picking cabbages, or an old process (Kaiserism, for instance) for preserving kings, we are from Missouri.

A philosophy of life having as its base blind optimism; a religion that won't work seven days a week, or a proposition that isn't practical, appeals to the intelligent not at all. It is results that we want and the acid test is: will it work?

The Master Key qualifies. It is the most lucidly scientific statement of "Truth" that I have seen. It reconciles rationalism and religion; illumines economic determinism and the materialistic conception of history, and is an infallible guide to understanding. It contains in condensed form the substance of an entire library on science. Its teaching, if consistently applied, will make a man healthy, wealthy and wise. Its distribution is supermissionary work in excelsis. Those who wish to think intelligently will find it invaluable.

Intelligence rules. Desire, intelligently directed, is a creative force which automatically causes its object to manifest on a material plane. It is the law. Let him that hath an ear to hear, hear.

Yours truly,
CHAS. A. HEARD.

May 15, 1918.

DEAR MR. HAANEL: Ever since I have been old enough to read, I have been reading metaphysical literature. I have waded ears deep through the books from all ages, all lands, all schools.

I have rejected tons of lies, oceans of misconceptions, an entire universe of false deductions.

I have found grains of truth in mines of folly, and worlds of truth in a single grain. The pursuit was interesting in itself, and I do not regret the time spent upon it. But it was a genuine surprise to read your Master Key System and find within, the essence of all that I had read, with much more added thereto.

In this extraordinary system you have sifted the true from the false; you have given in concrete form all that is worth while in many schools of philosophy.

You have placed arcane truths into the hands of the uninitiated as weapons they can learn to use without danger to themselves. I congratulate you. You are doing mankind a service.

Yours very sincerely,
CHARLES F. OURSLER.
501 Fifth Avenue, New York City, N. Y.

Detroit, Mich., May 28, 1917.

DEAR SIR: The words, "Your world will change as if by magic, the moment you realize the marvelous power within your control," page 6, I have underlined. They state a fact, a real live fact; and to me this is the most wonderful, the most important fact of all—that one may put this knowledge to an immediate test, that one may, after learning of this power, proceed to apply it with a definite knowledge as to results.

W. M. HOWE.

THE LOWE OBSERVATORY
Edgar Lucien Larkin, Director
Los Angeles, Cal., Dec. 6, 1916.
MR. CHAS. F. HAANEL, St. Louis, Mo.

DEAR SIR: Your booklet, Master Key, ought to be expanded into a book. Its teachings that Mind is the all-dominating creative force is precisely in line with the wonders of the most recent psychology. All persons having desks should have this pamphlet thereon. And it would be a fitting pocket companion.

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"The Master Key" is a key with which many are converting loss into gain, fear into courage, despair into joy, hope into fruition; a key with which many are finding health, self-reliance, power; a key which thrills, fascinates, carries conviction, understanding, perception, inspiration, the key which is changing the lives of many and may have an almost unbelievable influence upon your life.

Charles F. Haanel, 423 Granite Bldg., St. Louis, Mo.

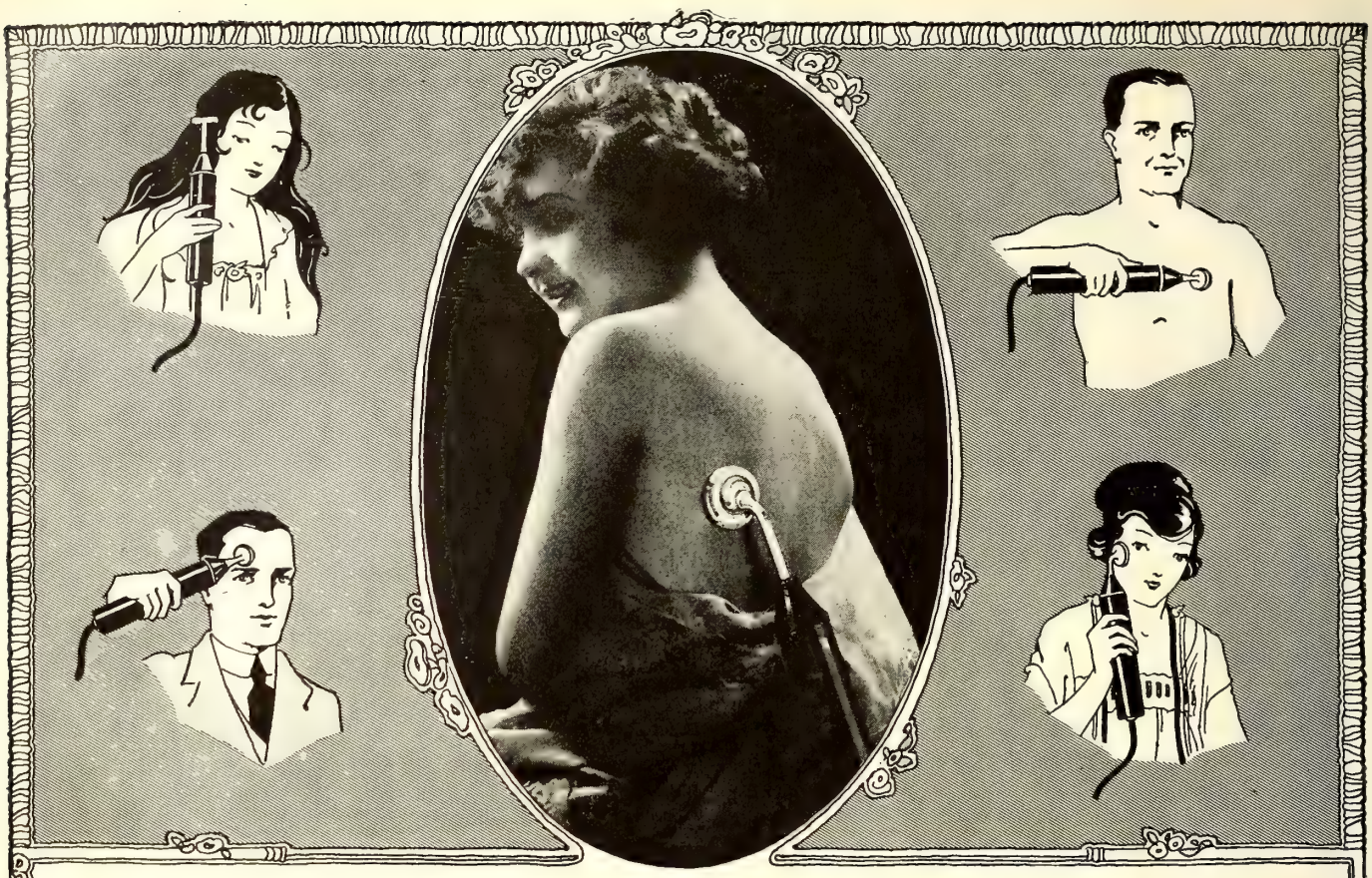
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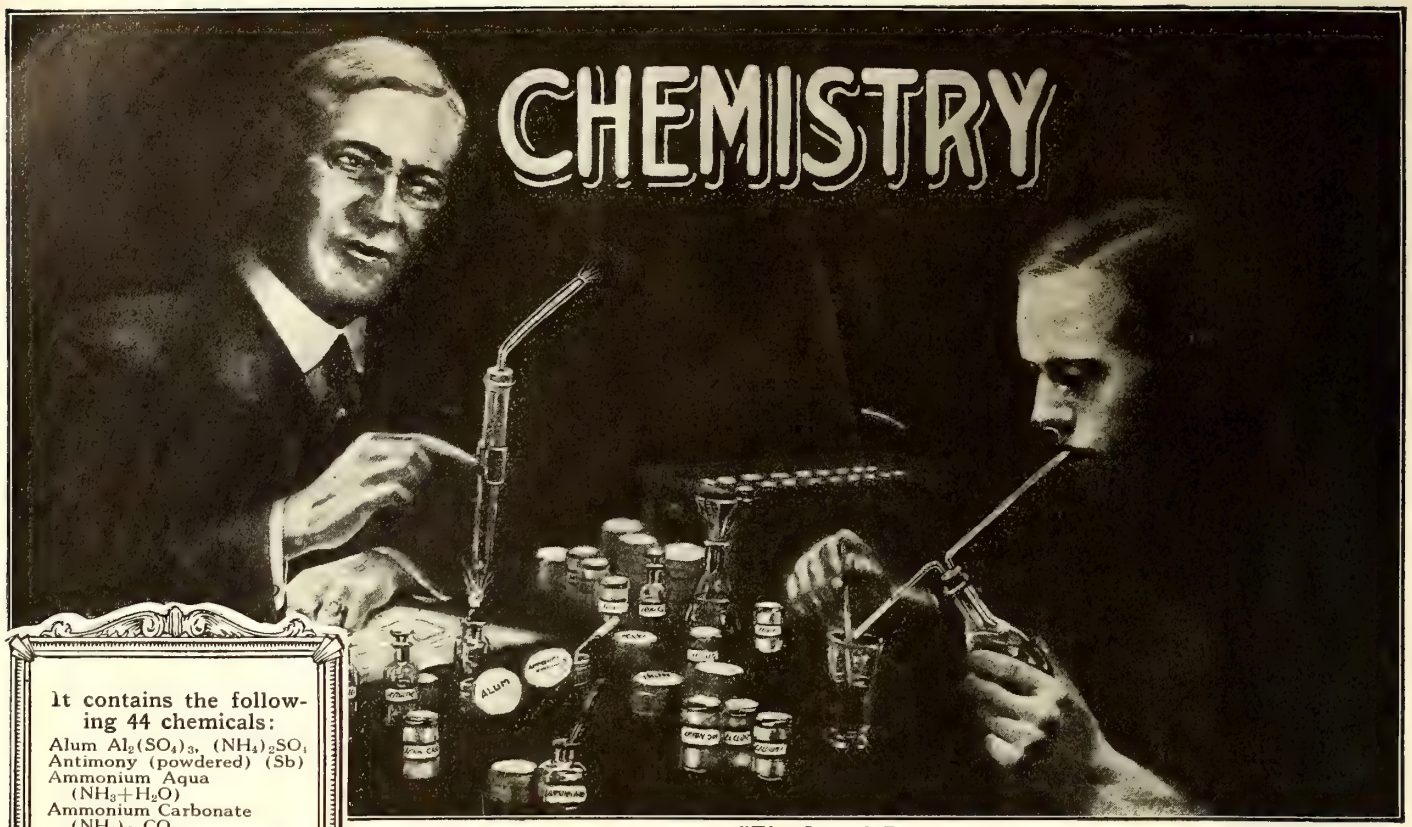
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Ammonium Carbonate $(NH_4)_2\ CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride ($BaCl_2$)
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride ($CaCl_2$)
Calcium Oxide (CaO)
Calcium Sulphate ($CaSO_4 2H_2O$)
Charcoal (Carbon) (C)
Chloride of Zinc ($ZnCl_2$)
Copper Sulphate ($CuSO_4$)
Ferrous Sulphate ($FeSO_4$)
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride ($FeCl_2$)
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate ($MgCO_3$)
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride ($NiCl_2$)
Oxalic Acid ($H_2C_2O_4$)
Sodium Bicarbonate ($NaHCO_3$)
Sodium Borate ($NaBO_2$)
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate ($NaNO_3$)
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride ($SnCl_2$)
Sulphate of Nickel ($NiSO_4$)
Sulphate of Zinc ($ZnSO_4$)
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
Zinc Carbonate ($ZnCO_3$)

The following apparata are furnished:

One Standard Washbottle
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One Conical Glass Measure
One Erlenmeyer Flask
One Glass Funnel
One Delivery Tube
Six Assorted Test-Tubes
One Test-Tube Holder
Ten Sheets of Filter Paper
One Glass Dropper
One Spoon Measure
Glass Tubing
One book containing Treatise on Elementary Chemistry and 100 Chemical Experiments to be performed with this outfit.

DESCRIPTION OF THE OUTFIT:

The outfit consists of forty-four (44) Chemicals all C. P. (chemical pure) put up in appropriate wooden boxes, glass bottles, and hermetically closed jars. The acids are put up in glass bottles, with ground-in glass stoppers and there is a sufficient quantity of chemicals supplied (mostly one to two ounces) enough to make dozens of experiments with each. See list of Chemicals herewith.

The apparata furnished are all of the best obtainable make and of standard laboratory size and shape. A list of the 17 pieces of apparata furnished with this outfit is printed also herewith.

The Instruction book is a real **Chemistry Course for the Beginner.** Some of the Contents are: **Division of Matter:** This is a Treatise on Elementary Chemistry and deals with the theory of the Elements, Molecules and Atoms, etc. **Chemical Nomenclature.** This explains in simple language the derivation of the chemical names of the Elements and their compounds. There is a chapter on **Laboratory Operations; Glass Working; First Aid; Fire Extinguishers; Experimenters' Aphorisms,** etc.

A good part of the book is devoted to Weights and Measures. The Metric System, the English system and the U. S. System are fully explained.

The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

Among the **100 Experiments** are:

How to make chemical tricks; How to make invisible and magic inks; How to test flour; How to test soil; How to Make Chlorine Gas and smoke (German War Gas); How to bleach cloth and flowers. How to produce Oxygen and Hydrogen; How to make chemical colors; How to test Acids and Alkalies and hundreds of interesting hints and formulas.

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Can You Be Given A Better Memory In One Evening?

It has been done for over a quarter of million men and women in all walks of life—what they say about their amazing experiences

A BETTER memory in one evening It sounds impossible. Yet this is exactly what Mr. Roth, the world-famous memory expert, has done for over a quarter of a million men and women—given them a better memory in a single evening!

You've doubtless seen Mr. Roth give his startling memory demonstrations in public. At any rate, you've heard of him.

No one denies that Mr. Roth himself has a remarkable memory—that has been proved beyond question. But many people say that while Mr. Roth's marvelous memory is beyond dispute, it was "born in him," and that it is doubtful if the average man or woman can ever develop a memory that approaches Mr. Roth's. And, least of all, in one evening! A fair question, that. So let us see how it works out in actual practice.

From time to time testimonials have been published from enthusiastic users stating the wonderful memory powers they have developed by following Mr. Roth's method. Evidence from people who have actually done it is conclusive. And, in addition to this, the publishers of Mr. Roth's Memory Course have offered to send it on five days' free trial. No money was asked for. The entire course was sent wholly on approval. The recipient was free to test Mr. Roth's method for five days. Then if he found that it had not brought about a remarkable improvement in his memory, he could return the Course and he wouldn't be out a penny. An offer such as this could not have been made unless the Course would do all that was claimed for it.

Over a quarter of a million Roth Memory Courses have been sent out to the general public—and paid for—on this basis. What happened? This—the publishers were flooded with letters endorsing the Roth Memory Course in the highest possible terms. By far the great majority of people paid for the Course in less than five days. So delighted were they with the remarkable improvement it had made in their memory, that they were eager to own it at once.

If you could drop into the offices of the publishers you would be shown a huge pile of enthusiastic testimonial letters which would take you days to read. They all tell the same story—amazement at the wonderful nature of the Course—enthusiasm over the marked improvement it has made in weak memories—appreciation of the opportunity to possess it—and surprise at the low cost!

These thousands upon thousands of letters of appreciation came from Members of Congress, ministers, doctors, lawyers, professors, teachers, students, managers, clerks, stenographers, bookkeepers, salesmen, factory executives—men and women in all walks of life.

What they say:

"Every business man should avail himself of this wonderful system of Memory Training."
G. L. Helms, Indianapolis, Ind.

"I have studied only the first lesson, but it has proved invaluable."
R. H. Gifford, Chicago.

"Worth thousands of dollars to anyone in business."
J. M. Thompson, Columbus, O.

"It has been of such great value to me as a lawyer that I cannot find words to express my appreciation."
George J. Lemmon, Denver, Col.

"So simple and fascinating that it is play to study it."
E. W. Buckingham, M.D., Norfolk, Va.

"I am amazed at my increased memory powers since studying the first lesson."
Anne S. Leach, Wytheville, Va.

"I am thankful to have your Course. It is worth many times five dollars."
Rev. J. A. Northrup, Streator, Ill.

"The system works like magic."
Ralph D. Stoddard, Cleveland, O.

"I was surprised to see how I improved my memory the first evening."
M. J. Blackenshop, Mohawk, W. Va.

"I find that I can do my work much easier after studying the first two lessons."
A. R. Johnson, Palestine, Texas.

"It has done wonders for me."
Arthur Lippincott, Erie, Pa.

"Wonderful!—I would not sell it for any amount of money."
Ella Busse, State College, Pa.

Here are extracts from a few of the many thousands of letters received from users of the Roth Memory Course:

"You claim to give 'a better memory in one evening.' You ought to change it to 'one hour,' for I improved my memory 100 per cent in one hour."

Many a man who is called upon to speak in public fails to get his message "across" because a weak memory forces him to read from notes. A prominent public man says:

"I have made a wonderful improvement in my ability to speak in public. Formerly I had to read from notes. Now I can speak extemporaneously and get a smash and drive in my talk which amazes me as much as it impresses my audience."

Lots of people who can think keen thoughts fail miserably when it comes to talking them. They blame their lack of confidence and a limited vocabulary. In most cases the real cause is a weak memory. An enthusiast writes:

"No longer do I stammer, and sputter my words. Now I am looked upon as a brilliant conversationalist, and the Roth Memory Course did it."

Many a business man is handicapped because he cannot instantly recall prices, selling talks, and other data about his business. A salesman says:

"I had been trying to memorize a selling talk for several weeks, but failed completely. By applying Mr. Roth's principles I memorized it in thirty minutes."

The main handicap of the young man in business is lack of experience. Experience is largely a matter of never forgetting facts and experiences which apply to the matter under consideration. A young man says:

"I have just been promoted to an important position which I never dreamed of getting for at least five years. The Roth Memory Course got me the promotion by enabling me to instantly recall all the vital facts and figures about our business which I have ever learned."

Educators by the score write in to say that the Roth Memory Course should be taught in every school and college, and that it would not only make better students, but would considerably shorten the period of instruction.

The father of a little girl of 13 says: "As a result of using Mr. Roth's principles my little girl's papers are rated the highest in the class."

Students by the dozen say that the Roth Memory Course enables them to master in a few hours studies that formerly required weeks of grinding effort.

One of the greatest surprises about the Roth Memory Course is that there is really nothing to study and no hard work to do. It is largely a question of following a few simple principles. In one hour you can improve your memory—in an evening you can easily double its power—and inside of a week you can have a memory that will surprise you as well as your friends.

"I am amazed at the simplicity of this wonderful work"—"studying it is a continuous pleasure"—"The system works like magic"—"I am thrilled by the power the Course gives me"—"It is as simple as child's play and as efficient as a filing cabinet"—expressions like these have been written in by the score.

And the price!—

"The first lesson alone is worth 100 times $5," says one enthusiast. Hundreds of people have stated that they would gladly have paid many times the price of five dollars. "I am sending you the money by return mail,"—and "I've never let go of a 'five' with so much pleasure," says another.

You have always wanted a "good memory." Now you can have it. There is no laborious study to undertake. Mr. Roth shows you that a good memory depends mainly on applying a few simple principles which you can learn in less than thirty minutes. You can master the whole Course in a few hours of delightful reading.

Here is what you will find after you apply Mr. Roth's simple principles: Names and faces will flash instantly to your mind. Facts and figures which you now forget, or laboriously write down, will be on the tip of your tongue the instant you want them. Your conversational powers will improve wonderfully. The right word, the right expression, the right thought will almost speak itself the instant you want it. Never again will you be humiliated by saying, "I forgot!" Once put a thing into your mind and it will be there as permanently as though etched in steel, and as easily recalled as taking a card out of a card-index. Your mental powers will become sharper and quicker. At all times you will have that keenness of mind most men experience only occasionally. Your self-confidence will increase. You will thrill with a new sense of power. You will——

But there's no need to go further. For you can see for yourself, at no cost, exactly what the Roth Memory Course will do for you. Merely fill in and mail the coupon. Send no money. The complete Course will be sent to you immediately, all charges prepaid. Examine it thoroughly. Test it in every way you can think of. Apply its simple principles. Note the almost magical change it brings about in your memory.

Then, after you have done this, if you feel that you can possibly afford to be without the Roth Memory Course, send it back and you will owe nothing But if you feel, as over a quarter of a million others have felt, that you simply cannot afford to be without the Roth Memory Course, then send only five dollars in full payment.

In one week from today you can have a memory that will thrill you with power and amaze your friends. You can do this if you mail the coupon NOW.

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is announced in the July issue of RADIO AMATEUR NEWS.

"An Ideal Receiving Outfit" is the subject of the contest. $100.00 in cash prizes for the best manuscripts submitted.

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Dr. Lee de Forest, Inventor of the Audion
Dr. Greenleaf W. Pickard, Inventor of the Crystal Detector
Dr. Louis Cohen, Ph.D., Radio expert and inventor
Samuel D. Cohen, Amateur Radio expert
H. W. Secor, Assoc. I.R.E., Associate Editor, Electrical Experimenter
H. Gernsback, Editor, Electrical Experimenter & Radio Amateur News
Fritz Lowenstein, Radio expert

EXPERIMENTER PUBLISHING COMPANY, 231 Fulton Street, New York City



"I was astounded at my new power over men and women. People actually went out of their way to do things for me—they seemed EAGER TO PLEASE ME"

The Secret of Making People Like You

"Getting people to like you is the quick road to success—it's more important than ability," says this man. It surely did wonders for him. How he does it—a simple method which anyone can use instantly

ALL the office was talking about it and we were wondering which one of us would be the lucky man.

There was an important job to be filled—as Assistant-to-the-President. According to the general run of salaries in the office, this one would easily pay from $7,000 to $10,000 a year.

The main requisite, as we understood it, was striking personality and the ability to meet even the biggest men in their offices, their clubs and their homes on a basis of absolute equality. This the firm considered of even more importance than knowledge of the business.

YOU know just what happens when news of this sort gets around an office. The boys got to picking the man among themselves. They had the choice all narrowed down to two men—Harrison and myself. That was the way I felt about it, too. Harrison was big enough for the job, and could undoubtedly make a success of it. But, personally, I felt that I had the edge on him in lots of ways. And I was sure that the firm knew it too.

Never shall I forget my thrill of pleasure when the president's secretary came into my office with a cheery smile, looked at me meaningly, handed me a bulletin, and said, "Mr. Frazer, here is the news about the new Assistant-to-the-President." There seemed to be a new note of added respect in her attitude toward me. I smiled my appreciation as she left my desk.

At last I had come into my own! Never did the sun shine so brightly as on that morning, and never did it seem so good to be alive! These were my thoughts as I gazed out of the window, seeing not the hurrying throngs, but vivid pictures of my new position flashing before me. And then for a further joyous thrill I read the bulletin. It said, "Effective January 1, Mr. Henry J. Peters, of our Cleveland office, will assume the duties of Assistant-to-the-President at the home office."

PETERS! Peters!—surely it *couldn't* be Peters! Why, this fellow Peters was only a branch-office salesman. . . . *Personality!* Why, he was only five feet four inches high, and had no more personality than a mouse. Stack him up against a big man and he'd look and act like an office boy. I knew Peters well and there was nothing to him, nothing at all.

January the first came and Peters assumed his new duties. All the boys were openly hostile to him. Naturally, I felt very keenly about it, and didn't exactly go out of my way to make things pleasant for him—not exactly!

But our open opposition didn't seem to bother Peters. He went right on with his work and began to make good. Soon I noticed that, despite my feeling against him, I was secretly beginning to admire him. He was winning over the other boys, too. It wasn't long before we all buried our little hatchets and palled up with Peters.

The funny thing about it was the big hit he made with the people we did business with. I never saw anything like it. They would come in and write in and telephone in to the firm and praise Peters to the skies. They insisted on doing business with him, and gave him orders of a size that made us dizzy to look at. And offers of positions!—why, Peters had almost as many fancy-figure positions offered to him as a dictionary has words.

WHAT I could not get into my mind was how a little, unassuming, ordinary-to-look-at chap like Peters could make such an impression with every one—especially with influential men. He seemed to have an uncanny influence over people. The masterly Peters of today was an altogether different man from the commonplace Peters I had first met years ago. I could not figure it out, nor could the other boys.

One day at luncheon I came right out and asked Peters how he did it. I half expected him to evade. But he didn't. He let me in on the secret. He said he was not afraid to do it because there was always plenty of room at the top.

What Peters told me acted on my mind in exactly the same way as when you stand on a hill and look through binocular glasses at objects in the far distance. Many things I could not see before suddenly leaped into my mind with startling clearness. A new sense of power surged through me. And I felt the urge to put it into action.

Within a month I was getting remarkable results. *I had suddenly become popular.* Business men of importance who had formerly given me only a passing nod of acquaintance suddenly showed a desire for my friendship. I was invited into the most select social circles. People—even strangers—actually went out of their way to do things for me. At first I was astounded at my new power over men and women. Not only could I get them to do what I wanted them to do, but they actually anticipated my wishes and seemed eager to *please me.*

One of our biggest customers had a grievance against the firm. He held off payment of a big bill and switched to one of our competitors. I was sent to see him. He met me like a cornered tiger. A few words and I calmed him. Inside of fifteen minutes he was showering me with apologies. He gave me a check in full payment, another big order, and promised to continue giving us all his business.

I could tell you dozens of similar instances, but they all tell the same story—the ability to make people like you, believe what you want them to believe, and to do what you want them to do. I take no personal credit for what I have done. All the credit I give to the method Peters told me about. We have told it to lots of our friends, and it has enabled them to do just as remarkable things as Peters and I have done.

BUT YOU want to know what method I used to do all these remarkable things. It is this: You know that everyone doesn't think alike. What one likes another dislikes. What pleases one offends another. And what offends one pleases another. Well, there is your cue. You can make an instant hit with anyone if you say the things they want you to say, and act the way they want you to act. Do this and they will surely like you, and believe in you, and will go out of their way to PLEASE YOU.

You can do this easily by knowing certain simple signs. Written on every man, woman and child are signs, as clearly and as distinctly as though they were in letters a foot high, which show you from one quick glance exactly what to say and to do to please them—to get them to believe what you want them to believe—to think as you think—to do exactly what you want them to do.

Knowing these simple signs is the whole secret of getting what you want out of life—of making friends, of business and social advancement. Every great leader uses this method. That is why he is a leader. Use it yourself and you will quickly become a leader—nothing can stop you. And you will want to use it if for no other reason than to protect yourself against others.

WHAT Peters told me at luncheon that day was this: "Get Dr. Blackford's 'Reading Character at Sight.'" I did so. This is how I learned to do all the remarkable things I have told you about.

You have heard of Dr. Blackford, the Master Character analyst. Many concerns will not employ a man without first getting Dr. Blackford to pass on him. Concerns such as Westinghouse Electric and Manufacturing Company, Baker Vawter Company, Scott Paper Company and many others pay Dr. Blackford large annual fees for advice on dealing with human nature.

So great was the demand for these services that Dr. Blackford could not even begin to fill all her engagements. So Dr. Blackford has explained the method in a simple seven-lesson course entitled "Reading Character at Sight." Even a half-hour's reading of this remarkable course will give you an insight into human nature and a power over people which will surprise you.

Such confidence have the publishers in Dr. Blackford's Course, "Reading Character at Sight," that they will gladly send it to you on approval. Send no money. Merely fill in and mail the coupon. The complete course will go to you instantly, on approval, all charges prepaid. Look it over thoroughly. See if it lives up to the claims made for it. If you do not want to keep it, then return it, and the transaction is closed. And if you decide to keep it—as you surely will—then merely remit Five Dollars in full payment.

Remember, you take no risk, you assume no obligation. The entire course goes to you on approval. You've everything to gain—nothing to lose. So mail the coupon NOW, while this remarkable offer remains open.

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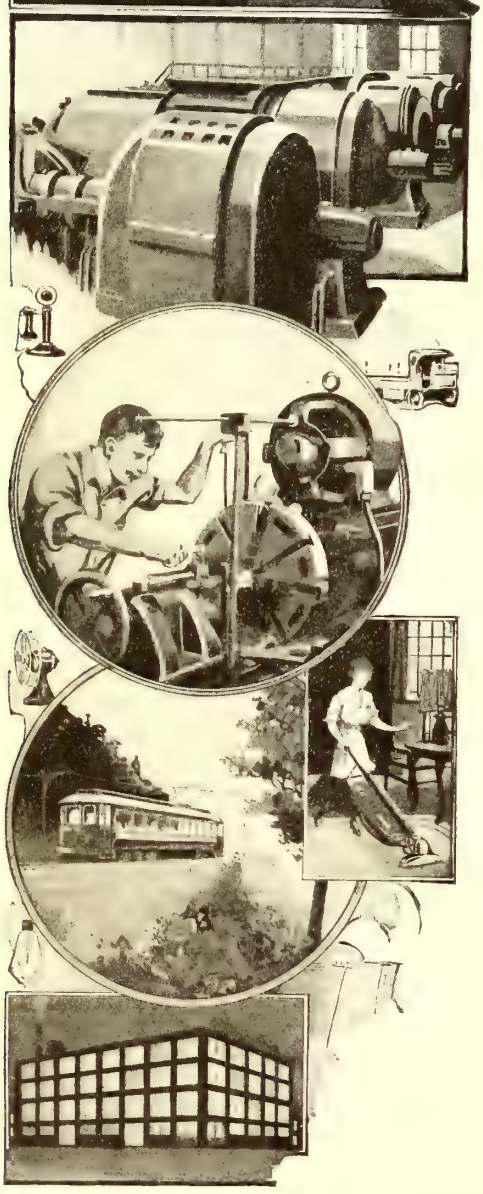
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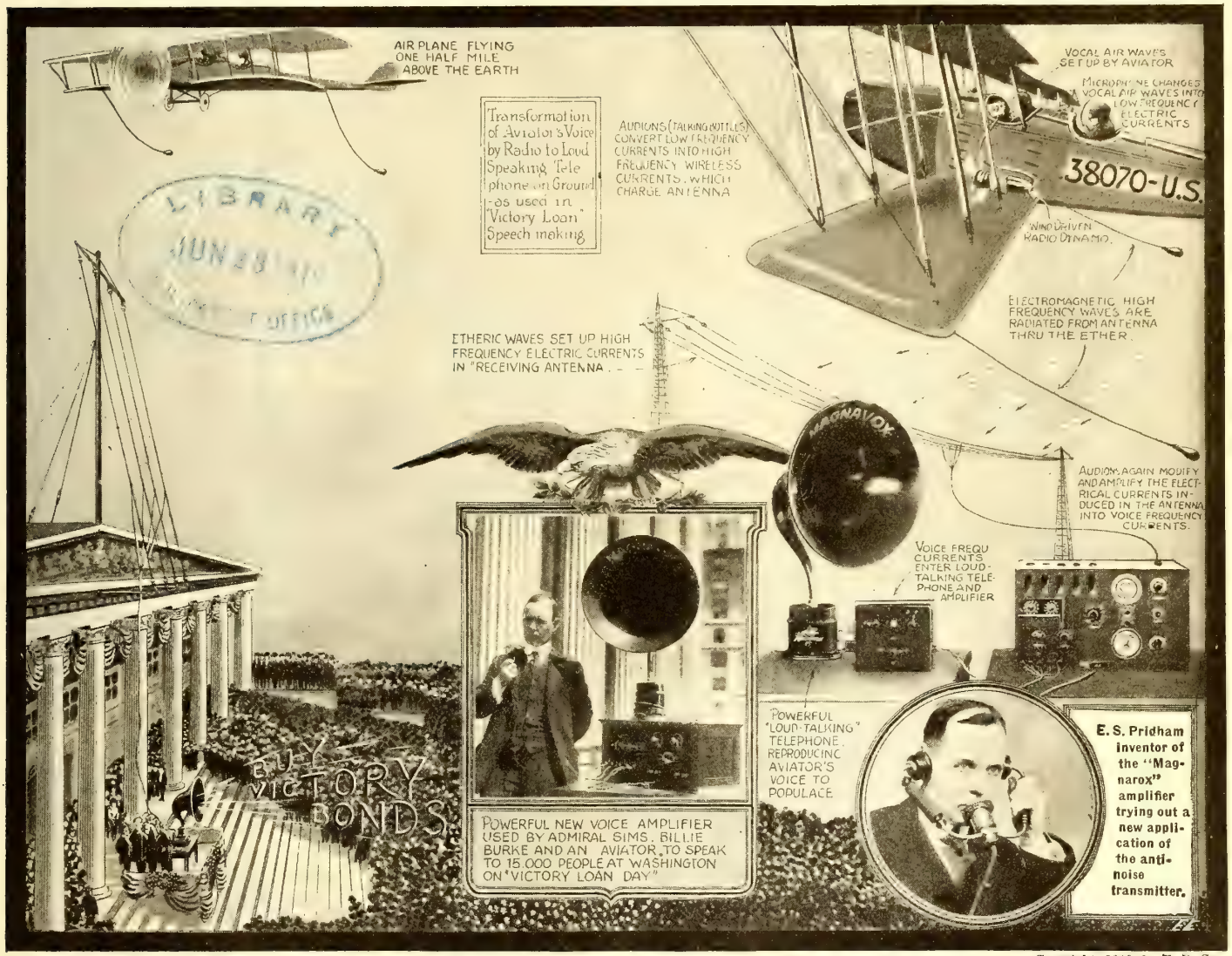
Talking from 'Plane to Earth

How it is Done Explained in Non-Technical Terms

"HELLO! hello, Treasury!" cried the aviator. "I am now 2,600 feet over you in plane 38,070 from Bolling Field." The aviation officer then read President Wilson's "Victory Liberty Loan" message by wireless, thru the air, and concluded by bidding good-bye to the crowd. Lieutenant H. E. Metcalf, the radio officer aboard the 'plane, talked from an airplane flying 2,600 feet overhead to 15,000 persons assembled at the southern steps of the Treasury, at Washington, D. C., by the use of the wireless telephone and a newly invented *sound amplifier*, which possesses great power.

The throng of Government employes, dismissed for the capital's opening demonstration for the loan, cheered the President's message as spoken thru the air and enun-

(*Continued on page* 281)



Copyright, 1919, by E. P. Co.

Thanks to the Remarkable Developing of the "Loudspeaking" Wireless Telephone in His Absence, President Wilson Will Be Able to Talk to His Constituents on This Side of the Atlantic from Midocean on His Way Home. It is estimated that the President's Voice May Be Heard by 50,000 Persons Grouped About a Reproducer Here, While He Is Yet 1,000 Miles at Sea. The New Wireless Telephone Device Is the Invention of Three San Francisco Men—E. S. Pridham (Shown in the Picture), P. L. Jensen and O. B. Moorehead. It Consists of an Anti-Noise Transmitter, Called a "Magnavox," and an Amplifier. It was Used by Admiral Sims and Billie Burke When They Addrest 15,000 People on the Steps of the United States Treasury Building, Washington, D. C. Mr. Pridham, on "Victory Loan Day," April 21, Personally Supervised the Demonstration of the Wonderful New Anti-Noise Telephone That Made Telephone History. An Aviator 2,600 Feet (One-Half Mile) Overhead Spoke, With This Instrument, to 15,000 People Thru a "Magnavox" Amplifier.

Talking Thru the Trees

By MAJOR-GENERAL GEORGE O. SQUIER

Chief Signal Officer, U. S. Army

How Trans-Atlantic Radio Messages Are Copied Via Tree Antenna

European Radio Signals, Via the Trees.

AS long ago as 1904, the author conducted some experiments with a view to utilizing growing trees as *antennae* for radio-telegraphy and discovered the efficacy, in a general way, of using a direct metallic contact to certain trees (principally *eucalyptus*) to increase the audibility of radio signals. My attention was first called to this phenomenon during the course of summer maneuvers of the Army at Camp Atascadero, Calif., where, due to the prevalence of the dry season and the unusual character of the soil, it was found that the regular Army buzzer telephone and telegraph sets were inoperative with any ordinary ground or earth but became operative when connected to a metallic nail driven in the trunk or roots of a *live tree*. This incident led the author to pursue the subject experimentally in the autumn of 1904 continuing the experiments to the range of frequencies then employed in radio-telegraphy.

Tree Antennae.

In connection with the organization and development of *Transatlantic radio reception*, which was carried out during the period of the war to provide against the possibility of the interruption of the submarine cable system, the Signal Corps established a chain of special receiving stations in different parts of the United States to copy and record enemy and Allied radio messages from European stations for the information of our Army General Staff.

In the prosecution of this work, directions were given to the Signal Corps Laboratory at Camp Alfred Vail, Little Silver, N. J., and also to the experimental staff in Washington to test the efficiency of *growing trees* as receiving antennae, in connection with this service, using the vastly superior technique and facilities now represented in the radio Art as compared with the crude apparatus with which the discovery was made in 1904. With a collection of apparatus representing the most advanced state of the radio Art, the problem, as a war measure, was attacked anew and has now reached a point where a very brief outline of some of the physical results obtained should be presented in the interests of the development of the Art in general. Since the phenomena involved embrace a variety of physical problems rather than strictly engineering ones, these data are presented in the hope that our scientists may see in the experiments some points of departure for further research.



Signal Corps Photo

The U. S. Signal Corps Laboratory Near Washington, D. C., Where Remarkable Results Were Obtained Using Living Trees as Radio Antennae. Signals from Europe and Other Countries Were Easily Copied. Trees Have Been Successfully Used Also for Radiophone Transmission. Insert View: Major General George O. Squier, Inventor of "Tree Wireless."

It was immediately discovered that with the sensitive amplifiers now in use it was possible to *receive signals from the principal European stations* by simply laying a small wire netting on the ground beneath the tree and connecting an insulated wire *to a nail driven in the tree well within the outline of the tree top*. See Fig. 1. Messages having been received from England, France, Germany and Italy.

This encouraging first result justified a more careful examination of the phenomena and the most suitable arrangement of circuits for the purpose.

And Now the "Floraphone."

The messages carried over this tree telephone and telegram system have been named by the writer. They are to be "floragrams." The tree telephone is to be a "floraphone"; the tree telegraph a "floragraph."

The discovery is now announced after experiments covering fifteen years, beginning in California and continuing intermittently until the outbreak of the war, when they went forward with vigor as an emergency means of communication. The system was utilized during the war in "listening in" on the German radio communication.

The final development took place in a small portable laboratory, purchased from a mail order house, capable of being carried to any place in the woods. A group of soldiers, sleeping in the house and taking turns at copying messages, assisted the writer in the development of the apparatus.

Without entering into the details of these preliminary experiments here it may be said that one of the best receiving arrangements is found to be an elevated tree earth-terminal in the upper part of the tree top, *and an earth consisting practically of several short pieces of INSULATED wire, SEALED AT THE OUTER END, radiating out from a common center, and buried a few inches beneath the surface of the ground in the neighborhood of the tree.* See Fig. 2.

It was soon found that a tree-antenna could be used efficiently as a *multiple radio receiving set over widely different wave lengths*, see Fig. 3A, receiving either from separate terminals at the same (shown dotted in Fig. 3A) or different heights of the tree, *or in series from the same terminal.* See Fig. 3B.

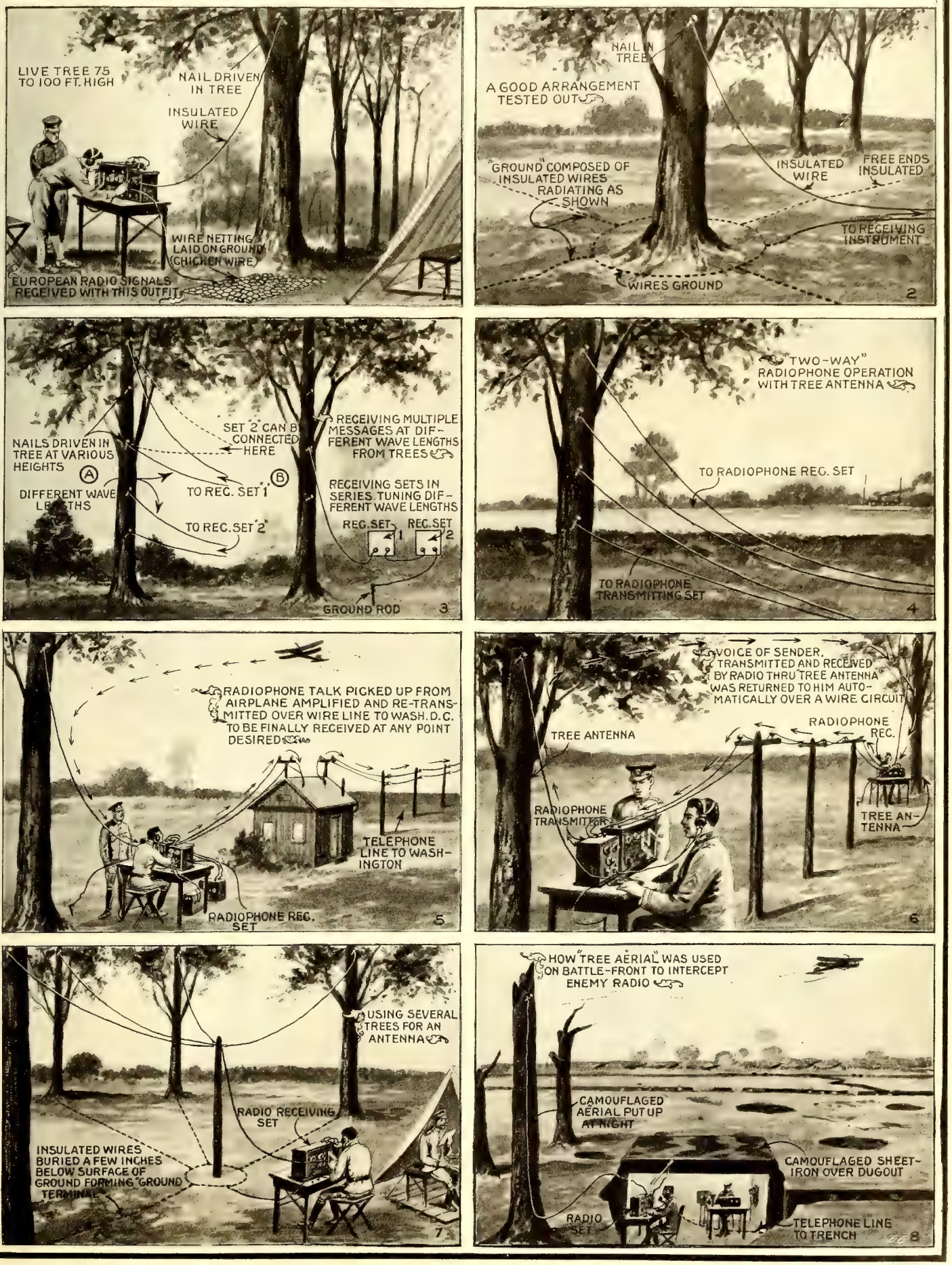
This same type of circuit was employed in an inverse manner for radio-telephonic transmitting purposes, altho the experiments thus far have been limited to short distances. It was found that *2-way radio telephonic communication* was easily established with remarkably low values of transmitting antenna current. See diagram of this test illustrated at Fig. 4.

The flexibility of this arrangement is very striking. The linking up of *wire* and *wireless* methods was found to be both convenient and efficient. *Radio-telephonic messages from airplanes* were readily received by the tree-antenna arrangement and *transferred thence to the wire system* of the city of Washington and finally received at any point desired. See Fig. 5.

Furthermore, *radio-telephonic transmission* thru the tree-antenna was *received by*

(*Continued on page* 271)

TREE WIRELESS



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FULL DESCRIPTION OF TREE AËRIALS ON OPPOSITE PAGE.



Copyright, 1919, by E. P. Co.

Dashing Thru the Night With Flames Spouting from Their Exhaust Pipes, and Propellers Whirling, Shoot These Captive Airplanes With Their Joy-Seeking Passengers. The Latest Idea in the Summer's Pleasure Grounds. The "Bronx Exposition Amusement Park," in New York City, Will Feature This Diversion. It Gives All the Thrills of a Real Ride in an Airplane.

A Dash to the Clouds

By GEORGE HOLMES

THE restless feeling that comes to everyone at the first sign of spring—the trees budding, birds returning from the South and gaily announcing the rise of the sun each morn—stirs the blood of every man, woman and child, the young or old, and makes them want to get out into the great outdoors. Those who are not able to go far away into the hills, mountains and seashore for extended periods to cure this "spring fever" must needs find some attraction nearer home. The average person dwelling in the city in the little cigar boxes we are wont to call apartments finds himself cramped for room. It is like the old story of the dog who was forced to wag his tail up and down, instead of sideways. He *had* to wag it up and down because the walls of the apartment were too close together and he could not wag it any other way.

Enterprising business men have found a solution for the everyday worker and his family, by bringing within easy reach amusement parks and seaside resorts, where he may either spend a week with his family or have his family there during the week and be able to go there himself in the evenings after he is thru with the business of the day, and also on Saturdays and Sundays. Principal among these resorts, one rather new and practically in its infancy, but rapidly growing, is the *Bronx Exposition Amusement Park,* within the boundary of New York City.

Just a short time ago, in visiting the grounds, you could hear the hammering and sawing of carpenters, the concrete mixers running, steel and structural workers on the job, and general signs of activity. To the layman this work has always proven of great interest, but so few have the opportunity of witnessing these gigantic buildings rise as if from nothing. Usually under cover in great secrecy, these surprises are manufactured. On the opening day, the great crowds of visitors come to gasp in astonishment at the amazing array of amusement devices, both old and new, devised and evolved during the long winter slumber between seasons.

This year we have what is perhaps the largest, greatest and most spectacular device ever before shown to the public. In the many years of fairs, expositions and amusement parks, gone by, we have never before witnest a most startling affair than that of the *"Captive Airplane"* complete in every detail, spouting flames from its exhausts, and the whirring of the propeller, mounting higher and higher into the heavens, and then shutting off its power, in a series of dips taking away one's breath, gradually coming back to the starting point. This device, which has never been tried out before, even in the model form, is being constructed from plans evolved as the work progresses, and has every possibility of becoming a success. There will be several machines which will consist of the regular airplane body, wings and necessary stays. In addition there will be a motor attached to the propeller. This motor and propeller will be more for attraction and sensation than actual driving power. The cars themselves will travel on a monorail track driven by electric power taken thru a contact shoe to the rail and back to the motors underneath the car. This machine will start from a height of about 5 feet above the ground and gradually rises over a steep incline several hundred feet over the tops of the amusement buildings, and, arrived at the top, the power will be shut off, when the car will begin its dizzy descent of the many loops of monorail track. Death defying, some people might say, but so scientifically and carefully is this device constructed that there is not the least bit of danger to any of the sixteen passengers in the car. Most glorious will be the spectacle at night when the many lights of the park and searchlights will play upon the snorting monster of the air as it carries its load of pleasure-seekers on its startling trip thru the clouds, for then it will present the true airplane appearance, as no track will be visible. It will give an effect far greater than can ever be shown in our illustration.

Approximately 175,000 feet of lumber will go into the making of this new airplane railway. The railway itself from start to finish will be 3,200 feet in length, each car carrying sixteen persons. The

(*Continued on page* 244)

The Oyster's Autograph

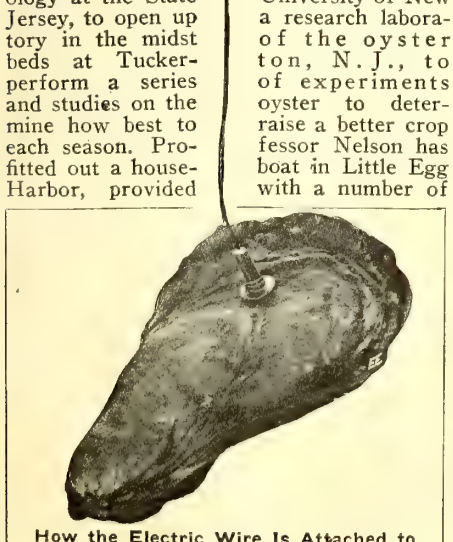
How the Oyster tells us when he eats

IF we could learn what food the oyster really needs, we could then raise better crops of this highly delicious and edible sea food. Not being possest of any supernatural powers, we must resort to some crude means, mechanical or electrical, for determining the environment factors and the foods which are best suited to the oyster. This field up to a short time ago had not been investigated to any appreciable extent. Heretofore, the growth of the oyster had been left mostly to fishermen, who, in raising these oysters in the oyster beds, had not been doing all that was best for them, causing illness and even deaths in many instances by poisoning in one form or another thru eating oysters which had possibly reposed in sewage or other polluted waters.



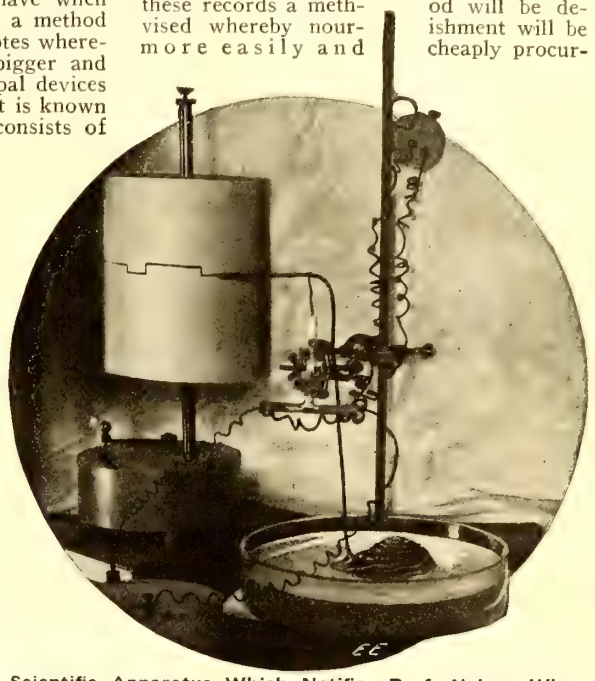
Professor Thurlow C. Nelson, Who Is Making a Scientific Study of the Oyster. He Is Here Seen Wiring an Oyster Preparatory to Feeding It. See Recording Apparatus at Right.

It remained for Professor Thurlow C. Nelson, Assistant Professor of Zoölogy at the State University of New Jersey, to open up a research laboratory in the midst of the oyster beds at Tuckerton, N. J., to perform a series of experiments and studies on the oyster to determine how best to raise a better crop each season. Professor Nelson has fitted out a house-boat in Little Egg Harbor, provided with a number of ingenious contrivances to aid him in gathering a fund of information as to the oyster's routine, particular stress being made on what he normally eats, and the effects that certain foods will have when fed to the bivalves. In this way a method may be determined from these notes whereby we can grow and breed a bigger and better oyster. One of the principal devices used in these experiments is what is known as a standard recorder, which consists of a drum with a cylinder mounted on it, and a cross-sectioned chart paper, on which the oyster records its various minute movements. To the oyster itself a wire is attached, which is connected to the indicator. When the oyster opens, the movement of the shell closes an electric circuit. The indicator or recorder then functions, and the observer can read on the drum the time that it takes to open, how long it remains open, and when the shell closes again!



How the Electric Wire Is Attached to an Oyster's Shell.

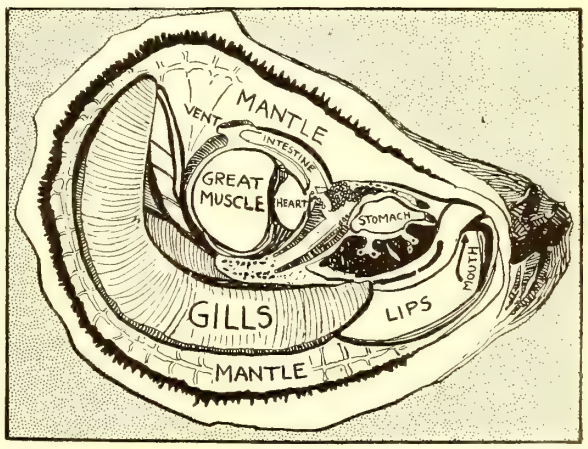
With the closing of this electric circuit, a bell rings notifying the attendant that the oyster is displaying some activity. By means of this apparatus it will be possible to determine the time, day or night, that the oyster feeds, the frequency of these periods and their duration and the kind of food that is consumed over any period. Just what kinds may be learned by removing the oyster from this apparatus and noting its weight after a period of treatment, the weight before going under the treatment being also carefully noted. A microscopic examination of the stomach is then made which shows the contents before assimilation. The rate of growth can also be studied in connection with the effects of artificial feeding. It is a generally accepted fact that it requires three seasons before an oyster reaches market maturity. It therefore becomes obvious that any reduction of this period will result in many advantages to the oyster grower, and also it will mean cheaper oysters to the consumer, with less chance of getting typhoid fever. The U. S. Government has conducted many experiments with oysters in different bodies of water. According to data issued in their bulletins, they have found that many of the tricks of the oysterman have robbed the oyster of much of its nutritive value. Another factor is the danger from disease infection in the waters which are saturated with filth from city sewers. Professor Nelson is now conducting experiments to collect a fund of definite knowledge of the oyster's dietary requisites. From these records a method will be devised whereby nourishment will be more easily and cheaply procurable. The natural flavor variety of oyster will again be restored, and the *drinking* process now used among dealers will be abandoned.



Scientific Apparatus Which Notifies Prof. Nelson When the Oyster Is Feeding and Records the Movement of Its Shell. Electricity Actuates the Instrument.

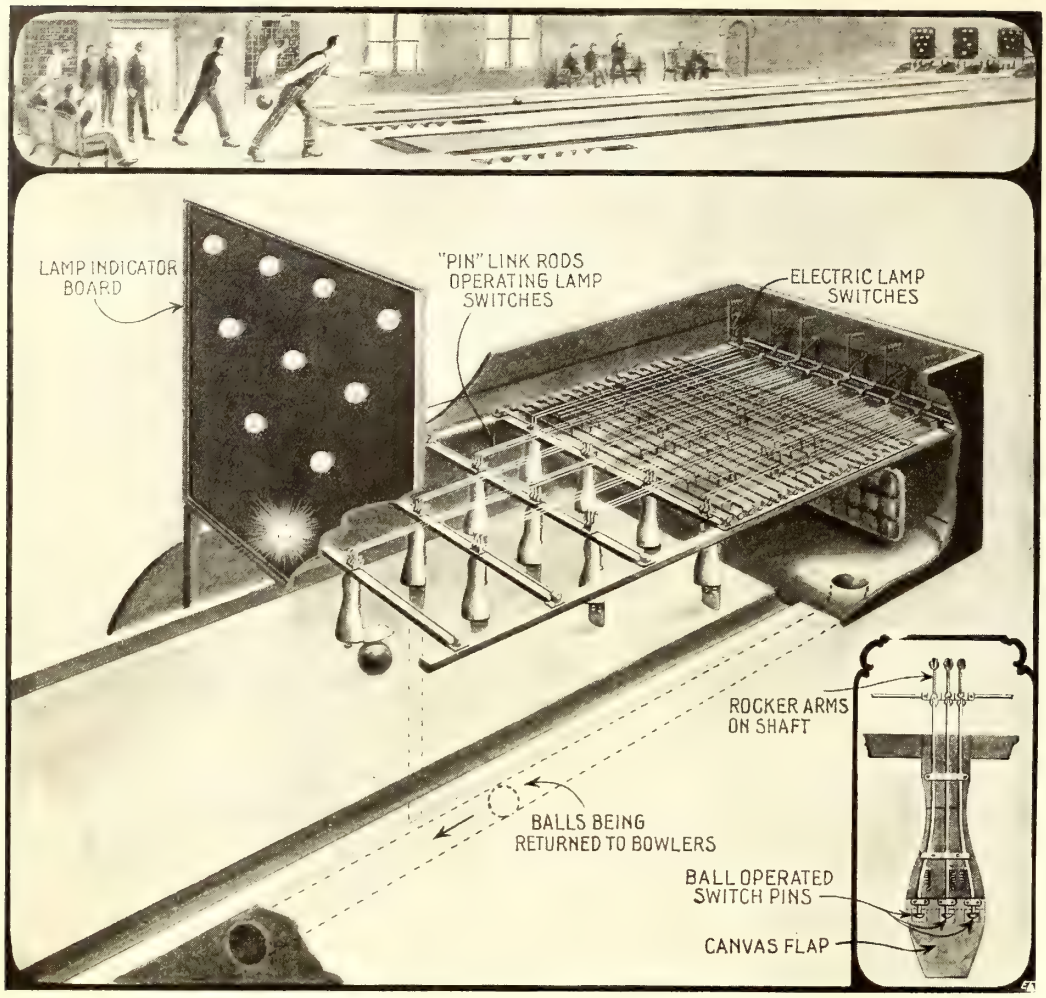
The *drinking* or *plumping* fraud as practised on consumers hoaxes the uninformed into the belief that the resulting bloated whiteness of the bivalves is a mark of par-excellence. As a matter of fact, the oyster so treated loses the greater part of its flavor, and due to conditions under which the trick is carried on, there is the likelihood of its being laden with germs, which may cause serious illness and in many cases death. Thousands of cases of typhoid fever and various other stomach and intestinal troubles result from the con-

(*Continued on page 244*)



The Anatomy of the Oyster—Just Think, Fellow-Banqueters, of All the Wonderful Machinery of Nature We Devour in Every Oyster Cocktail.

Electrifying The Bowling Alley



At Last—Sportsmen—an Electrified Bowling Alley. No Score Keepers, no Pin Boys. Just "Shoot" the Ball Down the Alley. The "Play" is indicated on the Lamp Indicator Board as Here Shown. The Pins Are Self-Resetting.

HATS off to a Milwaukee electrician, Max A. Drews, who has at last come to the rescue of the sporting man, who wonders what science is anyway, with an up-to-date *electrified bowling alley*. Who bowls? The answer is—everybody, in America. So, as we are all interested in bowling, let us take a look at the wonderful invention which Mr. Drews has solved and perfected, which makes it possible at last to bowl all by your lonesome self in your bomb-proof bowling alley down in the basement of your country castle, without the bother of pin boys. In this twentieth century electrified bowling alley *de Luxe*, all the "hits" are chalked up on an electric lamp score-board, automatically—the pins all reset themselves—and the balls, after having wrought more or less terrible havoc among the pin brigade return, thru a gravity conduit, to the bowler's position at the front of the bowling alley.

The details have been worked out very carefully, indeed, by the inventor, so that any regular bowling play is correctly registered on the electric-lamp score-board.

The pins are cleverly arranged and consist of a solid upper member and a canvas or other flexible flap for the lower member, as the detail illustration shows. Generally speaking, there are three electrical contacts and actuating fingers arranged on each pin, one in the center, and one at either side. In the general illustration a ball is shown just passing under the front pin of the set. It will be noted how it passes easily under the upper rigid portion of the pin and presses the flap backwards, without being checked in its onward travel. When the ball, however, passes under the stationary half of the pin, one of the three electrical contact pins is pushed upward, and in doing so it actuates a rocker arm fastened on the cross-wise plates supporting the pins, which in turn connects, thru a wire link, with one of a battery of switches at the rear of the alley, all in the manner apparent. The rear ball pocket of the alley is tapered so that all of the balls, after they have struck the padded cushion, move toward the conduit opening, thru which they travel under the effect of gravity back to the bowling pit at the front of the alley. The lamp score-board is arranged in the formation of the pin set-up, as the illustration shows. It represents one of the cleverest devices ever brought out.

Sawing a 74,000-lb. Steel Ingot

THE accompanying illustration shows a remarkable inserted tooth saw, developed at Pittsburgh, Penna. In the photograph may be seen an 84-inch diameter inserted tooth saw blade, with plate 1 inch thick, and a width of kerf 1½ by 5/16 inches, having a weight of 2,000 lbs., cutting a 35-inch diameter ingot of 31 carbon steel, weighing 74,000 lbs.! Some of these saws are made as large as 90 inches in diameter.

It may be stated that these inserted tooth saw blades are extensively used for cutting ingots, bars, forgings, castings, rails and structural shapes and are made for arbor or sprocket drive machines.

It is claimed that this design permits the use of more teeth than any other inserted tooth blade, and light sections of material can be cut more rapidly than with solid blades, as the rigid construction will withstand a heavier feed. The body of these blades is made of hardened vanadium alloy tool steel, in the grooved slots of which are inserted the best of high-speed steel cutters, treated suitably for all classes of metal cutting. The teeth are secured by interchangeable tool steel wedges and are adjusted from the bottom by hex-head brass screws to obtain correct height when assembling.

(*Continued on page* 250)



Sawing a 74,000 Pound Steel Ingot in Half with a Cold Saw. The Saw is Motor Driven. The Saw Teeth Never Touch the Steel—the Air Compress in Front of the Teeth Does the Cutting.

Typewriting in an Airplane

The photograph herewith demonstrates how the warring countries of Europe are fast adapting themselves to peacetime pursuits, in sport, pleasure and business. This illustration shows what was formerly a powerful French bombing plane converted into a business man's traveling plane, and fitted with an up-to-date office, including a typewriter. Many business men of today do not lose even a moment's time, once they leave their home for the office, and have typewriters fitted in their automobile. One of the leading New York newspaper editors, Arthur Brisbane, has a typewriter fitted in his car, and makes the trip from his home night and morning with his ever-ready "mill" at his side, in the event that he may wish to dash off a new editorial inspiration before it has flown away—unregistered. The same idea of recording thoughts on the wing, as it were, holds as well for business men as for authors and editors. Not only this, but in the spacious airplane cock-pit here shown, the business man using such a modern conveyance to or from business can carry his secretary along.



The Photograph Herewith Shows How a Powerful French Bombing Plane of Large Size Was Converted, After the Signing of the Armistice, Into a Model Business Man's Plane. In the Spacious Cabin of the Plane There Is Ample Room for a Desk and a Typewriter, and the Business Man May Carry His Secretary With Him. The Cock-pit Here Shown Is for Passengers, and Is Separate From the Pilot's Compartment.

Recording Galvanometer and Tuning Fork Timer

An ingenious recording galvanometer and tuning fork timer, as used by the U. S. Signal Corps, is shown in the photograph herewith. The recording galvanometer employs a paper tape, especially prepared by a chemical process, on which the light image reflected from the galvanometer mirror is photographically recorded, and the tape is afterward past thru a chemical bath, which develops the image, similar to the usual photo printing method. Wherever accurate measurements have to be made by means of such a recording device, in which the fluctuations of an electric current are to be recorded in the form of an undulating or wavy line, running along the recording tape, it becomes necessary to accurately space off the tape, so that the time period of each current variation can be readily determined, such as cycles per second, the interruptions of a circuit per second, its frequency, etc.

To solve this problem, use is here made of a simple and yet extremely accurate timer in the form of a musical tuning fork. It is well known that when such a fork is struck by a wooden hammer, that it vibrates with a certain musical note, depending upon the length of the fork and its other physical dimensions. This is the principle upon which the tuning fork timer, which has helped to solve many of Uncle Sam's intricate wire problems in electricity, operates. To one leg of the vibrating tuning fork there is attached an electrical contact which controls a second light image in front of the moving tape and at regular time intervals, this auxiliary timing circuit is closed so as to give spots of light on the paper tape at definite intervals, so that it becomes a simple matter to determine just how many pulsations of the galvanometer string, and in turn the current passing thru it, have taken place in a given space of time. These tuning fork timers are electrically operated in a very ingenious manner. The electromagnet is placed between the limbs of the tuning fork, and by means of a contact placed on one of the limbs, the magnetic circuit is made and broken many times per second, in exactly the same manner as the movement of ordinary vibrating bell functions.

The electrical tuning fork timer, as here described, has been used during the war in solving difficult problems in connection with harbor and coast-defense work, etc. The accurate periodic timing and the closing and opening of an electric circuit by this form of device, have proven very useful in many acoustic or sound problems on which they were engaged to the scientists connected with the Naval Advisory Board and the National Research Council, which covered the recording of sounds from coast defense and warship guns over considerable distances for the purpose of determining by *sound ranging* the distance at which a gun was located when it was fired, etc. Also much study was carried on during the war on the behavior and performance of various calibres of guns by detecting sound and other resultant characteristics whenever the gun was fired. In such work as this, the apparatus here shown, or similar apparatus, proved very useful, and in fact invaluable.

The United States Signal Corps Laboratory developed a great many new and novel instruments during the war. Some of these were not only ingenious and radically new both in conception and design, but marked a new era in scientific apparatus, especially that class of instruments which would lend themselves to use in the field where it is usually considered impossible to design an instrument of extremely sensitive nature, which will possess the proper qualities of high sensitivity and ruggedness so as to withstand rough usage.

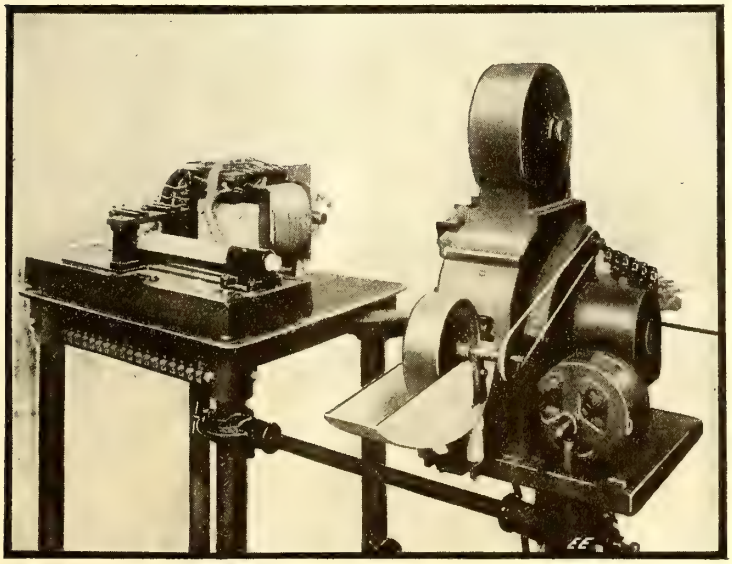


Photo © by Press Illustrating Service

The Accompanying Photograph Shows an Ingenious Recording Galvanometer and Electric Tuning Fork Timer as Used by the U. S. Signal Corps in Studying the Velocity of Sound of Large Guns and for Other Purposes Connected with Harbor and Coast Defence. The Recording Galvanometer Employs a Paper Tape Prepared by a Special Process, On Which the Light Image Reflected from the Moving Galvanometer is Photographically Recorded. The Paper Tape is Afterward Past Thru a Chemical Bath Which Develops the Image in the Same Manner as Photographic Prints Are Exposed and Developed. The Tuning Fork Carries an Electrical Contact On One of Its Prongs, and It Is Caused to Vibrate at a Constant Period by an Electromagnet Placed Between the Prongs, the Circuit of Which is Opened and Closed by the Vibration of the Fork Itself.



View at Left—A Close-up of the Thirty-two Wire Antenna Lead-in Entering the New Brunswick Station. Center—Mr. Alexanderson Standing at the Base of One of the 400 Foot Aërial Masts. Right—General View of Antenna Side of New Brunswick Trans-Atlantic Radio Station, Thru Which Station Secretary Daniels Talked by Wireless Telephone to Europe.

"Hello Europe"—Via Radio

By CHARLES M. RIPLEY

The powerful wireless telephone and telegraph plant at New Brunswick, N. J., described in full detail by an engineer who visited the plant—Why "N. F. F." (New Brunswick's call) called "P. O. Z." (Nauen, Germany), in war time—How the voice of Secretary of the Navy Daniels was wafted thru space over 2,000 miles by wireless to President Wilson, on board the "George Washington" in Brest Harbor, France—How the voice starts with an initial energy of one one-thousandth watt, which is amplified and boosted thru marvelous apparatus until it leaps forth from the 32-wire, mile-long antenna intensified 100,000,000 times, with the power of 270 horses or 2,700 men, a great, turbulent, seething mass of noiseless electrical energy, which shoots thru the earth and air at a speed of 186,000 miles per second! A modern express train, traveling at a mile a minute, is like the lowly snail by comparison.

WITH the outbreak of war an impenetrable curtain of censorship was dropt between the public and many of the world's activities. But, at fever heat, like the stage hands in the cosmic theatre, the world's scientists and inventors have been surpassing themselves in setting the stage for the showing of a new scene.

The Curtain Rises.

Now the curtain begins to rise on this new scene which will tell us a romantic story of accomplishment, out-rivalling the imagination of a Jules Verne. It discloses a great transoceanic wireless telegraph station, providing daily communications direct to our armies, with our Allies in London, Rome and Paris—and, what is most surprising of all, our *communication direct to Germany.*

Late in October, 1917, the Washington key which actuates the great wireless station in New Brunswick, N. J., clicked off

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This translated from the telegraph code into the alphabet reads:

P — O — Z — DE — N — F — F

And then in quick succession:—

"POZ—POZ—POZ— de —NFF—NFF—NFF"

This fairly electrified the men in the station: "Washington is calling Germany direct"—SOMETHING EXTRAORDINARY!!!

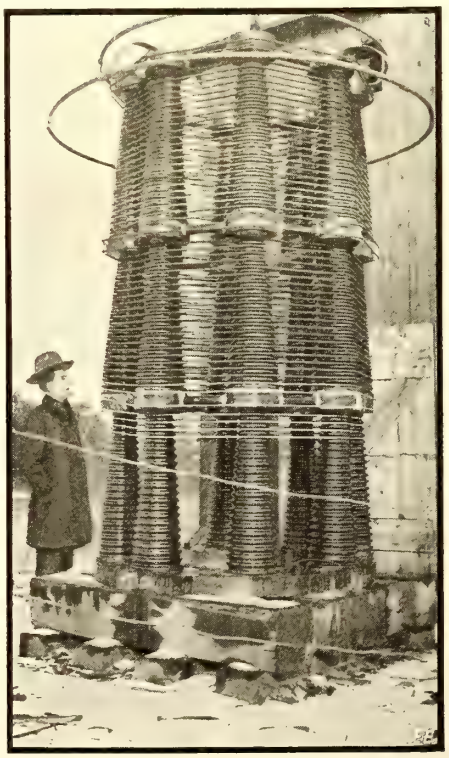
"POZ" is the call for the Nauen station in the outskirts of Berlin, and "de NFF" meant "from New Brunswick, U. S. A." Thus all diplomatic precedents had been shattered by direct communication between two nations at war! Shortly the message came from Nauen that they were in receipt of the call, and according to gossip the German operator said, "Your signals are fine, old man."

Then followed the historic note of President Wilson demanding the abdication of the Kaiser, stating that the American Government will not negotiate with any but the German people direct. So, from the very beginning, the negotiations leading up to the armistice were conducted thru the New Brunswick, N. J., Naval Radio Station.

Other achievements of this station are numerous; out of 44,640 minutes in the month of January, 1919, the New Brunswick station in the 41,961 minutes of its operation rendered some of the following services:

First—Every day New Brunswick communicated with San Francisco and San Diego, Cal.

Second—Every day New Brunswick communicated with Admiral Sims' flagship in British waters.



One of the Gigantic Tuning Coils Used on the "Multiple Tuned Antenna" Devised by Mr. Alexanderson, the Engineer Who Developed Trans-Atlantic Radiophony to a Practical Basis.

Third—Every day New Brunswick signals are received in Paris, Rome and Wales.

Fourth—So clear are these signals that the ordinary receiving sets on battleships in various parts of the world get these messages. It has been frequently reported that the small portable field sets in France have received the New Brunswick messages.

Fifth—For practically a year a daily International Press service was transmitted thru this station; thereby making American opinion known all over the world—particularly among Germany's dissatisfied allies.

Sixth—Secretary Daniels "spoke" to President Wilson thru the New Brunswick station while on board the *George Washington* in the middle of the Atlantic Ocean.

Seventh—And the wireless telegraph of the "George Washington" receives New Brunswick messages continually and keeps President Wilson informed of world and home events while on the high seas.

Such is the work done by this station.

Here is the stage-set, the curtain of censorship lifts still higher and discloses the station. A country road which swings in close to the Raritan River, which parallels the old Delaware and Raritan canal. Two old-fashioned canal boats are being towed by three mules. They suggest the days of hoop-skirted ladies in 1812, with ardent gallants in knee breeches and silk stockings dancing attendance and quadrilles. The effect is heightened by the stooped old gray-haired driver, trudging thru the red mud beside the horses.

In the distance are seen the thirteen giant 400-foot steel towers of the U. S. Naval Radio Station piercing the sky—their insulators glistening in the Spring morning's sun.

What a contrast—the most powerful radio station in the New World, flashing messages thru the skies to our armies in Europe, and the old canal boat passing close to the weird building. A century and a half stretched its wonderful history between that old unpainted barge and this modest red brick building bristling with

(*Continued on page* 262)

"HELLO EUROPE"—VIA RADIO

How Secretary of the Navy Daniels' voice was hurled by wireless telephone across the broad expanse of the Atlantic Ocean to President Wilson who was on board his ship, the "George Washington," in Brest Harbor, a distance of 3,000 miles.





TELEPHONE EXCHANGE

VOICE CURRENTS TRAVEL OVER CIRCUIT TO RADIO STATION

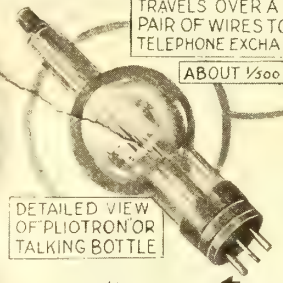
TELEPHONE TRANSFORMER



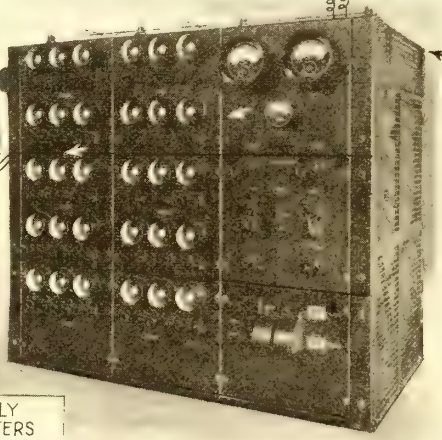
TALKING TO AND FROM AIRPLANES

THE HUMAN VOICE TRAVELS OVER A PAIR OF WIRES TO TELEPHONE EXCHANGE

ABOUT 1/500 H.P



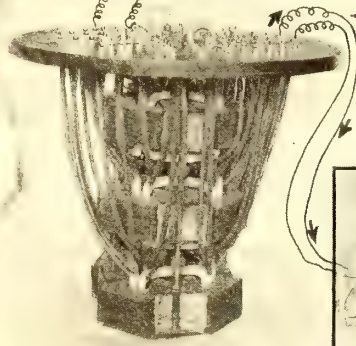
DETAILED VIEW OF "PLIOTRON" OR TALKING BOTTLE



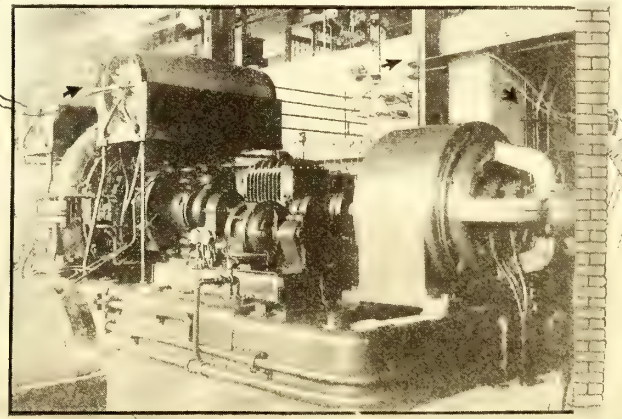
MILD VOICE CURRENTS ENTER AMPLIFYING SWITCH BOARD PASS THRU BANK OF THIRTY "PLIOTRON" BULBS (TALKING BOTTLES AND EMERGE INTENSIFIED TO SEVERAL HUNDRED WATTS!

SECY OF THE NAVY DANIELS SPOKE TO PRES. WILSON ACROSS THE ATLANTIC OCEAN

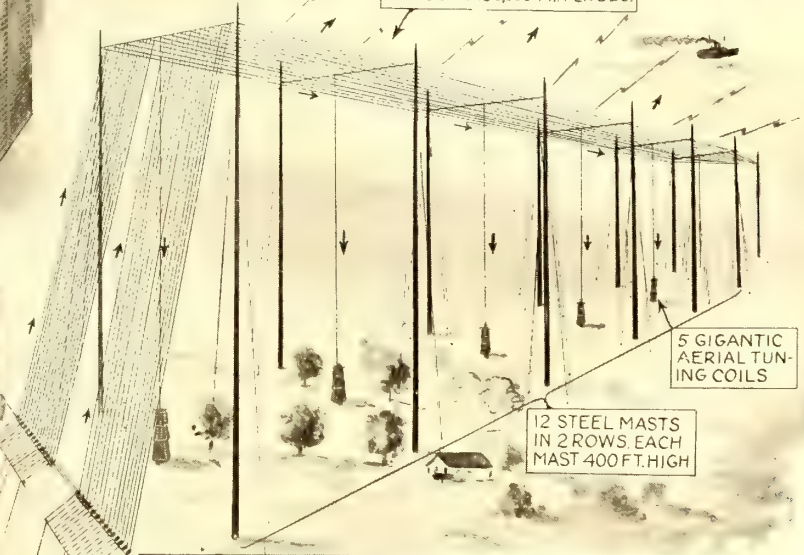
HERE'S YOUR VOICE, MULTIPLIED 100,000,000 TIMES, SHOOTING THRU EARTH & SPACE AT 186,000 MI. PER SEC.



YOUR "VOICE" GREATLY AMPLIFIED, NOW ENTERS THE MAGNETIC AMPLIFIER AND COMES OUT STILL MORE POWERFULLY INTENSIFIED



HERE YOUR VOICE CURRENTS, ENTER THE CONTROL WINDINGS WHICH REGULATE THE OUTPUT OF THE ALEXANDERSON 200 K.W. (270 H.P.) ALTERNATING CURRENT DYNAMO



5 GIGANTIC AERIAL TUNING COILS

12 STEEL MASTS IN 2 ROWS. EACH MAST 400 FT. HIGH

32 ANTENNA CABLES BUNCHED AND LEAD INTO STATION THRU PLATE GLASS WINDOW

ANTENNA 1 MILE LONG

The Accompanying Article Explains the Details of the Apparatus Shown in the Illustration Above. The Majority of This High Power Radio Apparatus Has Been Under Secret Development During the War. As Will Be Evident Upon Inspection of the General Illustration Above, Secretary Daniels' Voice Was Carried Over the Telephone from Washington Thru a Telephone Exchange and Then Entered the Great Radio Station at New Brunswick, N. J.

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A 100 Horse-Power Voice

By JEFFERSON WILLIAMSON

A PRACTICALLY unlimited range for the voices of orators addressing outdoor crowds is now made possible by the introduction of what is called the *loud speaking* telephone. This device was used by speakers thruout the recent Victory Liberty Loan Campaign at "Victory Way" in New York City. "Victory Way" was a section of Park Avenue, five blocks in length, just north of the Grand Central Terminal. It had been specially decorated and otherwise elaborately fitted up as a "show place" which was meant to be the center of outdoor activities on behalf of the sale of Victory Notes. Each day several programs were presented at the "Way" and by means of the loud speaker the orators and musical entertainers were distinctly heard at all parts of the "Way," regardless of the fact that the line of fire of the voice of the average orator normally is only about eighty feet. In other words, without the loud speaker, the average orator could convey his ideas at a closely packed outdoor meeting to only about *five thousand* persons. The loud speaker, with its five-block range, made it possible for *tens of thousands* of people to hear the voices of the speakers intelligently.

But the range of the loud speaker is practically limitless. The farther in any direction your audience extends, the more telephone receivers of the loud speaker variety you use. The size of the audience does not matter if the orator speaks clearly and distinctly, and an orator is not an orator unless he does so speak.

Mrs. Carter Glass, wife of the Secretary of the Treasury in Washington, D. C., was the principal speaker at the opening ceremonies of "Mothers and Wives Day" at "Victory Way." Mrs. Glass spoke over the long-distance telephone from the Capitol and her words were distinctly transmitted to every person on the "Way" by means of the great receivers hung at intervals over the heads of the crowd. Mrs. Glass was followed by Mrs. Vincent Astor, who spoke from the platform at "Victory Way" into the transmitter, which carried her words to every woman in the crowd.

The crowds in "Victory Way" were thrilled one night by speeches from officers in the Great Naval Dirigible 34, which flew over the Way from the station at Rockaway Point. The words of the man in the air were carried distinctly to the waiting throngs thru the receivers of the wireless telephones overhead.

"Hello," came the message from Lieutenant Gilbert Douglas in the airship.

"Hello," was the answer from the speakers' platform, while every person on the Park Avenue plaza hurried to join one of the groups under the receivers.

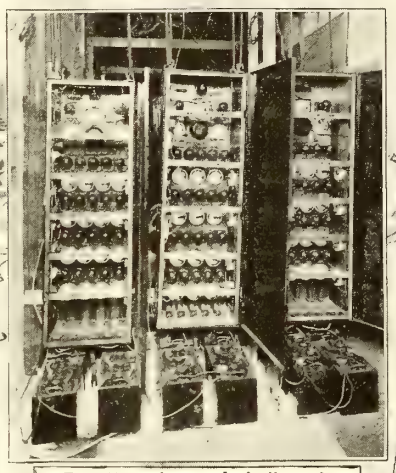
"We hope every man and women in 'Victory Way' will buy a Victory Note," was Lieutenant Douglas's parting message as the great aircraft turned her course homeward.

It is not necessary for the orator to be in front of his audience. He can be hundreds of miles away and yet be heard distinctly. For instance, each day the crowds on "Victory Way" heard at least one address transmitted from Washington. Among these speakers were Secretary of War Newton D. Baker, General Peyton C. March, and other high governmental officials. And at the close of their addresses the speakers in Washington were able to hear the applause of the New York crowds at "Victory Way." Also, a message delivered by wireless telephone from the U. S. Dirigible C-4, of the Rockaway Naval Air Station, as it hovered five thousand feet high over the East River, was transmitted to all parts of "Victory Way" by means of the loud

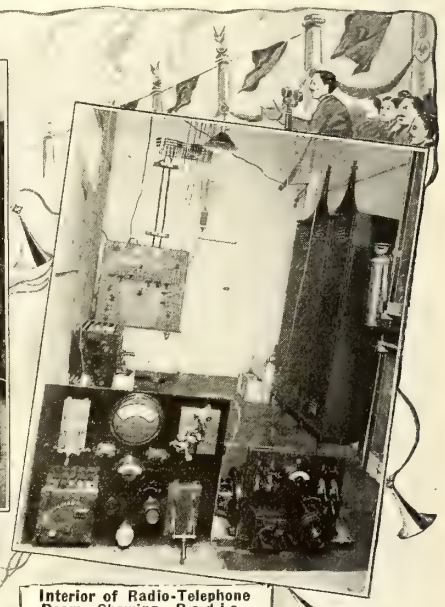
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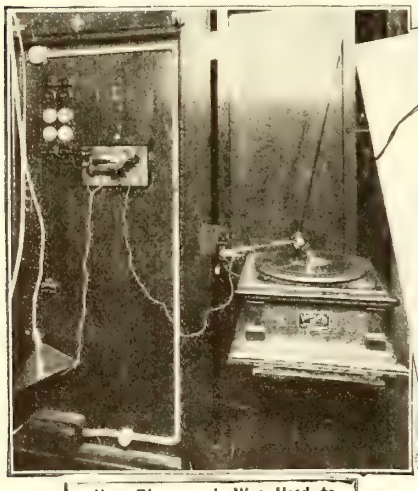
Interior of Telephone Control Station for "Victory Way" Amplifiers.



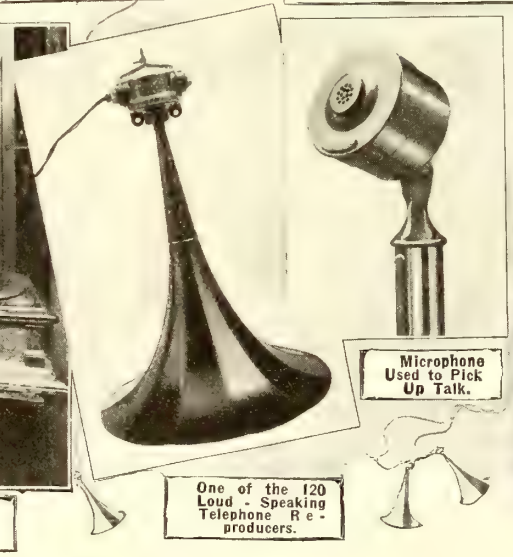
The Vast Array of Audions for Amplifying Voice.



Interior of Radio-Telephone Room Showing Radio-Telephone Apparatus.



How Phonograph Was Used to Talk Thru Amplifier and Loud-Speaking Telephones.



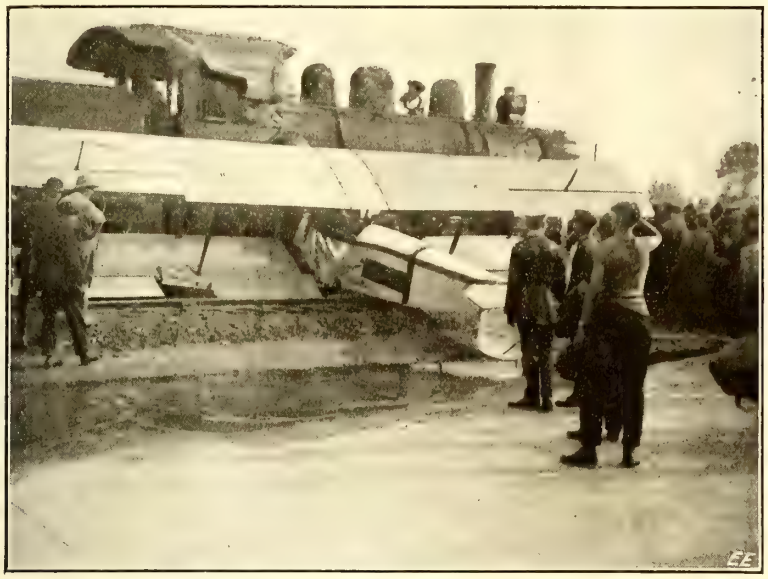
Microphone Used to Pick Up Talk.

One of the 120 Loud-Speaking Telephone Reproducers.



View of "Victory Way" and Some of the Loud-Speaking Telephones Suspended On Wires.

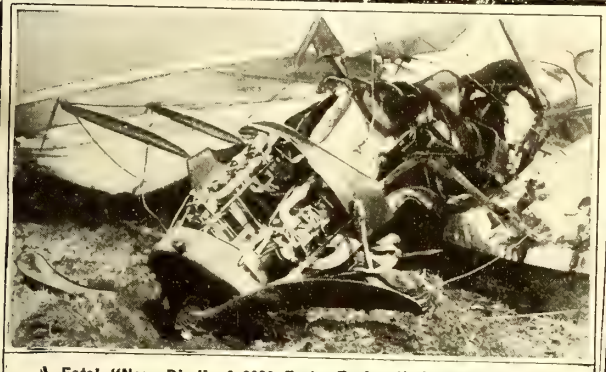
Disastrous Airplane Crashes



Some Crash! The Airplane Pilot—a Cadet at the Leaside Aviation School, Near Toronto, Can., Was Trying to Land. He Hit the Locomotive and Then He Landed Quickly.



Photographed at a Texas Flying Field, the Result of a Crash Caused by the Cadet Losing Control of His Machine, and Allowing It to Crash Into a Building. Photo U. & U.



A Fatal "Nose Dive" of 2000 Feet. Engine Undamaged But Pilot Killed. Blood Stains On Left Wing. Photo Frank Hall.



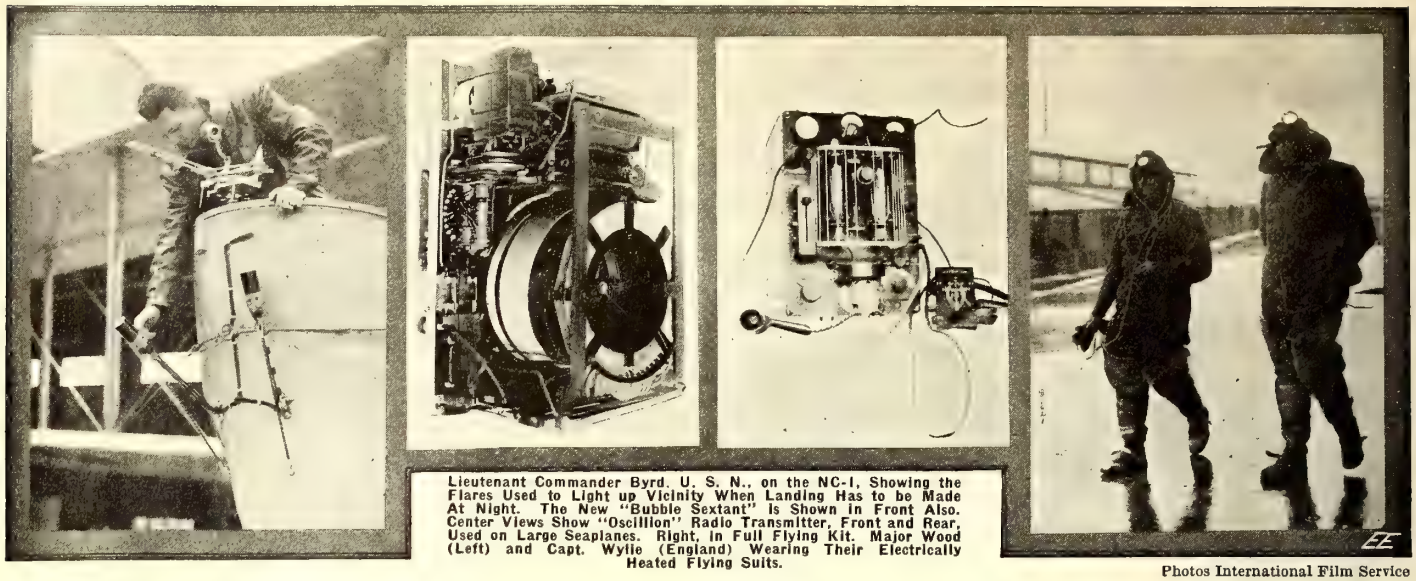
The Cadet Failed to Clear the Big Steel Crane When Taking Off (Starting a Flight) with this Startling Result. The Scene is at Leaside, Toronto, Canada. Photo U. & U.



The Wreck of a Small Seaplane which Crashed Into a Tank of Hydrogen at Rockaway, L. I., May 6th. The Two Aviators, Were Instantly Killed. Photo © by Press Ill. Ser.



Another Fine Crash at an Illinois Flying Field. 'Plane Fell 200 Feet While Piloted by Student Aviator. It Turned Over After Landing. Photo Frank Hall.



Lieutenant Commander Byrd, U. S. N., on the NC-1, Showing the Flares Used to Light up Vicinity When Landing Has to be Made At Night. The New "Bubble Sextant" Is Shown in Front Also. Center Views Show "Oscillion" Radio Transmitter, Front and Rear, Used on Large Seaplanes. Right, in Full Flying Kit. Major Wood (Left) and Capt. Wylie (England) Wearing Their Electrically Heated Flying Suits.

Photos International Film Service

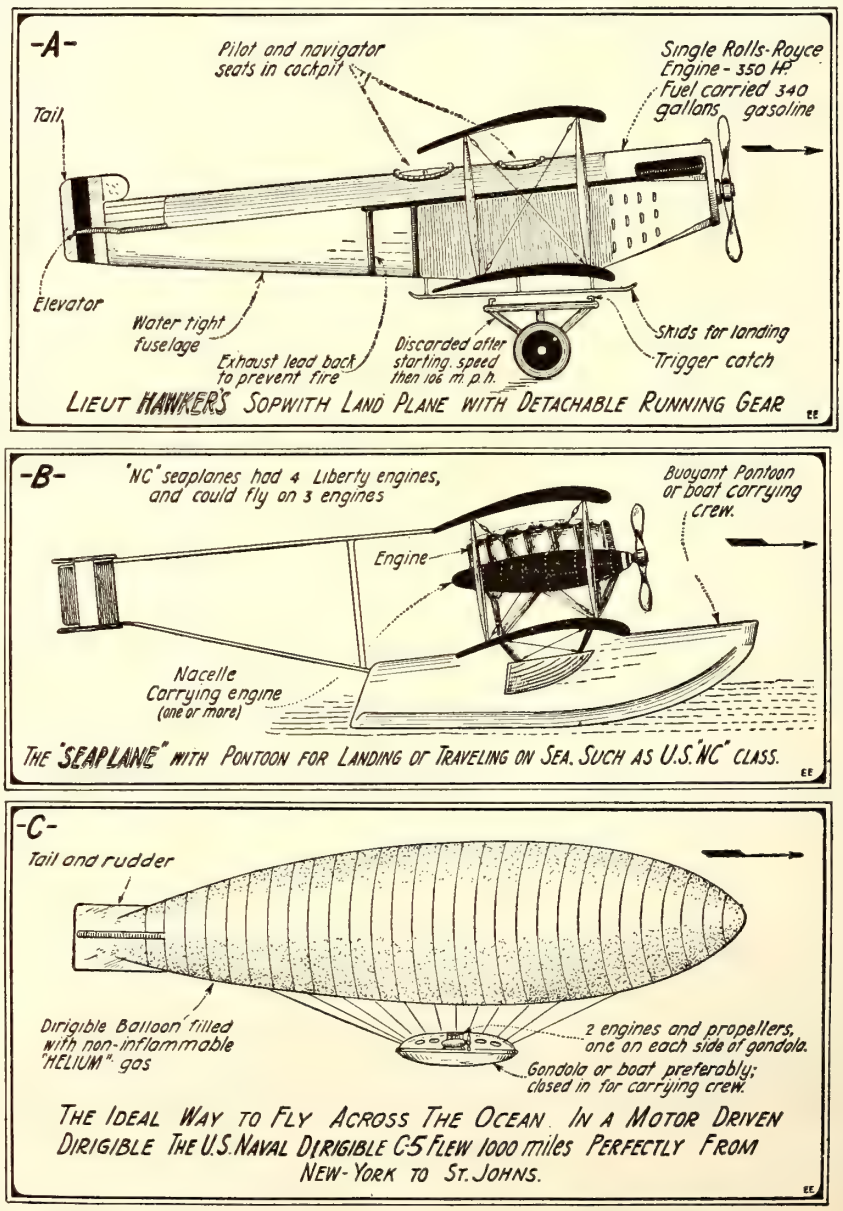
Flying Across the Atlantic

By H. WINFIELD SECOR

TRANS-ATLANTIC flying has been a dream among aëronautical enthusiasts for many years, and we of the present generation are indeed fortunate in seeing this great feat of aërial engineering and exploitation carried to a successful conclusion by the U. S. Naval seaplane NC-4. At the same time we cannot help but pause and give honor to Lieut. Harry G. Hawker, the daring young English pilot who undertook to fly the Atlantic Ocean over a course which was not even covered by the regular ocean steamships, let alone marked by even a single English naval or other ship. Hawker demonstrated that he had unlimited faith in his machine, which was shared by his navigator, Lieut. Commander McKenzie Grieve, R. N. This trip as planned averaged from 1850 to 2000 miles, and was to have required from 22 to 26 hours of flight.

In considering the trans-Atlantic flight we are, after a little philosophizing on the subject, bound to be confronted with the three principal methods of crossing such a great span as this, i.e., with respect to the type of machine which should be employed. The U. S. Navy has shown that its undoubted faith in the large pontoon form of seaplane was based on sound logic and correct scientific design. As an example of the efficiency of this type of flier for such form of travel over vast water distances, the NC-3 has shown that it can land on the ocean and stand considerable buffeting about without sinking for several days.

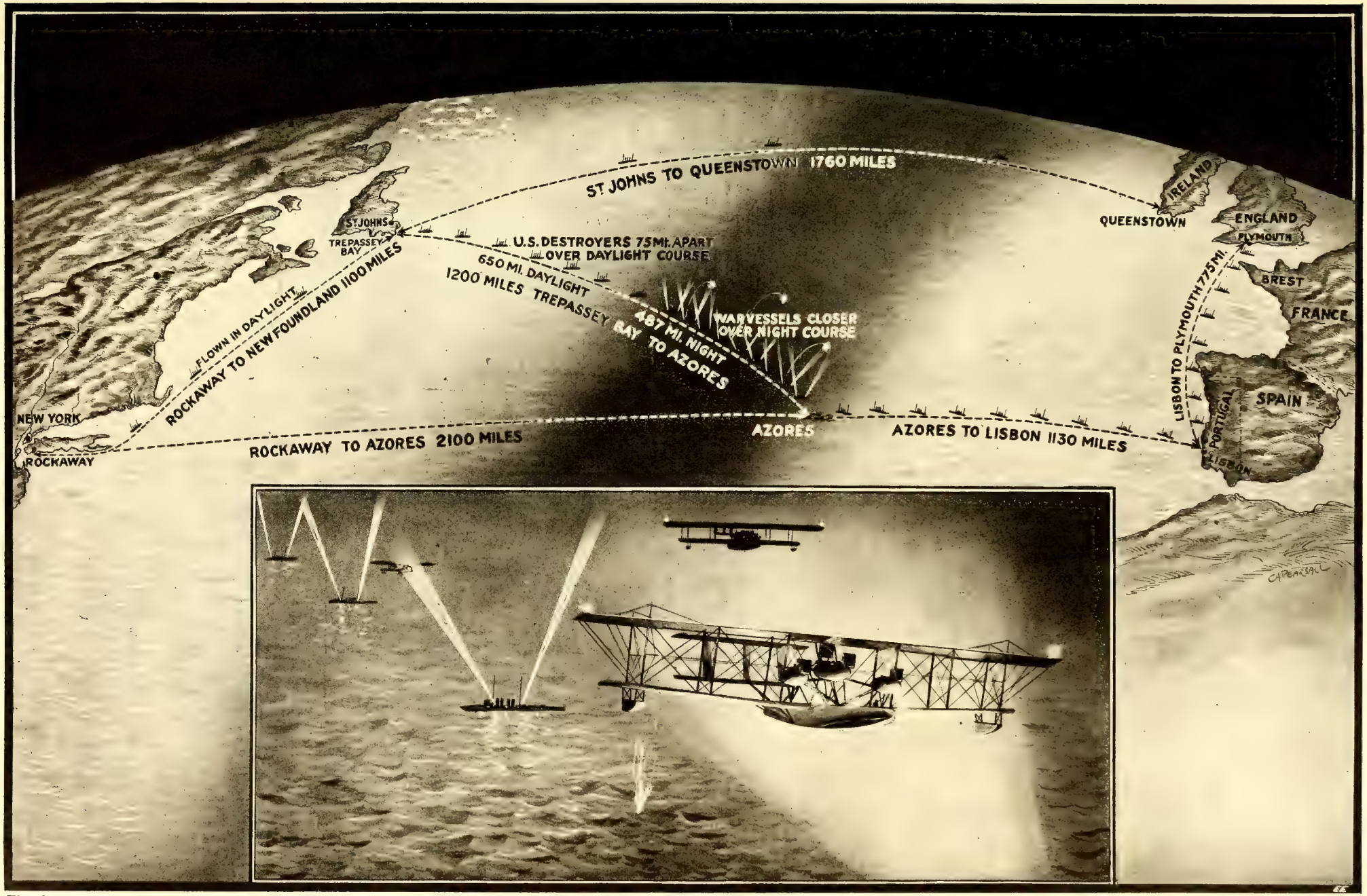
Types of Trans-Oceanic Aircraft



The Three Principal Forms of Aircraft Proposed for Trans-Atlantic Flight.

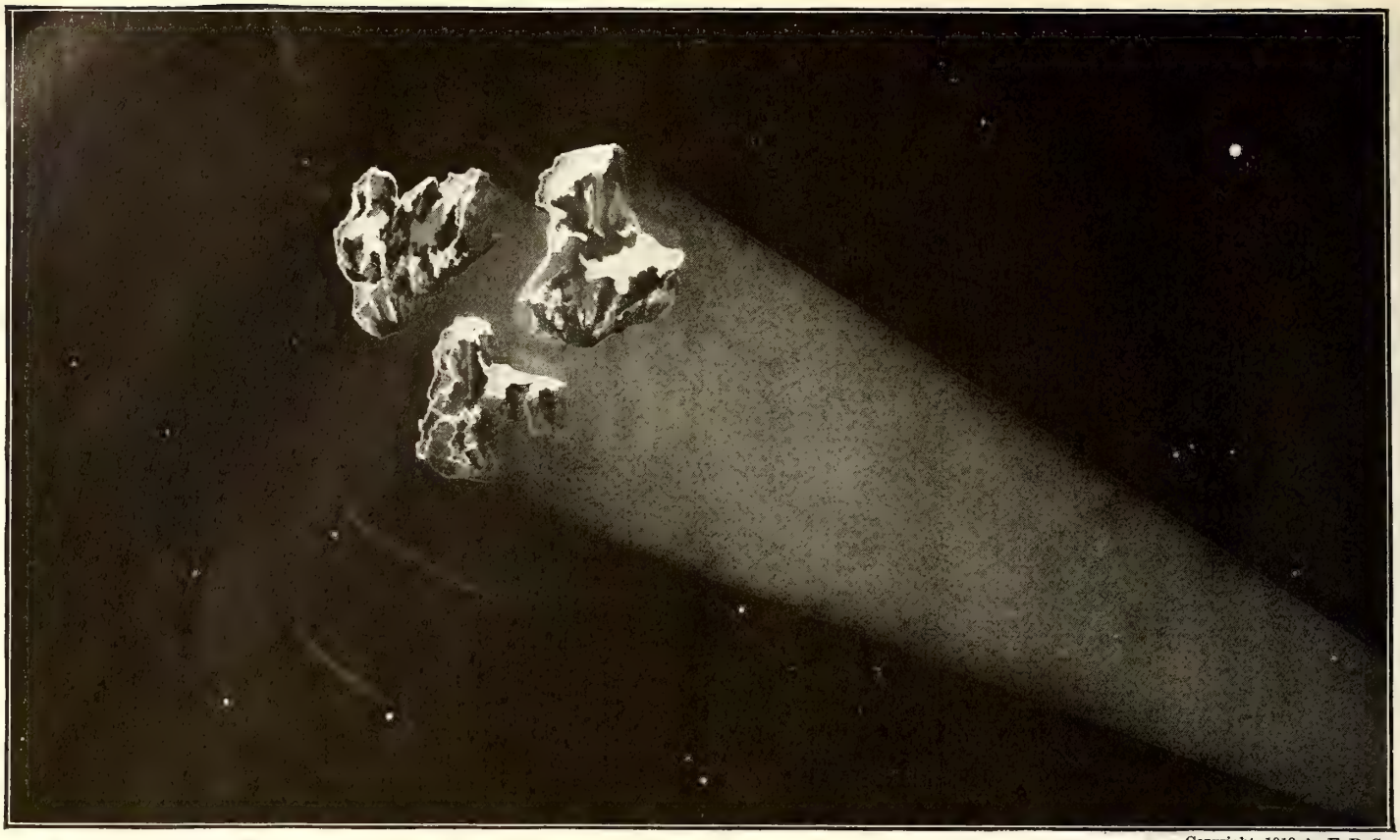
Let us take up the three distinct types of aircraft suitable for trans-Atlantic flight, each of which has been or soon will be tried for bringing the Old and New Worlds closer together. The first type we will consider principally because it seems to have a slight chance of carrying its passengers safely across the 2000 miles of watery deep, is that employed by Hawker and his navigator, Grieve. Lieut. Hawker's airplane was, to begin with, of the *land-going type* and not adapted in any way to oversea travel. Many people have asked why he should have ever thought of starting out with a 'plane of this type on such a long and hazardous trip over the vast ocean span, on the greatest aërial feat ever attempted in the history of flight by man. The reason for choosing this form of 'plane was, primarily, that he was thoroly familiar with it from considerable war experience in Europe, and also there was no useless weight being carried such as is occasioned when any form of pontoon is attached. Lieut. Hawker had the right theoretical idea, but he carried it too far, it would seem to us now. Not only did he choose a land-type 'plane, but he had the under-running gear, comprising the cradle and wheels on which the 'plane traveled over the ground in starting, specially arranged with a trigger release device, so that once he got in the air and started oceanward he could, by the pull of a lever, disengage the running gear so as to reduce the weight of the 'plane

(*Continued on page* 245)



The Accompanying Illustration Shows Us Vividly a Few of the Outstanding Features of a Trans-Atlantic Flight—the Greatest Aërial Feat of the Age. Like Columbus When He Set Out to Discover New Lands, with His Three Tiny Ships, So the U. S. Naval Birdmen Flew Away from Trepassey Bay on the Afternoon of May 16th. Of the Three Giant Seaplanes to Start, the NC-4 Alone Completed the Trip on Schedule. The NC-1 Was Forced to Land on the Water—the Crew Was Picked Up by a Vessel. The NC-3 Also Landed on the Water Due to the Heavy Fog and After a Day and a Night of Floating on the Water, It Came Into Ponta Delgada, Azores, Under Its Own Power. The NC-4, the First Heavier-Than-Air Flying Machine to Cross the Atlantic Ocean, Will Undoubtedly Be Preserved and Placed on Exhibit in the Smithsonian Institution at Washington, D. C. The NC-4 in Its Flight from Trepassey Bay to Lisbon, Portugal, Covered a Distance of 2,150 Nautical or 2,506.9 Statute (Land) Miles in 26:47 Hours actual Flying Time, or at an Average Speed of 80.3 Nautical Miles. The Three Seaplanes Left Trepassey at Sunset on May 16, and the NC-4 Reached Lisbon Soon After Noon on May 27, the Eleventh Day After Its "Hop" from Newfoundland. The Official Trans-Atlantic Flight Ended with the NC-4's Arrival at Lisbon. The NC-4 and Her Original Crew Then Proceeded to Plymouth, England, Where They Were Officially Congratulated and Welcomed.

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For a Long Time Astronomers Have Been Puzzled on Account of the Variability of the Light of Many of the Asteroids. These Small Heavenly Bodies Measuring an Average from 3 to 5 Miles in Diameter Are Nothing But Huge Rocks Hurtling Thru Space Along Well Defined Orbits. It Is Now Believed That the Variability of the Light Is Caused by Two or Three Asteroids, Very Close Together, Revolving Among a Common Center. Our Artist Has Shown in This Illustration How a Small Cluster of These Asteroids Would Appear When Viewed from a Distance of About Ten Miles. The Three Bodies Shown Average from 3 to 5 Miles in Diameter.

Popular Astronomy

By ISABEL M. LEWIS

Of the U. S. Naval Observatory

Astronomical Facts For All

FOR the past year Mrs. Lewis has presented a series of very fine astronomical articles to the ELECTRICAL EXPERIMENTER. We are happy to say that we have renewed our arrangement with Mrs. Lewis for another year, and we believe that our readers will welcome the announcement.

In the past Mrs. Lewis has written a monthly article covering only one subject. For the coming year, this arrangement will be slightly changed, and we will endeavor to show every month a variety of articles—"Astronomical Facts for All." In addition to this, we have opened a Question and Answer department which is starting in the present issue. We invite our readers to send in their questions on astronomical subjects which Mrs. Lewis will answer monthly.—EDITOR.

1. Asteroids and How They Are Discovered.

ONE is apt to picture the asteroid seeker painstakingly sweeping the heavens with his telescope to discover a new asteroid or comet. As a matter of fact astronomers spend very little time searching for new asteroids or comets these days when so many other problems are demanding attention. These heavenly bodies are now usually picked up photographically.

The comets are always welcome and interesting visitors, the discovery of a new asteroid is not apt to arouse any marked enthusiasm in the astronomer's heart, despite the fact that occasionally an asteroid has turned out to be an important tho tiny member of the sun's family—as, for instance, Eros, an asteroid only a few miles in diameter that comes within thirteen million miles of earth at times and therefore furnishes a very valuable means for determining the distance of the earth from the sun. Approximately one thousand asteroids have now been discovered, and to name and keep track of these troublesome little members of the sun's family is a tremendous task, especially since they are subject to so many perturbations from the larger members of the sun's family, in particular Jupiter. It is only the hope of finding out a few valuable facts from the exceptional asteroids that keeps the astronomers at the task of caring for this troublesome family of asteroids.

If a photographic plate is fastened to the eye end of a telescope and the sidereal clock work of the telescope started so that the telescope will follow the stars, the stars will be immovable in the field and their images will be sharp points of light on the plate, but any object within the field of view that is moving relative to the earth will leave a short trail of light on the plate owing to its motion during the period of the exposure of the plate, which is usually two or three hours.

Practically all asteroids and all periodic comets whose returns are predicted are discovered by this method. Whether the body is a faint comet or an asteroid, additional plates and an approximate computation of its path will decide.

The four largest asteroids, Ceres, Pollas, Vesta and Juno, are respectively 485, 304, 243 and 118 miles in diameter. These are the values found by Barnard as a result of measurements with the 36-inch telescope of the Lick Observatory. A few more of the asteroids may exceed one hundred miles in diameter, but the great majority are simply huge rocks five miles or less in diameter. These small bodies have such a weak gravitational attraction that they are unable to hold an atmosphere and as a result there can be no form of life, either animal or vegetable, on even the largest of them.

Various estimates have been made of the total mass and bulk of the asteroids. Their average density has been estimated as about equal to that of the earth's surface crust. The great mathematician and astronomer, Leverrier, the discoverer of Neptune, proved that the total mass of matter between the orbits of Mars and Jupiter, where the asteroids are to be found, could not exceed one-fourth of the earth's mass, and later computations reduced this to one-one hundred and fifteenth of the earth's mass. As the combined mass of all the asteroids so far discovered falls far below this value there are probably thousands of small asteroids still undiscovered, tho it is very unlikely that any asteroid whose diameter exceeds one hundred miles has escaped detection.

As the mass of Mars is about one-tenth

and the mass of Mercury about five one-hundredths that of the earth, it is evident that all the asteroids combined could not furnish enough material to fashion a planet that would approach even the smallest of all the planets, Mercury, in size.

The orbits of the asteroids differ greatly in size and form and in inclination to the ecliptic. Some are almost perfect circles, others greatly elongated ellipses. Their inclinations to the plane of the earth's orbit vary from zero to thirty-five degrees. In this respect they differ greatly from the orbits of the planets which lie very nearly in the same plane.

It has been suggested that variability in the light of many of the asteroids may be due to a difference in the reflecting power of different portions of their surface or to irregularities of form. Unlike the major planets, the asteroids are not spheres but simply jagged rocks, huge mountains hurtling thru space, whirling round and round on their axes as they journey about the sun. Possibly, as some have suggested, they may be the larger fragments of periodic comets of unusual size that have in the course of ages been shorn of their appendages. This might account for the suspected existence of double or multiple asteroids, in which two or more of these huge rocks are grouped so closely together as to appear as one in the telescope. This would also account for the variability in the light of some of the asteroids.



This Shows How Asteroids Are Discovered, Not Thru the Telescope, But on the Photographic Plate. The Stars Standing Still, Any White Streak Left on the Plate Must of Necessity Be Either a Planet or a Comet.

2. Shooting Stars.

"SHOOTING stars" is an unfortunate name for the small masses, weighing usually only a few ounces, that enter the earth's atmosphere from outer space, are ignited by friction with the atmosphere, glow brightly for a few brief seconds and then fall to the surface in the form of dust.

It has been estimated that shooting stars or meteors, as they are more fittingly called, enter the earth's atmosphere by the millions every day, only a very small percentage of them being visible to the naked eye at any one place. They fall by day and by night, over land and sea, in polar regions and in the tropics. The snowy wastes of the far north are dusted with the ashes of shooting stars that have been consumed by friction with the earth's atmosphere, which they enter at a speed varying from ten to forty miles a second.

Astronomers quite frequently observe meteoric particles invisible to the naked eye, flitting across the field of the telescope.



Showing Where the Orbits of Several Thousand Asteroids (Planetoids) Are Located. Their Orbits Take in the Intermediate Space Between That of Jupiter and Mars. These Little Planets Vary in Size from Three Miles to 485 Miles in Diameter. There Are Undoubtedly a Great Many Thousands Also of Even Smaller Diameter or as Small as an Ordinary House.

Some of the larger of these masses weigh several pounds, in rarer instances even several hundred pounds. They are thus referred to as meteorites or fire-balls. These are not entirely consumed by friction with the earth's atmosphere, but after traveling with loud reports and explosions a distance of many miles, fall to the earth's surface.

Comets, it is generally believed, disintegrate gradually into swarms of meteors and the earth and other planets are constantly encountering these fragmentary particles in their journeys around the sun. Periodic swarms are encountered at certain definite times of the year whenever the earth's path crosses the paths of these disintegrated comets.

The study of the origin and nature of meteors forms a most interesting branch of astronomy to which even the amateur astronomer may contribute observations of value.

Questions and Answers.

1. *How many stars are there in the sky and how do astronomers know the number of the stars?*

The approximate number of stars of each magnitude has been found by counting the number of stars in regions of a certain definite size and then estimating from the result the number of stars of each magnitude in the whole sky.

In speaking of "magnitude" of a star, its apparent brightness and not its true or intrinsic brightness is meant. A star of the first magnitude is, according to the scale adopted, two and one-half times brighter than a star of the next fainter magnitude, the second magnitude, and one hundred times brighter than a star of the sixth magnitude, which is the faintest star visible without a telescope. The exact ratio of one magnitude to the next lower is the fifth root of one hundred, so that a drop of five magnitudes represents a division of the brightness by one hundred. A sixth magnitude star has only one hundredth the brightness of a first magnitude star and an eleventh magnitude star only one hundredth the brightness of a sixth magnitude star or one ten-thousandth the brightness of a first magnitude star.

There are in the whole sky only five thousand stars visible without the aid of a telescope; that is, five thousand stars of the sixth magnitude or brighter. Since only one-half of the sky is visible at any one point and since faint stars near the horizon are invisible on account of the greater density of the earth's atmosphere in this direction, there are only about two thousand stars to be seen at any one point on a clear, cloudless night, though one receives the impression that an infinite number of stars exists.

A small three-inch telescope will show stars down to the ninth magnitude and there are two hundred thousand stars brighter than the ninth magnitude.

Fainter stars are far more numerous and it has been estimated that there are approximately *fifty-five million stars* in the first seventeen magnitudes.

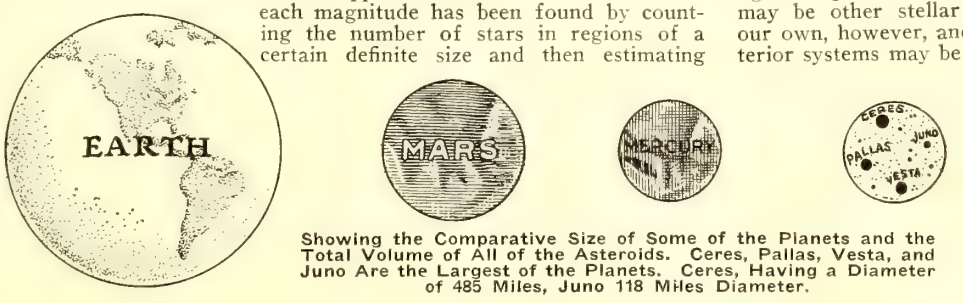
The forty-inch Yerkes refractor will show stars of the seventeenth apparent magnitude and the great one hundred inch Mt. Wilson reflector stars of the twentieth magnitude. This represents the limit of telescope power at the present time, and it is doubtful if it ever can be greatly surpast.

It has been estimated on the basis of counts of stars in sample regions that there are three hundred million stars in the sky within reach of the great reflector.

It is assumed that there is a definite limit to the number of stars within our own sidereal system, for it is evident from actual star counts that the ratio of the number of stars of one magnitude to the number of stars of the next fainter magnitude falls off rapidly for the fainter stars. By the time the seventeenth magnitude is reached a falling off of fifty per cent. in the ratio is reached, which is an indication that the total number of stars is approaching a finite limit provided, as is generally assumed, there is no marked extinction of light in space. It is conceivable that there may be other stellar systems far beyond our own, however, and light from such exterior systems may be in some manner shut off from our own. Nothing is known either to prove or disprove this belief.

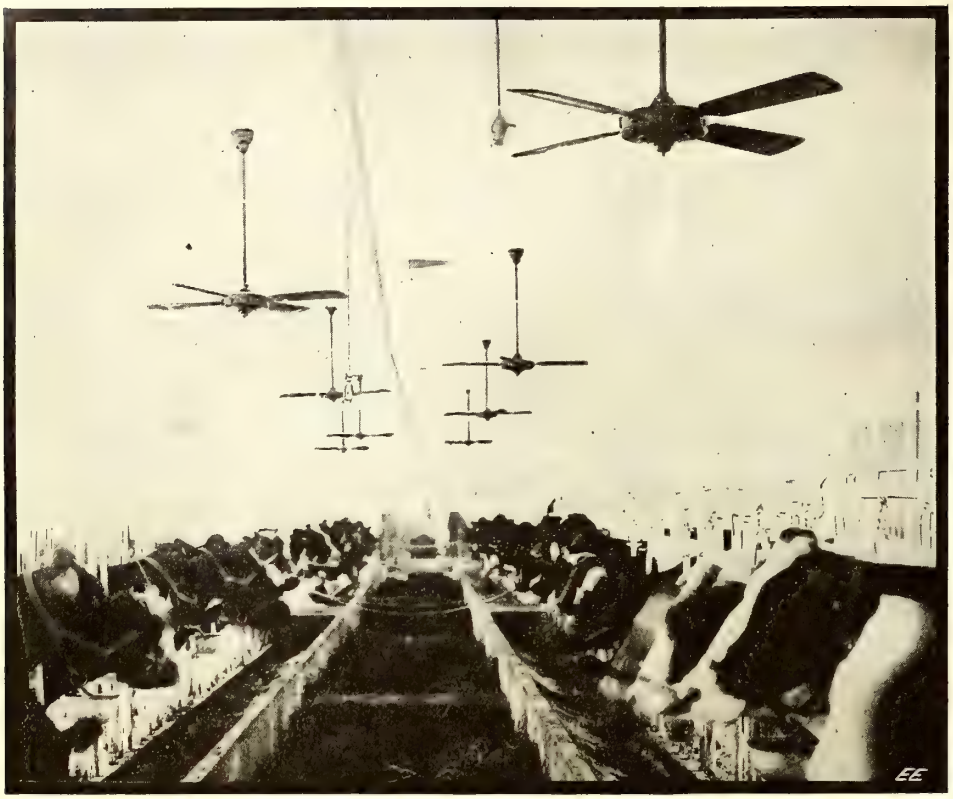
Some astronomers have devised formulas based on star counts to ap-

(*Continued on page 258*)



Showing the Comparative Size of Some of the Planets and the Total Volume of All of the Asteroids. Ceres, Pallas, Vesta, and Juno Are the Largest of the Planets. Ceres, Having a Diameter of 485 Miles, Juno 118 Miles Diameter.

Electric Fans for Madame Holstein



Madame Holstein in Her Glory—180 of Her Enjoying the Cool Breezes from the Electric Ceiling Fans as Installed in a Large Southern Dairy. As Abie Kabibble Would Say—"Some People's Cow-Barns Are Better Than My Parlor, Ain't It?—the Wery Idee."

The cow is distinctly a feminist. Pigs aren't: they don't care. But Madame Holstein is as exacting in her tastes as the most pampered female of the species. Doesn't it strike one as a little ultra-fashionable for 180 cows to drink out of individual fountains while electric fans waft the cool breeze over their aristocratic backs? Mr. Asa D. Chandler, Jr., of Atlanta, Georgia, doesn't think so. He says that his cattle show the results, and he proves it by referring to "Lizzie," who since her entrance into the lap of luxury produces 44 quarts of milk daily.

The barn is provided with concrete floors, wooden blocks, *electric lights, fans* and milking machines, steel frame stalls, novel drinking fountains, concrete feed troughs, electric equipment for the silo and bottling the milk. The Farm has a colony of 180 full-blooded registered Holstein cattle.

Electric *Ceiling Fans* are shown cooling the atmosphere in summer and ventilating in winter. The electric lights are also shown. "Lizzie" has a private drinking fountain. There is always a small amount of water in the bottom of the cement cup to entice her. When she makes the attempt unconsciously, she forces the valve open and hence always has fresh water.

The green corn for ensilage is cut with the aid of a 15-H.P. electric motor, and is blown thru a conveyor into the top of a 40-foot Silo.

Just as soon as the milk arrives at the milk house, it is strained and past over a cooler until it reaches the proper temperature. From here it passes to a bottle filling machine, where the bottle is automatically filled and sealed. (Photo courtesy Westinghouse E. & M. Co.)

Instructor Telephone Boards for Students

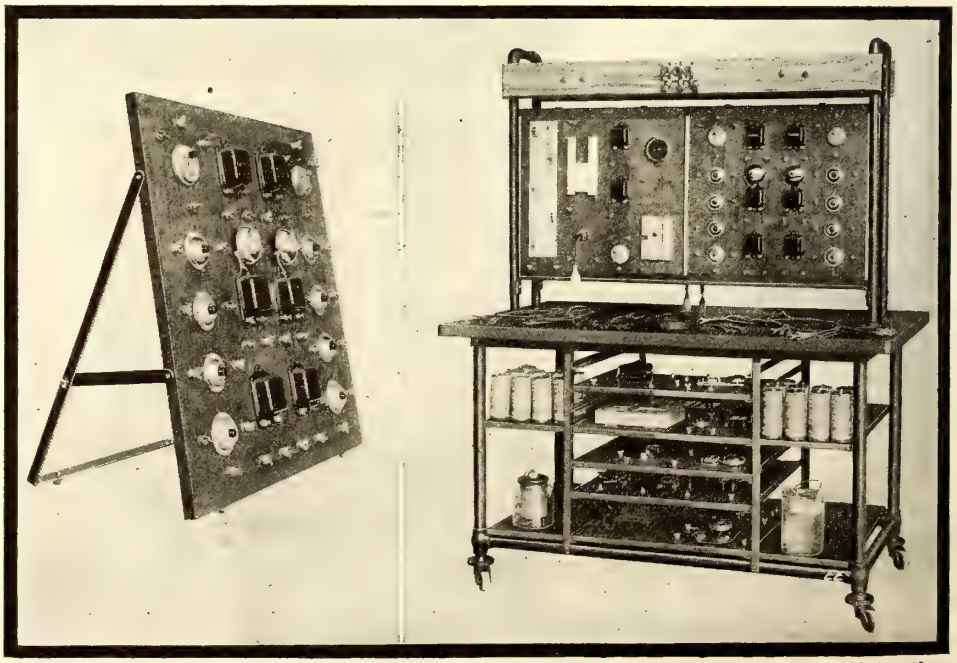
There has long been a demand on the part of high school physics instructors the country over, for a practical method whereby the principles of *telephony and telephone wiring* may be taught in the High School courses. Hitherto it has been extremely difficult to secure proper apparatus, sufficiently durable for laboratory purposes, and inconvenience and expense of installing the necessary instruments for successful instruction in telephony has been very often the cause of the absence of this important branch of instruction in many schools.

To overcome the objections to the old method, and furnish a substantial, practical set of telephone apparatus for the laboratory, the telephone board here illustrated has been designed.

One of the most important features from a practical standpoint of the telephone units is the method by which the contacts are made for interior wiring of the instruments, Ordinarily in laboratory instruments of this character the wiring must be attached directly to the delicately constructed terminals of the apparatus itself, and naturally thru the wear and tear of laboratory usage they quickly become worn out and broken. By the "Instructor" method, these connections are made, not to the instruments themselves, but to substantial wing-nut terminals, which are in turn permanently wired to the proper terminals on the instruments. In this way the life of the apparatus is indefinitely prolonged, as well as much time and effort saved by the making of quick, efficient connections.

There are two types of the bracket form of intercommunicating telephone boards. The single form of board, size 24" x 24", contains two sets of instruments for experiments in intercommunication, while the other type has four telephone sets, permitting the wiring of two, three, or four intercommunicating systems on the same unit. The frame of this latter unit varies from the single bracket board in that it is constructed so as to contain four separate unit boards 9" x 24" in size.

In connection with both of the bracket units there has been designed a *portable table*, substantially constructed with an iron pipe frame, and a heavy, stained table top.



Something New in Telephone "Instructor" Switch-boards. The Students Have to Make the Proper Connections on the Face of the Boards. The Best Idea for Schools That Has Been Brought Out in Some Time.

"The Kaiser is Canned—Can Food"

By GRACE T. HADLEY
SOCIETY FOR ELECTRICAL DEVELOPMENT

TO save vegetables and fruits by canning this year is a patriotic duty. War has made the need for food conservation more imperative than at any time in history. America is largely responsible for the food supply of Europe. The American family can do nothing more helpful in this emergency than to can all food that can be canned. In this way, the abundance of the summer may be made to supply the needs of the winter.

The preservation of food stuffs by canning is always food thrift. It effects the saving of a surplus of foodstuffs that would otherwise be wasted, thru excess of supply over immediate consumption. It eliminates the cold storage cost that must be added to the prices of commodities bought during the winter. Of vital importance also, is the fact that it relieves the strain on transportation facilities of the country.

The president of the *National War Garden Commission* tells us in the *Home Canning Manual* that victory must necessarily bring a large increase in our obligation. We must not only produce food as close to the kitchen door as possible, but we must *save* a vast volume of this food for winter use. To save it, we must can it, dry it, or otherwise prepare to have it in readiness for the winter months. Canning and drying, therefore, are as imperative today as if the great world war were just beginning. A country whose people "can" will never be found wanting.

The Demonstration Kitchen in Ambler, Pa.

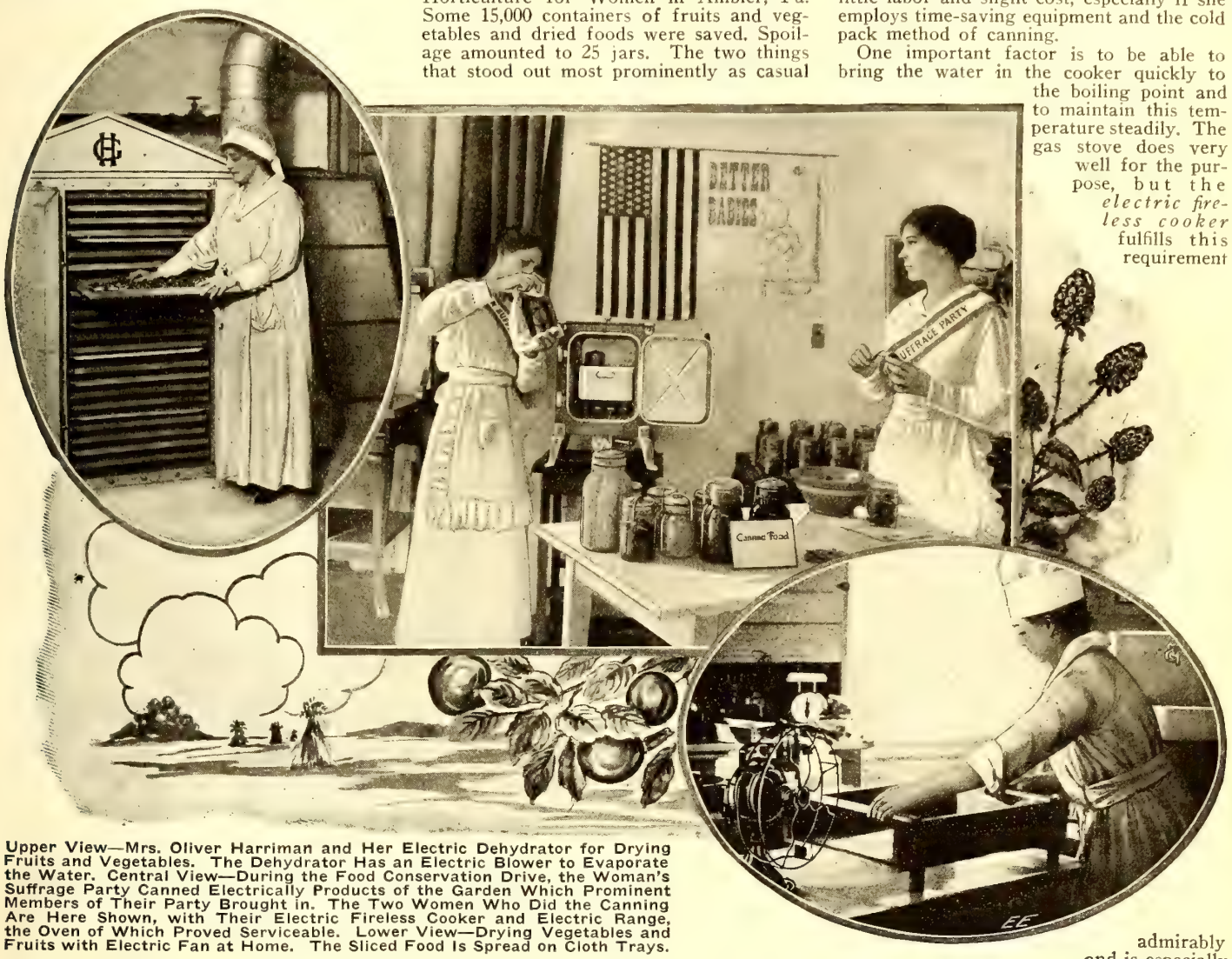
During the food conservation drive several hundred women worked in the demonstration kitchen at the School of Horticulture for Women in Ambler, Pa. Some 15,000 containers of fruits and vegetables and dried foods were saved. Spoilage amounted to 25 jars. The two things that stood out most prominently as casual factors were poor rubbers and the development of flat sour.

"In spite of quick and scientific work," Caroline G. Peeler states, "*flat sour* gave us some trouble. We looked for the cause at the beginning of the work and followed it right thru the processing but never thought of looking for it at the time when the jars were sitting happily on the table cooling off. In reply to an 'S. O. S.' call, Washington told us to cool those jars quickly and to do this by placing them one foot apart, so that the air could circulate thru and around them. They must not be in a draft, but the temperature must be reduced rapidly. The jars when first removed from the sterilizer can be seen to be bubbling or boiling. If they are placed close together the heat is confined as in a fireless cooker, causing them to keep warm for hours, chemical changes take place and *flat sour* develops."

Lamp Socket Canning.

Whether one has a sixteen-acre farm or one of the three sizes of commuter's garden, one is sure to have some surplus products and such products should be either dried or canned. "Can surplus food, but use jars and cans wisely," was the verdict last season in order to save every ounce of available food. The thrifty housewife who heeds the foregoing will find that she has quite a store for winter use, with little labor and slight cost, especially if she employs time-saving equipment and the cold pack method of canning.

One important factor is to be able to bring the water in the cooker quickly to the boiling point and to maintain this temperature steadily. The gas stove does very well for the purpose, but the *electric fireless cooker* fulfills this requirement admirably and is especially well suited to take care of surplus products from a commuter's garden. All thru the season odd lots of vegetables that might otherwise go to waste, may be gathered, canned by the cold pack method and sterilized in an electric fireless cooker which is a lamp socket appliance, easy to operate and a great time-saver.



Upper View—Mrs. Oliver Harriman and Her Electric Dehydrator for Drying Fruits and Vegetables. The Dehydrator Has an Electric Blower to Evaporate the Water. Central View—During the Food Conservation Drive, the Woman's Suffrage Party Canned Electrically Products of the Garden Which Prominent Members of Their Party Brought in. The Two Women Who Did the Canning Are Here Shown, with Their Electric Fireless Cooker and Electric Range, the Oven of Which Proved Serviceable. Lower View—Drying Vegetables and Fruits with Electric Fan at Home. The Sliced Food Is Spread on Cloth Trays.

In New York City during the food conservation drive, the Woman's Suffrage Party canned electrically at one of the headquarters stations. Prominent suffragists brought in the products of their gardens which were canned by two women volunteers and the canned products were then sold for the cause of suffrage. Electric fireless cookers were used for the processing as well as the oven of an electric range.

Home Canning Manual.

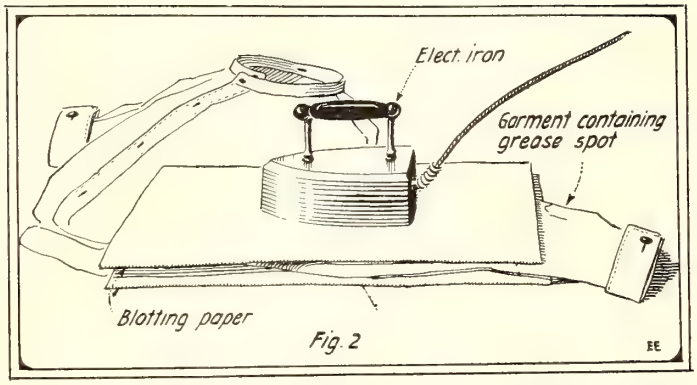
The *Home Canning Manual* issued by the National War Garden Commission of Washington should be in the hands of every woman who contemplates canning. It contains all the necessary instructions for canning vegetables and fruits, the princi-

(*Continued on page 277*)

Practical Chemical Experiments

By ALBERT W. WILSDON

Cleansing and Washing Agents



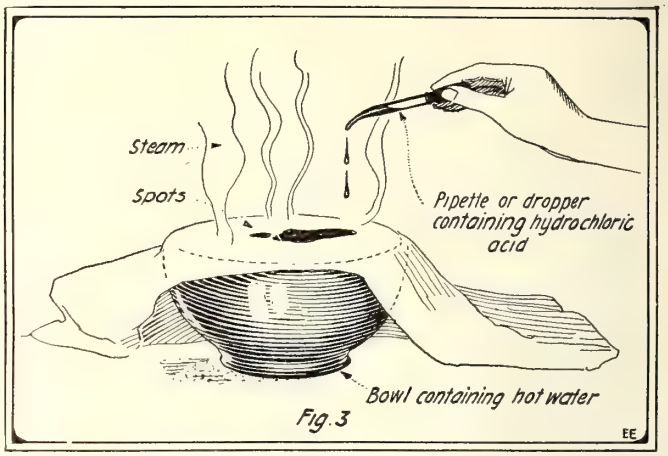


Fig. 2. Left—Method of Removing Grease Spots With a Hot Iron (Electric Iron Very Adaptable) and Two Sheets of Blotting Paper.
Fig. 3. Right—Removing Iron Rust Spots. Place the Soiled Cloth Over a Bowl of Steaming Hot Water. Drop Hydrochloric Acid on the Spots and They Will Come Out.

IT is quite likely that practically every reader has at some time encountered the problem of removing some stain or cleaning some substance, and due to the lack of chemical knowledge of the principles of cleaning, has failed in his object. This subject has such frequent applications that it was deemed of sufficient importance to warrant its presentation in this form. Formulas have been omitted, but if desired information regarding them will be furnished by the writer.

Substances used for cleaning may act either mechanically or chemically to remove the dirt or other substances from clothing. In the use of soap and sand for scouring, there is a combination of these methods, and in fact, when the chemical loosens up the fibers or sets free the dirt, some mechanical process, as the washboard or washing machine, preferably electrically driven as shown in Fig. 1, is required to remove it.

Most of the polishing and cleaning powders on the market depend for their efficiency upon the action of a very finely divided substance like Silica, precipitated chalk, or rouge. These are mixed with some fat or oil. In selecting a polishing material, care should be exercised in selecting one that is so finely divided that it will not *scratch* the metal. Dry sodium Bicarbonat (Baking Soda) can be safely used for cleaning and polishing.

Borax, added to water, greatly aids in the removal of dirt. Most readers are familiar with the household Ammonia, which is used for this purpose. As ammonia forms a soap with the oily matters of the fabrics washed, it is a convenient cleaning agent. A teaspoon of Ammonia to a quart of water is an excellent wash for wood-work, and may be used to brighten carpets or rugs. Much of the household ammonia on the market is of a very low grade, and so it is always advisable to purchase it from a supply house, or if necessary from the druggist.

A cleaning material should not only remove the grease or dirt, but it must be of such a nature that the article cleaned will not suffer injury by its application.

Cleansing Leather and Metals.

In some cases, as with wood, leather, metals, etc., the dirt does not penetrate into the interior, but remains on the surface. In other cases the whole fabric is filled with dust and grease. All polished wood surfaces, except those finished with wax, may be cleaned with a weak solution of Ammonia, or soap, but they should never be treated with a strong alkali solution.

As solvents for grease, either kerosene or turpentine may be used, and ordinarily should be applied with a soft cloth. Painted surfaces, especially in white, may be cleaned with a little whiting (Calcium Carbonat), which may be applied with a piece of cheesecloth. The wood is afterwards washed with water and wiped dry. Painted walls, if painted with oil paints can be cleaned in the same way, but tinted walls, since water colors are used, would be disfigured by this treatment.

Leather may be kept bright and clean by the use of kerosene, or occasionally a little oil. Marble may be scoured with sandsoap, and finally polished with a coarse flannel. It should not be forgotten that marble is Calcium Carbonat, and therefore should never be treated with an acid. Metals can usually be cleaned with a hot alkaline solution or a little kerosene. To clean glass, it may be covered with a paste of whiting, ammonia, and water, and after this is dried this may be rubbed off with a woolen cloth or with paper. Alcohol is used extensively for cleaning delicate glass, as for instance, lenses and microscope objectives. In using alcohol for lenses, great care must be exercised, as the mounting paste or adhesive may be dissolved. In extremely cold weather, when water would freeze, kerosene may be used.

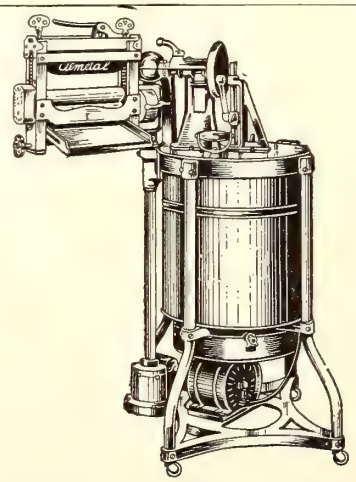


Fig. 1. The Modern Way to Cleanse Clothes Is by Means of the Electric Washing Machine. Many of These Devices Possess Distinctive Improvements Which Make Them Much Superior to Hand Methods.

Dangerous Cleaning Solutions.

Household fabrics are often washed with alkaline solutions or with soap. In some cases Naptha may be used for washing such fabrics. It is to be remembered that in some of the solvents, as Naptha, Benzine, Turpentine, and Gasoline, which are frequently used for cleaning, these vapors are all very volatile, and for this reason *they are dangerous, if employed near a FLAME of any character. These vapors may take fire from a lamp, gas jet, or stove, even at some distance.* Thus it is advisable to do work of this character out of doors if possible. Not infrequently have very serious disasters occurred through failure of the operators to familiarize themselves with the combustibility of the cleansing agents which they employ. Carbon Tetrachlorid is used widely as a scouring and cleansing agent as a substitute for gasoline. Owing to the lack of Hydrogen in its composition, it has the great advantage over the substances mentioned above, of being non-inflammable. In the use of volatile solvents, like gasoline, enough should be used to cover a large portion of the goods, and if possible afterwards washed thoroly with water.

Grease Spots.

To remove stains, spots, and tarnish, the knowledge of a limited chemistry will serve an excellent purpose. As grease is readily absorbed by blotting paper, spots may often be removed from fabrics by placing the goods between two pieces of blotting paper, and then heating with a warm iron, see Fig. 2. French chalk will sometimes absorb the grease, especially if the spots are fresh. Grease may also be removed by the use of hot water and soap, ammonia, or even borax. If there is no danger that these solvents will injure the goods or the colors, it is better to use some solvent such as Chloroform, Ether, Alcohol, Turpentine, Benzine or Naptha. Ether and Chloroform are better adapted to the more delicate fabrics. The troublesome dust spot has usually a neglected grease spot for its foundation. After the grease is dissolved the dust must be cleaned out by rinsing thoroly with fresh liquid or by brushing after the spot is dried.

Removing Paint Spots.

Paints consist of *oil* and *some coloring matter* and *lead or zinc oxids,* thus paint spots should be treated with a solvent for the oil, and then the coloring matter can be brushed off. Fresh spots may be treated

(*Continued on page* 251)

How Big Are Atoms and Electrons?

By L. R. JEWETT

THE study of electrons has recently led to great improvements in apparatus for producing and detecting currents of radio frequency. Doubtless many wireless enthusiasts read about the electron and its behavior in the operation of the electron relay (Audion) but do not know of the characteristics of the electron. The writer will endeavor to set forth some interesting, yet elementary, facts in reference to its characteristics, according to the modern theory of matter.

All bodies are complex structures composed of small particles called atoms and still smaller particles known as electrons. Molecules are groups of atoms and a molecule is the smallest part of a substance which can exist and still retain its chemical properties. For instance, two atoms of hydrogen and one atom of oxygen compose one molecule of water, namely, H^2O. Electrons may be contained in the molecules or free in space between the molecules. None of the particles can be detected by a microscope and the smallest visible particle so far detected with the ultra-microscope is about *twenty-five times the diameter of one of the largest molecules.*

An *atom* is about *one three-hundred-millionth of an inch in diameter.* If the earth were composed of baseballs, it would be an approximate model to a drop of water composed of atoms. In size the *electron* is very much smaller than the atom and it is believed to have a diameter of about *one one-hundred-thousandth that of an atom;* i.e., 1/100,000 of 1/300,000,000 inch, or 1/30,000,000,000,000 inch, diameter of an electron (or there would be 30 trillion electrons to the inch). Thus, if a large building 200 feet square and 350 feet high represented a comparative size of an atom, *an electron would be about the size of the head of an ordinary pin.* Thus the reader may be able to realize the size of the electrons whose performance is so important in many electrical phenomena.

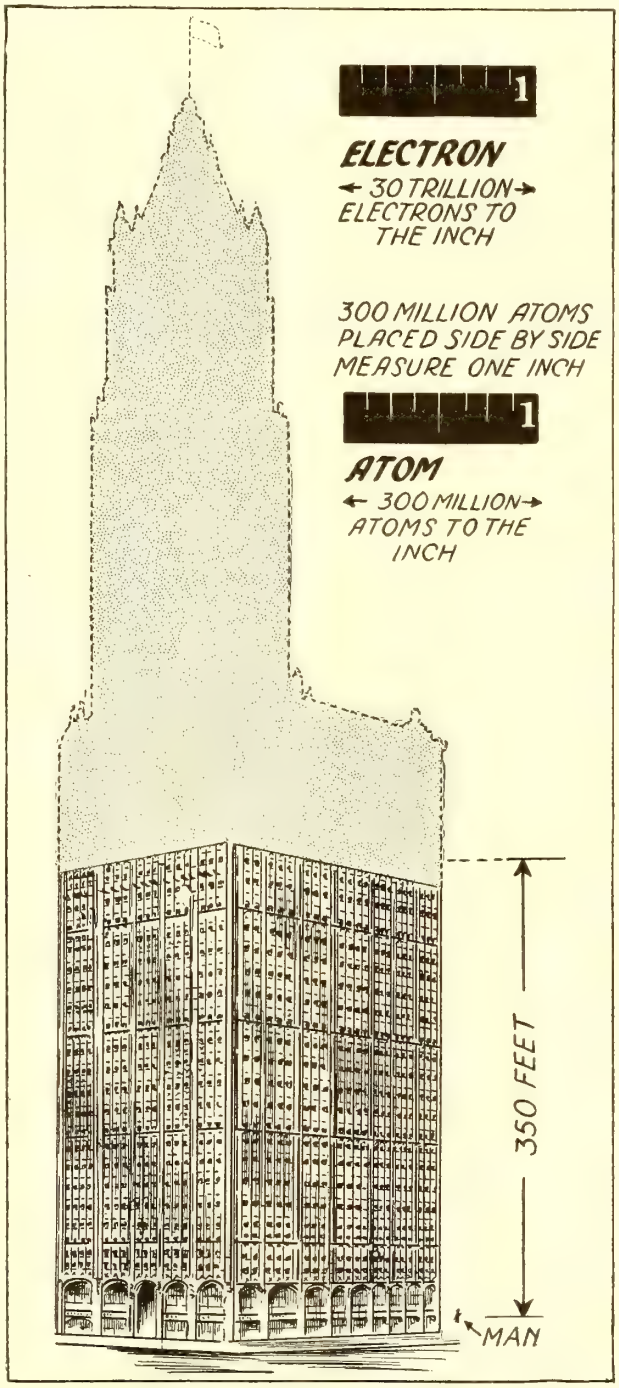
The assumption upon which the electron theory is based is that in every substance, whether charged or uncharged electrically, there exists both positive and negative electricity, distributed on discrete particles. All bodies appear to have large quantities of both positive and negative electricity, usually in equal amounts; thus one charge neutralizes the other and consequently no electricity seems to be present.

The smallest negatively charged particle which can exist in nature and which it is possible to detect is called an electron. Its charge, which is always negative, is less than one billionth of a billionth of a coulomb.

Experiments indicate that the electron is spherical in shape, al- been proven. Its ly regarded now by physicists to be entirely electro- contains a negative charge only and *does not consist of a material substance.*

attracted towards all positive charges and repel each other, since they are all of the same charge. There is an attraction between an atom and an electron, but it varies according to the characteristics of the atoms. Attraction between atoms and electrons in non-metals is weak, whereas in metals it is comparatively strong. Thus an electron could move about in a metal with comparative ease. If a stream of electrons is caused to move thru a metal, an electric current results. Therefore, an electric current thru a metal is said to be a stream of electrons moving thru relatively large spaces between the atoms or thru the atoms themselves. The actual speed of the electrons is exceedingly slow, but the rate of transmission of motion from one electron to another electron is very great. This impulse travels one hundred and eighty-six thousand miles per second, but *the electrons themselves may move only a few inches a minute.*

Interesting Facts About the Electron



How Big is an Atom? It is Estimated that an Atom Measures One Three-hundred-millionth of an Inch in Diameter. There Are 30 Trillion Electrons to One Inch. If a Building 200 Ft. Square and 350 Ft. High Represented the Comparative Size of an Atom, an Electron Would be About the Size of the Head of an Ordinary Pin. See Comparative Size Man Holding Pin in Illustration.

Hertzian waves are always produced by causing a charge of electricity to oscillate back and forth, and according to the modern wave theory when this electronic charge vibrates to and fro it radiates electrical waves which go out in all directions in space.

If a metal which contains large numbers of electrons is heated hot, some of the electrons would be given off into space. This is true when the filament of an electron relay or audion tube is heated. Since the plate is positively charged the electrons are attracted to it. Further discussion of the theory of the action of the electron relay or tube will be found in previous issues of this magazine. It is possible to calculate the magnitude of the electron flow from a hot filament.

$$I_B = A T^{\frac{1}{2}} \epsilon^{-\frac{b}{T}}$$

Where I_B = Electron current in milli-amperes per CM^2 of filament surface,

T = absolute temperature
$A = 2.5 \times 10^{10}$
B = 52500

A and B are true for a tungsten filament.

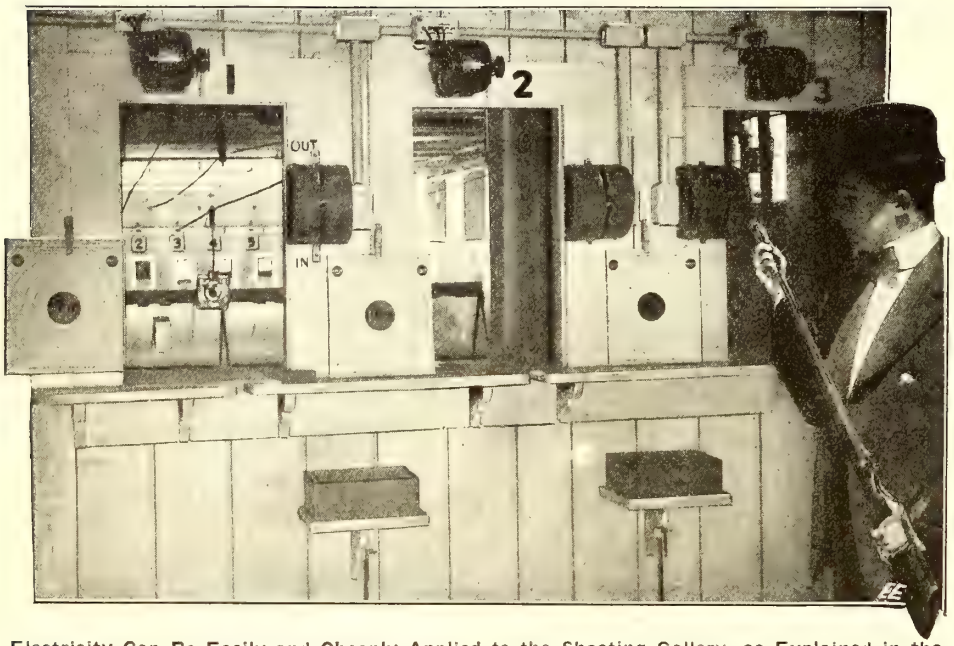
There is sometimes a misunderstanding concerning the difference between an electron and an ion. An electron has been defined as an "electromagnetic mass" having a negative charge. An ion is a material mass having a negative or positive charge as signified. Thus, if a tube containing a heated filament is purely a vacuum tube containing no air, it is a purely electronic emission and no ions are present. This is true of the so-called pliotron and dynatron, the Coolidge X-Ray tube, etc. But if a gas of any sort, for example, ordinary air or pure nitrogen is present in any degree in the tube, ions will be present also since the gas is "ionized" by the collision of the electrons and the atoms.

The modern electron theory is playing a very important part in the theory of the performance of different wireless instruments and systems. The above facts will no doubt tend to give the amateur a general idea of what an electron is and its behavior.

Those interested in the study of the electron theory will do well to look up some of the highly interesting articles publisht in back numbers of this journal, as well as such works as Professor Millikan's excellent treatise, "The Electron"; "Conduction of Electricity Thru Gases," by Thomson, and "Nature of Matter and Electricity," by Comstock and Troland. Articles in past issues of this journal: "Cosmic Force," by L. M. Correll, April, 1918; "Can Electricity Destroy Gravitation?" by Nipher, March, 1918; "Modern Physics and the Electron," by Prof. R. A. Millikan, January, 1918; "Does Radiant Light Possess Weight?" by A. R. MacPherson, July, 1917, issue.

THE CONSTRUCTOR

An Electric Shooting Gallery



Electricity Can Be Easily and Cheaply Applied to the Shooting Gallery, as Explained in the Accompanying Article. The Targets are Carried to and from the Marksman's Position by Motor Operated Cables. The Motors are Reversed by a Simple Switch. The Motors May Be Ordinary 1/15 H.P. Fan Motors. You Can Thus Check Your Own Targets.

IN the ordinary shooting gallery or rifle range it is invariably necessary for someone to replace the targets and also to keep the score where continuous shooting is carried on. Therefore, even with the individual rifle range, it has always been a serious draw-back in that someone had to be employed to change the target and either keep the score in a score book, or else after a given number of rounds to return the target to the marksman. These desideratums have been well taken care of and circumnavigated by a very ingenious electrical scheme which has proven an unqualified success at the rifle range of the Lynn Rifle and Revolver Club, maintained by the employees of the General Electric Co., at Lynn, Mass.

The Lynn Rifle and Revolver Club has about 160 members and the membership is open to all employees who are citizens of the U. S. A. In addition to the Rifle Range, the club has also facilities for pool, billiard, chess, checkers and cards. The whole is installed in the basement of an old office building on Center Street, together with the Bowling Club Alleys.

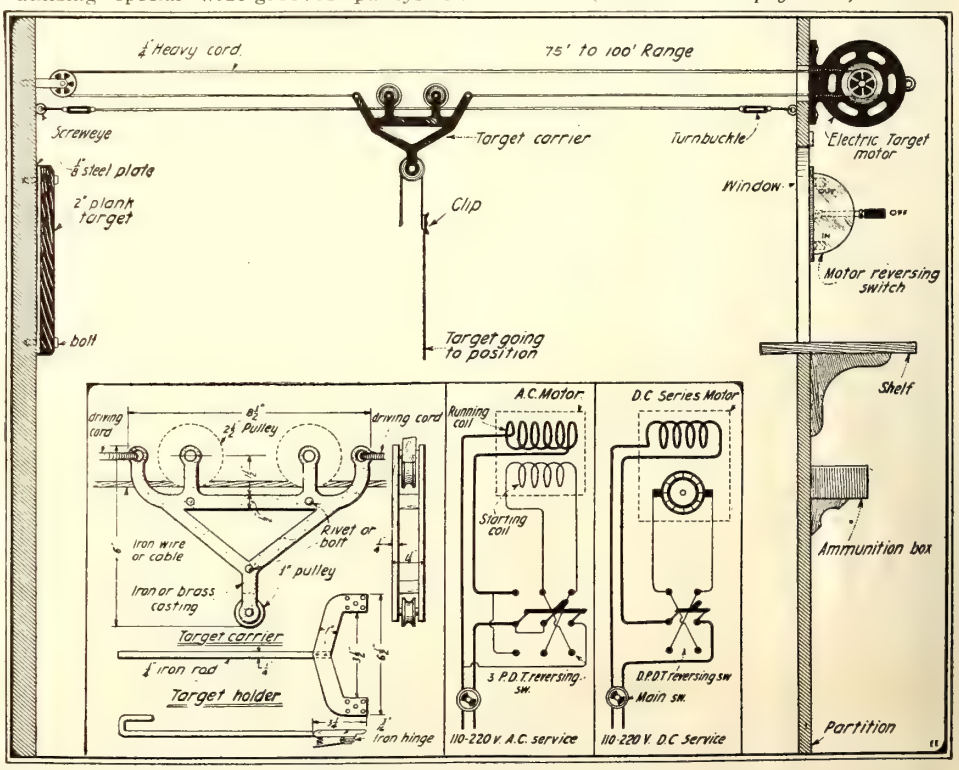
This electric shooting gallery contains eight stations. The present view was taken from the firing station and shows the small electric motors for driving the target carriers which are type 1/15 H.P.-220 volt-60 cycle motors. These are controlled by double-pole double-throw knife switches with a fiber guard which is also shown.

The accompanying diagrams show how the carrier, which may be made of aluminum or cast iron, wrought iron bar, or even of wood, is arranged to travel along the carrier cable. This cable may be made of ¼ inch galvanized steel stock, such as is sold for wash line purposes, and it can be anchored on either end by means of large screw-eyes, thoroly secured in walls or posts, and placing a turnbuckle at one end of the cable so that it can be tightened up as required. The driving cord which pulls the target carried back and forth may be a piece of ¼ inch rope, and by utilizing special wide-grooved pulleys on the motors, the hauling rope can be given a turn or two about the pulley, so as to have a much better frictional contact with it.

Two different ways of starting, stopping and reversing electric motors suitable for controlling the target carrier are shown herewith. Any electrician can hook up these motors, and in fact anyone a little handy in electricity and mechanics can rig up the switching scheme whereby the motors are controlled. The principle of reversing small motors may be stated as follows: For small series-wound D.C. motors, the stationary or field coil terminals must be reversed to change the direction of rotation. However, either field or armature connections may be reversed for shunt-wound D.C. motors, while for the usual type of self-starting single phase A.C. motors, it is necessary in order to reverse the direction of rotation, to reverse the connections of the starting coils, or rather the terminals going to these coils and which lead out to the terminal board of the motor.

The *modus operandi* of this electric shooting gallery is carried out thusly: The marksman turns the main switch and then throws the *reversing switch* to the "in" position, if the target carrier happens to be at the rear of the range. When it approaches the forward end and the range at which it is stationed, the reversing switch is pulled out to the "neutral" position. A new target card is then inserted in the spring clip of the carrier and the old target kept for checking up the score. The reversing switch is then thrown to the "out" position, so that the motor reverses its di-

(*Continued on page* 254)



Details and General View of Electrical Target for Shooting Gallery or Home Practise Range. The Details are Simple. Its Efficacy Is Attested by the Fact that It Is in Use at a Large "Gun and Revolver Club" at Lynn, Mass.

Improved Capillary Battery

By THOMAS REED

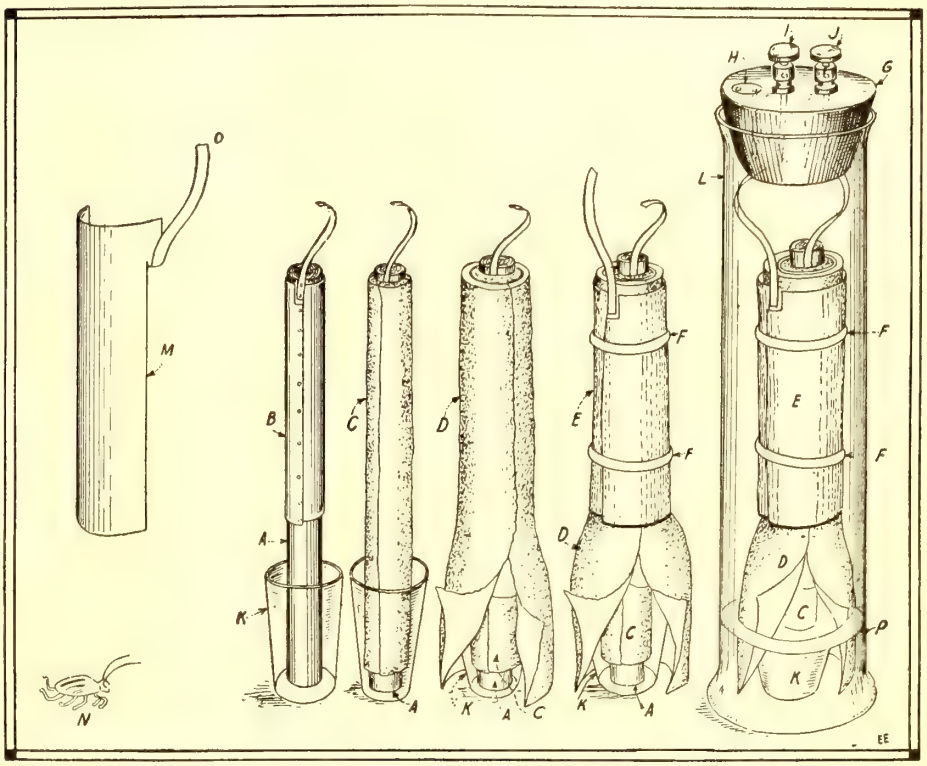
YOU remember my *capillary battery* using two solutions, copper and zinc sulfate, which demonstrated that the solutions wouldn't mix when contained in a capillary mass like burlap, thus giving a battery of very long life on open circuit, or one of small output? The only trouble with *that* battery was its high internal resistance, and I've doped out a startling modification of it with a lower resistance, which may amount to something, provided the solutions still decline to mix under the new arrangement.

I have to postpone trying it out until I get to the "summer place" on the Cape, where my tools are; but as it's so simple perhaps some fellow "Bug" would like to make the experiment now, and beat me to it. I'll say it's worth while, for even if the cell produces but ¾ of a volt, it wouldn't take an unreasonable number of 'em to form a nice "B" battery for Audions, while they'd cost practically nothing, and if they worked at all they'd work for years.

I've drawn the thing in successive stages, to make its construction perfectly clear. You begin with a wooden dowel A, of a length proportioned to the containing bottle you're going to use. Around this you bend the very thin copper sheet B, and tack it on with copper tacks. M shows the manner of preparing this sheet, with a strip O slit nearly to the top and turned up to form a connector. K is a small whiskey-glass (anybody'll give you a whiskey-glass after July 1st) which will contain the sulfate of copper solution.

Next, you wrap the dowel—with its partial copper-coating—in the thick burlap C. I should think one layer would be enough. This goes nearly the full length of the dowel, as it is to extend down into the copper solution and draw it up by *capillarity*. At this point soak C with copper solution, so you won't have to wait for it to soak up later, also to prevent its exhausting the contents of K.

Now for another layer of burlap, D, a little longer this time, as it goes down outside of K, and dips into the sulfate of zinc (or acidulated water) solution. Nothing between these two layers of burlap; each will be saturated with its own solution and they're supposed not to mix on account of the capillary action. I have folded D back to show the interior, but the flaps will be let fall in practise. Soak D in acidulated water before putting on.



Successive Stages in Building Tom Reed's Improved Capillary Battery. It Gives Approximately Three-quarters of a Volt and Should Prove Useful in Making up "B" Batteries for Audion Circuits.

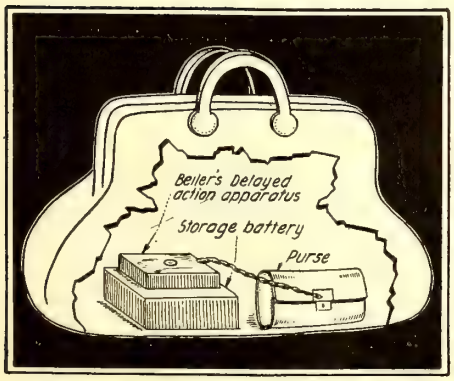
Finally comes E, a sheet of zinc, also prepared with a connecting strip. No soldering necessary, just bent around and held by the two rubber bands F F. 'Tis well to amalgamate the zinc.

Now for the bottle, L, an olive or pickle bottle with a well-fitting cork G. The zinc and copper strips are connected to the binding posts I, J. You'll also want a vent-hole H, covered with a piece of soft rubber, to release the gases without evaporating the liquids. P shows the common level of the liquids both inside and outside the cup K—saturated copper sulfate, with a few crystals added inside, and acidulated water outside.

N represents an industrious "Bug" beating me to it. Hope he doesn't return with news it's no good. We thank you for your kind attention. Refreshments, second door on the left.

That Wonderful Electric Action-Delayer

By THOMAS REED



Applying Mr. Beiler's "Thermostatic Time-Switch" or Action-Delayer to the Shopping Bag. It Opens the Purse Two Minutes After You Decide to Buy Some Worthless Junk—Giving You Time to Change Your Mind!

DID you read that article in the November number by Mr. Albert H. Beiler, describing a "thermostatic time-switch" he'd invented? Lighting a lamp, not just when you push the button, but two minutes afterward? And did you mind what he said—"If you ask me what real use it has. I can't tell you?" S-ay . . . !

If ever there was a Regular inventor—"Regular" with a Capital "R" at the beginning and a Scotch growl at the other end—it's A. H. Beiler. Invents an invention—and such an invention as THAT—and doesn't know what it's good for! Why, Al, for the love of Pete wake up and put your collar on before the cheering crowd gathers at your door! It's an epoch-maker.

There may not be any great object in delaying the action of a light, because you generally want it about the same time that you get around to pushing the button; but if you substitute for the lamp a motive apparatus, think, Man, what you've got—the greatest little second-thoughter in the world! You can have all the effect of a final decision in pushing the button, and yet have two whole minutes in which to change your mind.

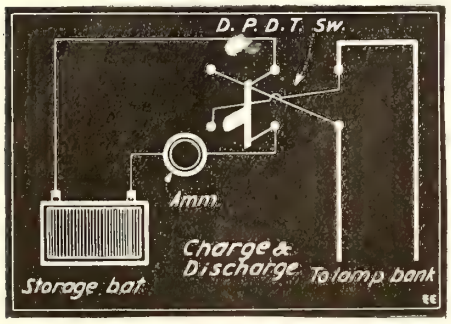
I see where it's going to be applied to every door-lock right away. The Missis hears a ring, and pushes the door-button. Almost immediately she thinks, "What if it's a tramp?" She goes to the window, and sure enough there's a coat-tail sticking out from under the porch. It looks untidy, possibly ragged. Visions of robbery and murder, but—the lock has not yet operated, thanks to the beneficent Beiler. There's time to run back, press another button and cancel the order. As a matter of fact it's not a "burgular" but her brother with a nice

(*Continued on page 277*)

Storage Battery Testing

By Harold R. Adams
STORAGE BATTERY ENGINEER

AN outline of the methods used in commercial storage battery work, adapted to the requirements of the layman and amateur electrician is given in the following paragraphs, which may prove of assistance. The first



Handy Circuit for Charge and Discharge of Storage Battery in Testing Work. An Ammeter Should Always Be in Series With the Battery.

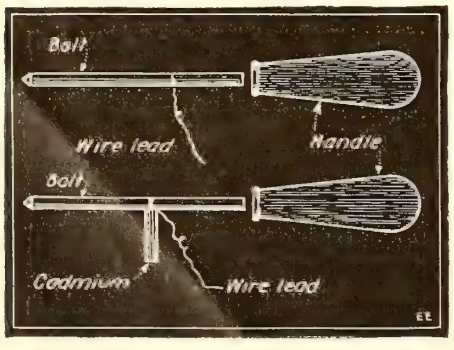
step is to determine the capacity of the battery under test. The capacity in ampere-hours, the charging rate at start and finish, etc., will usually be found on the name-plate of the battery.

When these have been determined the battery should be connected to a source of *direct current* and charged at the finishing rate until the cells gas freely and the E.M.F. (voltage) reads in the neighborhood of 2.5 to 2.6 volts, connected to charging current.

If the battery is of the starting or lighting type the specific gravity should read 1.285 at 70 deg. F. The *gravity* of truck batteries sometimes is a little lower than the above; however, it should be given on the name-plate or in the instruction pamphlet that is sent with the battery.

Before going any farther we will sum up the instruments needed to properly conduct the tests.

1 Hydrometer reading from 1.150 to 1.300
1 Thermometer (floating type)
1 Ammeter
1 Voltmeter (3 volt scale)
1 Lamp bank (where 110 volt direct current is used) or
1 Rheostat (where low voltage generator is available)
2 Iron bolts, 4 inches long, ¼ inch dia.
1 Cadmium rod 3 inches by ¼ inch
12 Feet stranded rubber covered cable, 14 B. & S. gage.



How the Battery Testing Prod and Cadmium Electrode Is Constructed. Brad Awls Make Good Test Prods and Cost About 10 Cents Each.

The heads should be cut from the bolts and the threaded ends inserted in wooden handles shown in figure. The cadmium rod should be soldered to one of the bolts as shown in the same drawing.

The stranded wire should be cut in half and one piece soldered to each *prod*, as shown in the illustration, the other end being connected to the voltmeter. The prod with the cadmium electrode should be connected to the positive terminal of the meter.

A very convenient hook-up is here given for charging and discharging the battery or cells. An ammeter should be in series with the battery all of the time.

When everything is ready the battery should be put on charge at the finishing rate, until the cells gas freely and the voltage reads 2.5 to 2.6 volts per cell, and the gravity of the electrolyte is correct. If the gravity of the electrolyte does not increase to the proper point after a couple of hours charging it will be necessary to add a little strong acid, great care being exercised in doing so and also in making temperature corrections in case the temperature is other than 70 deg.

The following rules governing the cadmium test should be carefully studied before going any farther if the tests are to be a success.

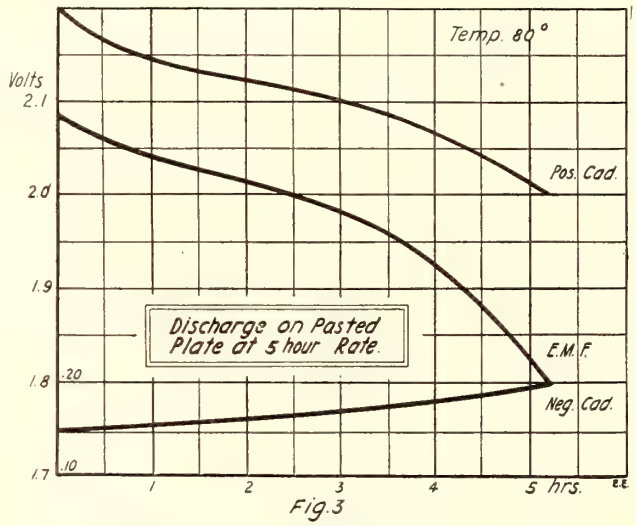


Fig. 3

Curves Showing Cadmium Readings on Test of Pasted Plate Battery at Five-Hour Rate.

The sum of the positive and negative cadmium readings should nearly equal the voltage across the cell when the cell is charging.

The difference between the pos. and neg. cadmium readings should equal the voltage of the cell when on discharge.

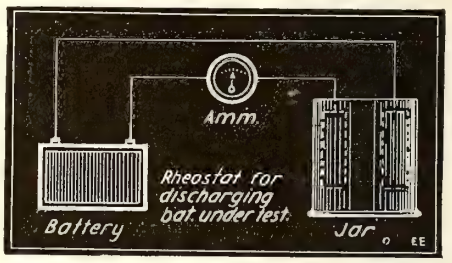
The positive cadmium always reads plus.

When the cell is charging neg., cadmium reads minus.

When the cell is discharging the neg., cadmium reads plus.

To take a cadmium reading immerse the cadmium electrode in the electrolyte and bring the other prod in contact with either the pos. or the neg. pole of the cell according to which cadmium you wish to read. When the cadmium is not in use it should be kept immersed in dilute acid (electrolyte), otherwise the readings will be incorrect.

When the cell is fully charged the E.M.F. across the cell should read from 2.5 to 2.6 volts and the pos. cad. from 2.38 to 2.44 plus. The neg.— cad. should read from —.16 to —.20 when the cell is in good condition. It has once been noticed by the author that a neg. cad. read *plus* on charge. This was found to be due to the fact that the battery had been heavily overcharged.



A Water Rheostat Proves Useful for Absorbing the Energy from Storage Battery on Discharge Test.

The plates were removed and prest, and gave very good service afterwards. The heavy overcharge had filled the pores of the plates with hydrogen which is positive to cadmium.

A slight overcharge of a couple of hours at the finishing rate about every five cycles is good for the battery, but a heavy prolonged overcharge, especially at a high temperature, will result in the ruin of the battery if allowed to occur too often.

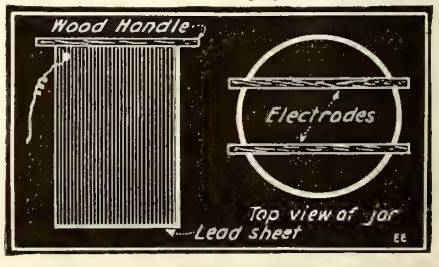
When the battery has been fully charged and the readings recorded it should be arranged for discharge.

To discharge a battery at the standard *eight-hour rate* requires quite a little time. However, it has been noticed that when a battery is discharged at a higher rate that the *ampere-hour output is lessened a certain per cent.*, depending on the ratio of the rate of the discharge. Advantage may be taken of this fact and the following table of percentages and the time needed for the test considerably reduced. The figures in this table are taken from experiments made by the author and may be used for any make of lead plate battery, except the Edison, which is an iron-nickel element.

Table 2

Hour Rate	Pasted Plate	Plante Plate	Hour Rate	Pasted Plate	Plante Plate
8.00	100 %	100 %	1.50	53.5%	63%
7.00	96 %	99 %	1.00	46 %	55%
6.00	92 %	96.5%			
5.00	86.5%	93 %			
4.00	80 %	88 %			
3.00	72 %	80 %			
2.00	61 %	70 %			

(*Continued on page 282*)



Details of Water Rheostat for Battery Testing. The 2 Electrodes are Made of Lead or Iron, Etc. Solution May Be Salt and Water or Bicarbonate of Soda.

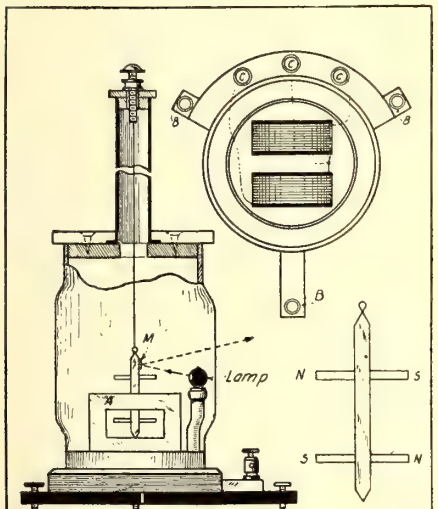
HOW TO BUILD AN ASTATIC GALVANOMETER.

By C. G. Yungblut.

THE great trouble with many "how-to-make-it" articles is that they call for tools or material which the experimenter does not possess, and generally time or pocket-book prevents him from obtaining them. But luckily in electrical construction, if one thing is lacking, another can generally be supplied that will perform the service quite as well, and the experimenter can turn out a creditable piece of work whatever his resources may be. Especially is this true in the constructing of galvanometers.

Suppose, for instance, you want a good sensitive galvanometer, and you want to make it yourself. The *D'Arsonval* type is out of the question, let us say, because you haven't the required magnets. Make an *astatic*, then. The first thing that causes trouble is a covering to protect the delicate suspension from currents of air. A clear glass cover the proper size and shape would cost a good deal. But here's an easy way out of that dilemma. Get one of those glass chimneys used on gas burners, one of the cylindrical kind, that narrows down at both ends. Procure one of good clear glass, free from bubbles and ridges, and you have an excellent cover. The next difficulty is the suspension. To be delicate, it should be high, higher than the cover itself.

Let us make a top for our cover. If you have a lathe turn one from wood or fiber that will just fit into the top of the cover,



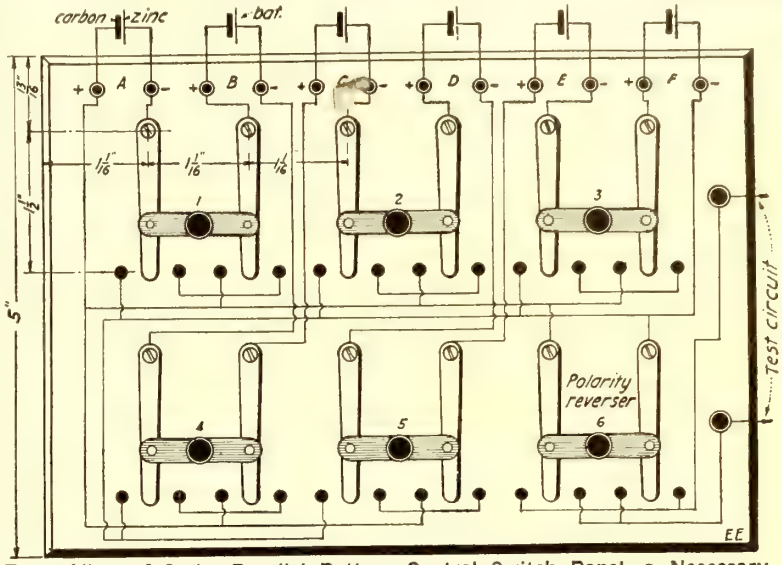
An "Astatic Galvanometer" Is an Instrument Which Every Student Does Not Care to Purchase. Yet He Often Needs It Urgently. The Present Article Tells How to Build a Very Sensitive One of the Reflecting Mirror Type.

with a flange to keep it from slipping thru. If you have no lathe, cut out two disks of thin wood with your pen knife, or a scroll saw, one just large enough to slip into the top of the chimney and the other about three-sixteenths of an inch larger all around. Fasten the two disks together, and you have a cover as good as one turned on a lathe. Next get a large test tube, and cut off the closed end, so that a cylinder of glass with a flange at one end is left. Bore a hole in the center of the cover you have just made, slightly smaller than the internal diameter of the test tube, and fasten the tube in place over this hole. If you have made the cover of two disks, the flange of the test tube can conveniently be placed between the two before you fasten them together, as the diagram suggests. Now assemble the cover and its top with the tube in place. You can at once see that if the astatic element, M, is hung from the top of the tube, the suspension will be high enough, and will be completely protected.

(*Continued on page 278*)

A Series-Parallel Battery Switch

A very convenient switch for quickly and easily connecting battery cells in a variety of combinations is herewith described. No machine work or intricate designing is necessary. Carefully lay out the location of the holes on the fiber base according to the diagrams. The holes on the under side of the base, which are not shown in the present illustrations, are drilled with a No. 40 drill to a depth of 3/16" with a 4/36 tap; tap one turn enough to get a screw started. Be careful not to go thru the base with the drill or tap. The continuation of these holes in the fiber strips forming the sub-base are drilled with a No. 32 drill, to allow the 4/36 screw to slip thru easily, and slightly countersunk. The size of the holes for the binding posts will depend on the size of the binding post shank. All other holes in the base are drilled with a No. 18 drill. Fasten the sub-base strips to the under side of the base with the No. 4/36 by 7/8" screws; be careful not to strip the threads. File and sandpaper the whole base to give as near as possible the appearance of a solid piece.



Front View of Series-Parallel Battery Control Switch Panel—a Necessary Adjunct to the Experimenter's Laboratory. Any Desired Grouping of the Cells—Series, Parallel or Series-Parallel—Is Possible by Its Use.

The following materials will be needed:

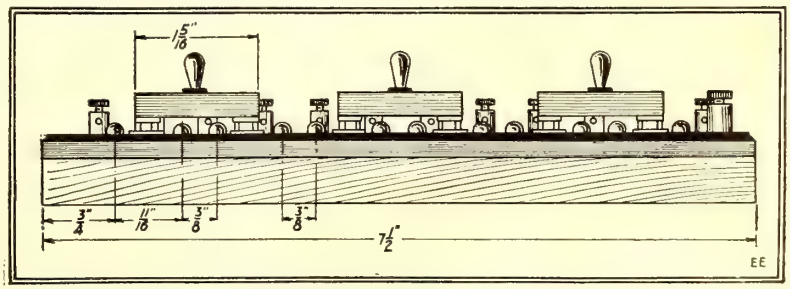
One fiber base, 7½" x 5" x ¼".
Two fiber strips, 7½ x ¾" x ¼".
Two fiber strips, 4½" x ¾" x ¼".
Twelve fiber strips, 1 5/16" x ¼" square.
Twelve copper strips, 1¾" x ¼" x 1/32".
Fourteen small binding posts.
Twenty-four round-head machine screws, 8-32 x ½".
Twelve round-head machine screws, 8-32 x ¾".
Twelve flat-head machine screws, 4-36 x 3/8".
Eight flat-head machine screws, 4-36 x 7/8".
Forty-eight hexagonal 8-32 nuts.
Eighty-four ⅜" dia. washers.

Next, drill a No. 18 hole ⅜" from one end of each of the copper strips; also drill a No. 32 hole 1⅜" from the same end, and countersink. The corresponding holes in the ¼" square by 1 5/16" fiber strips are drilled to a depth of 3/16" with a No. 40 drill; make these holes ⅛" from each end, and tap the turn with 4/36 tap; the screw will then go in very tightly without binding on the copper strip. Fasten these handles on the switch blades first; then put an 8/32x¾" screw thru from the top of each blade and run up a nut on the other side. Then put on a washer and insert in the proper holes in the base, and put on two washers; then fasten with one nut. For the contact-points, put an 8/32x½" screw thru each of the proper holes on the base, put on two washers underneath and then proceed to fasten with one nut.

The connections are made according to the diagram in Fig. 3. Unless all connections are soldered, the wires must be run from one contact to the other, instead of being tapt off as shown. Do not use smaller wire than No. 18 D. C. C. for this purpose. Place all ends of wires between washers, and screw nut up tightly, being careful the switches do not bind. Then coat the wires with heavy shellac or glue to hold them in place.

The cells to be operated are permanently connected to the binding posts marked by the letters "A, B, C, D, E, F" in Fig. 3; connect one cell to each pair of posts; the positive and negative polarities must alternate as indicated. The possible combinations are tabulated in Fig. 4, which should be used for reference. Switch No. 6 is first thrown to the left or right, according to the polarity desired at the test current terminals. When using the switch-board this switch must be thrown either in one position or the other. Under "CELLS" look for combination desired; under "SWITCH POSITION" find position of switches to give the combination. For example: to obtain current from 3 cells in series and 2 in parallel, look in column marked "CELLS" and in "Series" column find 3 and in "Parallel" column find 2. Under "SWITCH POSITION" in columns marked "LEFT" and "RIGHT" find "2" and "1, 3, 4, 5," respectively. Place switch No. 2 on its left-hand contacts and switches Nos. 1, 3, 4 and 5 on their right-hand contacts; the current is taken from the pair of binding posts near the right-hand edge of the base. If the polarity is to be changed, move switch No. 6 to the opposite position. The switches that are not specified in the table for any particular

(*Continued on page 275*)



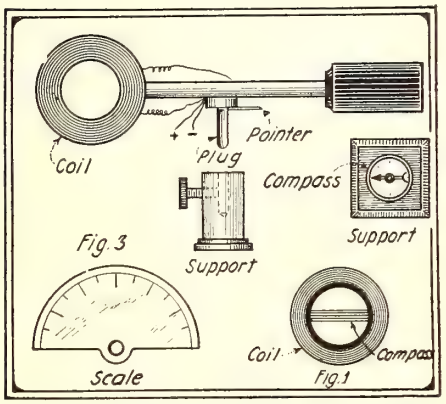
Edgewise View of Series-Parallel Battery Control Switch. Every Electrical "Bug" Will Find This Switch of Great Usefulness in His Laboratory.

HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

A Laboratory Measuring Instrument

FIRST PRIZE, $3.00

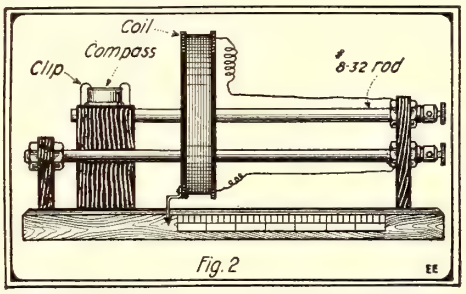


The Magnetic Coil Used to Actuate the Calibrated Compass Is Here Shown Mounted in a Pivoted Pedestal.

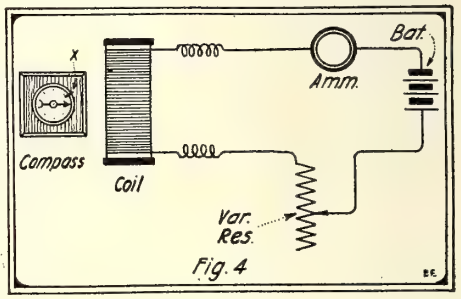
If we take a coil of wire as shown in Fig. 1 and set a compass in the center as shown, with the compass needle pointing in the plane of the coil, then when current is past thru the coil the needle will swing at right angles to the plane of the same. One objection to this type of apparatus is that it is very critical and no direct readings can be taken to scale—for this reason the following instruments if properly constructed will be of advantage to any experimenter in his laboratory. It not only being cheap in construction but it is likewise efficient when calibrated by a method given below.

In Fig. 2 one type of instrument is shown. A compass is clamped on a wooden stand by two brass clips as shown and the coil (current coil) is supported by the 8/32 rods and slides back and forth on them. A pointer is affixt to the coil and moves over the scale.

In Fig. 3 the compass is supported on a wooden stand in the same manner described above, but here the coil rotates away from the compass on a 90 degree angle (or quarter circle) decreasing its distance from the compass in that manner. Here, of course, the scale has to be affixt to the support which also holds the coil, its arm and handle.



A Very Useful Form of Home-Made Measuring Instrument. The Compass Is Affected in Proportion as the Coil Is Moved Toward or Away from It.



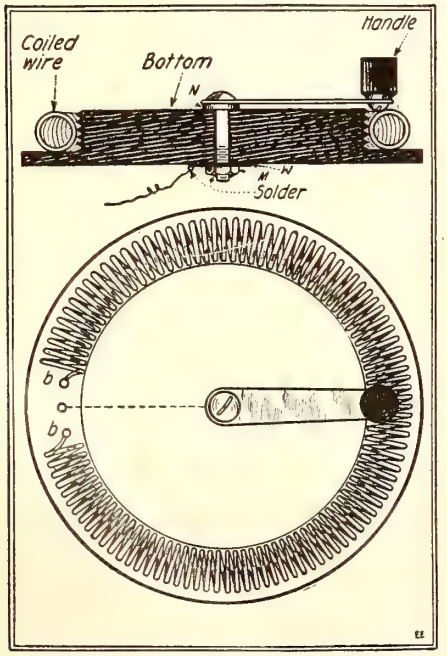
Hook-Up of Apparatus for Calibrating. The Current in the Coil Is Varied by a Rheostat.

Calibration of the Instrument: As shown in Fig. 4 a standard ammeter for battery use is connected in series with the coil and the batteries, the current from the batteries is regulated by a variable resistance. A mark is made with black paint on the compass as shown at X in the drawing. This mark is employed in the following manner: The coil is moved one degree on the scale and the resistance varied until the compass deflects to the mark—this is noted on the scale—and the coil is then moved back another notch on the scale and the same procedure complied with, until finally the entire scale is plotted. This makes a very neat and efficient measuring instrument.

Contributed by E. T. JONES.

A Rheostat Push-Button

SECOND PRIZE, $2.00



Push Button Bases Lend Themselves Nicely to the Construction of Home-Made Spiral Wire Rheostats.

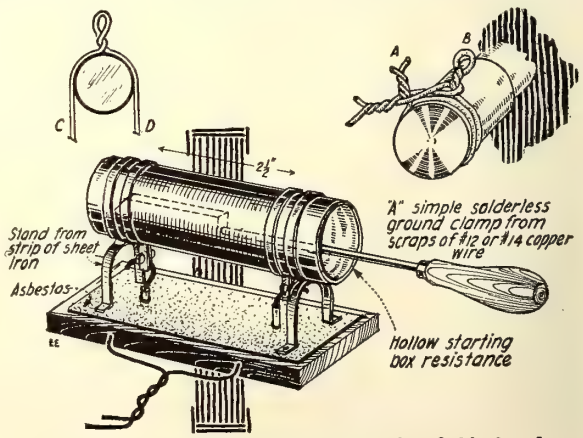
Remove all contacts and other trimmings from the bottom of a common wooden push-button. Then make a coil of resistance (iron, German silver, etc.) wire, put it in position shown, and fasten the ends in place by two binding posts, b and b. The contact arm is sheet brass, 1/16 inch thick. The handle is a piece of one-half inch dowel, fastened by a small round-head wood screw, which makes contact with the wire. The arm is fastened securely to the bolt by a nut, N. A washer, W, is slipt over the bolt on the back at the bottom, and then another nut, M, which is soldered to the bolt. A wire is soldered to the washer for connections. This rheostat should be used for light work only.

Contributed by ROBERT HERTZBERG.

Soldering Iron Heater

THIRD PRIZE, $1.00

sketch explains the stunt sufficiently, except that in putting on the clamp the loop (B) should be made first; then the two ends (c and d) bent around and twisted at (A). The lead wire is looped around A and B and twisted up tight, giving a firm joint.



Making a Ground Clamp in a Jiffy—and a Soldering Iron Heater.

A "TWO SECOND" GROUND CLAMP AND SOLDERING IRON HEATER.

My "two-second" ground clamp is made from scraps of No. 12 or 14 B. & S. gage copper wire. I have used a clamp like this and find it gives entire satisfaction. The

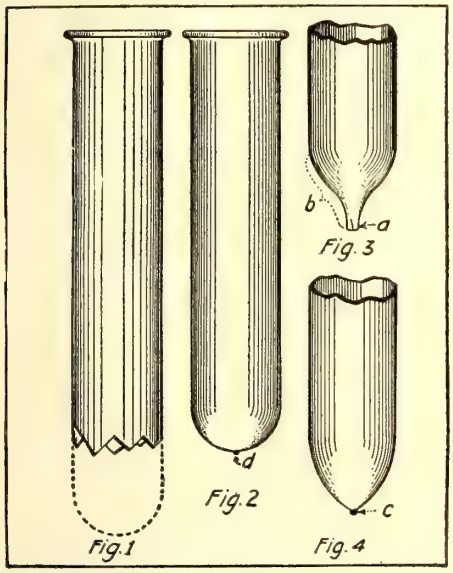
The other stunt is a soldering iron heater made from a discarded starting box coil.

Contributed by E. McALLISTER.



REPAIRING TEST-TUBES.

Being short of test-tubes and unable to obtain more at the time, I chanced upon the idea of mending some of the broken ones. My first trials were unsuccessful because of the bottom being too thick. I



Don't Throw Away Your Broken Test-Tubes. You Can Repair Them Easily. Just Try!

managed to get a good, thin bottom by the following method:

The broken test-tube was lowered into the Bunsen flame and the jagged edges, when soft enough, (still held in the flame) were pulled out with the aid of an ordinary pair of pliers. When the walls seemed thin enough, the jagged ends were drawn together thereby closing the end of the tube as in Fig. 3. The heat was concentrated on "b," Fig. 3, and when soft enough the tip "a" was drawn out (*while held in the flame*). The result appears at Fig. 4. Still holding the tube in the flame, the bottom was heated until soft when it was quickly removed, the open end placed to the mouth, and the breath forced into it. This was done several times until the bottom assumed the shape of that at Fig. 2. Then it was annealed well in the luminous flame and set aside to cool. The result is a test-tube that may be used for all ordinary purposes not requiring heat. The tube may also be used in the flame if the tip of thick glass "d," Fig. 2, is removed with the aid of a grinding wheel or an oil-stone and the tube re-heated and annealed again.

The jaws of the pliers must be hot when it comes in contact with the hot glass and preferably one with narrow jaws and insulated handles. Before introducing the broken test-tube in the flame it must be well heated in the air above the flame to prevent further cracking.

Contributed by HAROLD OLSEN.

SHOP KINKS

Lay dull files in diluted sulphuric acid until they are eaten deep enough.

Chasing Threads in Aluminum: When cutting threads on aluminum use a little oil with coal oil, about (1) one teaspoon of oil to (1) one pint of coal oil, and the threads will not clog up, but will take a fine finish as if cut in steel.

Contributed by CLYDE G. PATTERSON.

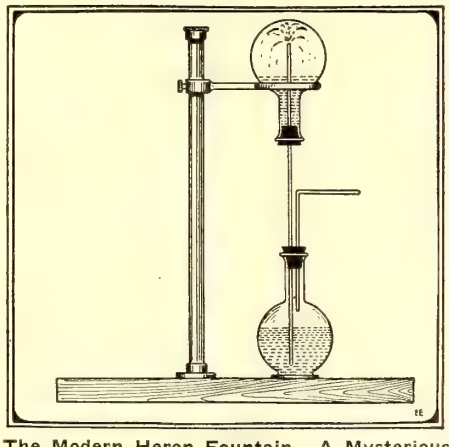
SOLUBILITY OF GAS PRODUCES FASCINATING EFFECTS.

A very interesting chemical experiment can be performed with the apparatus shown in the illustration. A perfectly dry Florence flask is used for the upper vessel. It is filled with hydrogen chlorid gas, which is prepared by heating a mixture of moistened common salt (sodium chlorid) and sulfuric acid. The gas is collected by downward displacement as it is heavier than air.

This flask is connected by means of a glass tube to a similar vessel, which is nearly filled with a blue litmus solution. This solution is made by dissolving a very small quantity of the blue litmus dye in water. The end of the tube, opening into the upper flask is drawn out, so as to make a rather fine jet. All the stoppers are fitted tightly.

By blowing into the open tube of the lower vessel, a few drops of the liquid are forced into the upper flask. The hydrogen chlorid at once dissolves, thus diminishing the pressure inside the vessel. The blue solution then forms a fountain at the jet and continues to do so, until almost all the chlorid is used up. This gas has also the property of changing blue litmus to red, hence as soon as the solution comes in contact with it, the color is changed immediately, thus presenting a very mysterious appearance to a novice.

Contributed by JOHN C. JACK.



The Modern Heron Fountain. A Mysterious Trick of Fascinating Effects.

FIREWORK PAPERS AS PYROTECHNICS.

Red Fire

Strontium nitrat	20 parts
Potassium chlorat	10 "
Alcohol	20 "
Water	100 "

Green Fire

Barium chlorat	20 "
Alcohol	20 "
Water	100 "

Yellow Fire

Sodium oxalat	10 "
Potassium chlorat	10 "
Alcohol	20 "
Water	100 "

Blue Fire

Potassium chlorat	10 "
Copper chlorat	20 "
Alcohol	20 "
Water	100 "

Violet Fire

Strontium chlorat	15 "
Copper chlorat	15 "
Potassium chlorat	15 "
Alcohol	50 "
Water	100 "

Lilac Fire

Potassium chlorat	20 "
Copper chlorat	10 "
Strontium chlorid	10 "
Alcohol	50 "
Water	100 "

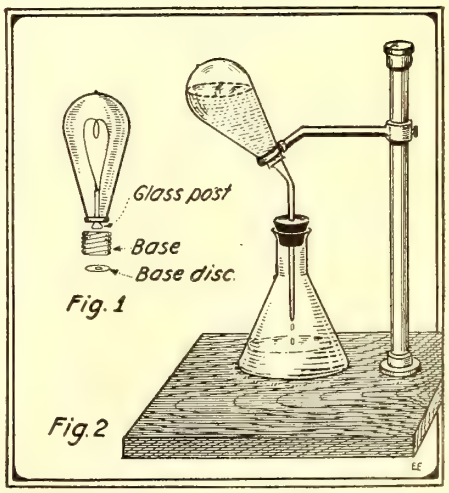
Unsized paper is put in the solutions. When the paper becomes saturated, then remove and dry by hanging it over a string stretched across a warm room. A sheet of paper about 12 by 16 inches may be made to burn for several minutes.

Contributed by BRUCE L. LEWIS.

DROPPER FROM OLD LAMP BULBS.

I have found a very good use to which old worn out electric bulbs can be put. First, the solder is melted from end of the base and the small disc is removed. Now, by using a little pressure, the entire base may be removed. Then, with a piece of heavy wire or a nail, the glass post on which the tungsten filament is attached, can be broken. The glass pieces and tungsten wire must then be removed. Care should be taken to keep the opening at the bottom as small as possible. If the bulb is now filled with water and quickly inverted, the water will not flow out but by slightly tilting it, the water will come out drop by drop. This makes a very good dropper for use in chemical experiments. If a rubber tube is attached as in Fig. 2 the dropper may be used on any receptacle.

Cont. by WERNER KRETSCHMER.



The Burned Out Bulb in the Laboratory. A Cheap and Efficient Dropper!

Electrical Oscillators

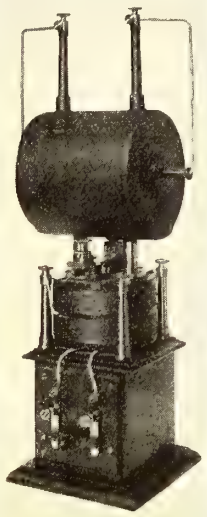


Fig. 1. Oscillator with detachable transformer for experimental purposes

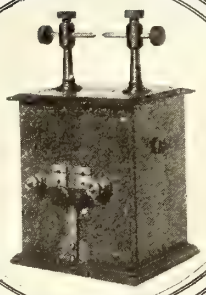


Fig. 2. Small Tesla Coil for gas engine ignition and similar uses

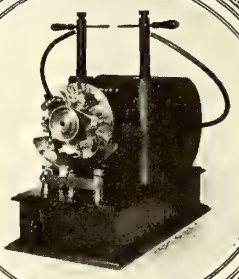


Fig. 3. Tesla Transformer, 12 inch spark, chiefly for wireless

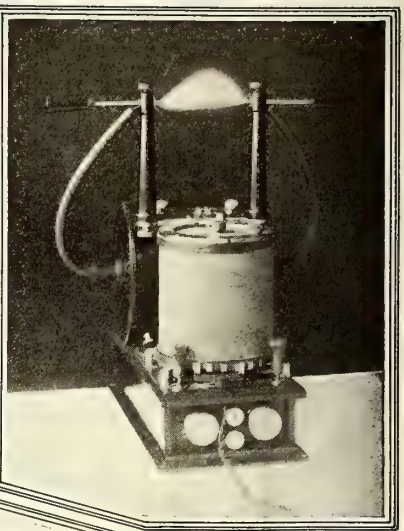


Fig. 4. Tesla Oscillator in action, generating undamped waves



Fig. 5. Later type of Tesla Transformer

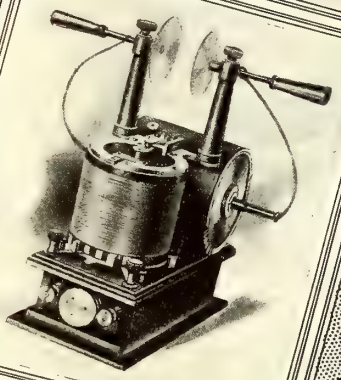


Fig. 6. Small oscillator for production of ozone

Fig. 7. Large Tesla Transformer for various purposes

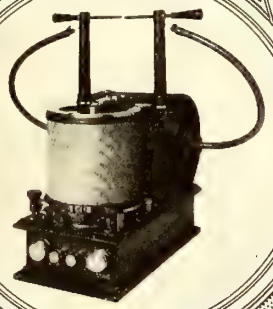


Fig. 8. Tesla Transformer with rotary break for wireless

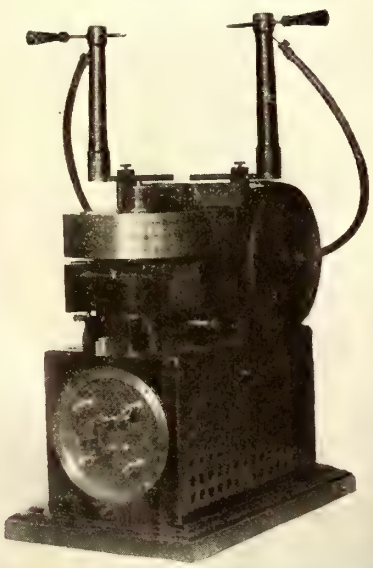




Fig. 9. Tesla Transformer with mercury interrupter

Fig. 10. Large Tesla Transformer with hermetically sealed mercury interrupter

Fig. 12. Another type of Tesla Transformer with sealed mercury interrupter



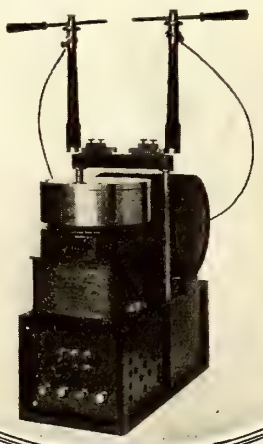
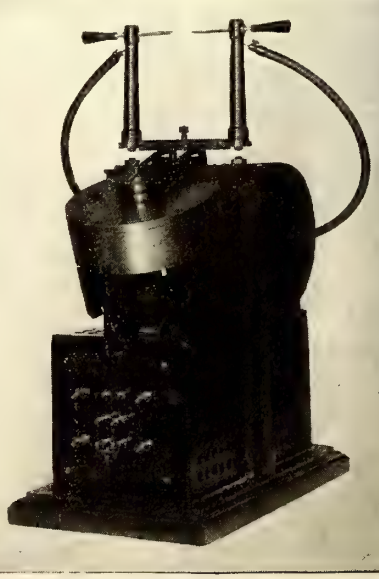


Fig. 11. Tesla Transformer with sealed mercury interrupter for low tension work



Electrical Oscillators

By NIKOLA TESLA

FEW fields have been opened up the exploration of which has proved as fruitful as that of high frequency currents. Their singular properties and the spectacular character of the phenomena they presented immediately commanded universal attention. Scientific

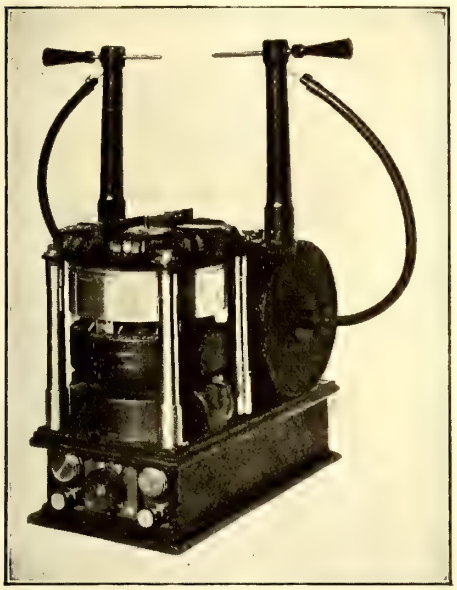


Fig. 13—Tesla Oscillator with Magnetically Controlled, Sealed Mercury Interrupter.

men became interested in their investigation, engineers were attracted by their commercial possibilities, and physicians recognized in them a long-sought means for effective treatment of bodily ills. Since the publication of my first researches in 1891, hundreds of volumes have been written on the subject and many invaluable results obtained thru the medium of this new agency. Yet, the art is only in its infancy and the future has incomparably bigger things in store.

From the very beginning I felt the necessity of producing efficient apparatus to meet a rapidly growing demand and during the eight years succeeding my original announcements I developed not less than fifty types of these transformers or electrical oscillators, each complete in every detail and refined to such a degree that I could not materially improve any one of them today. Had I been guided by practical considerations I might have built up an immense and profitable business, incidentally rendering important services to the world. But the force of circumstances and the ever enlarging vista of greater achievements turned my efforts in other directions. And so it comes that instruments will shortly be placed on the market which, oddly enough, were perfected twenty years ago!

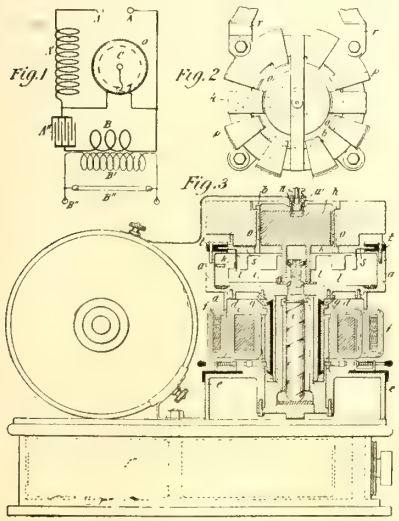


Fig. 14—Electrical Oscillator, Illustrated in Fig. 13, Showing Details and Circuit Connections.

MR. TESLA makes a very important contribution to the electrical arts with this article.

The pioneer of all high frequency apparatus divulges much that is new and startling in these pages. Few people realize the enormous value of Mr. Tesla's machines and the many different important uses to which they can be applied in our everyday lives. New and startling uses are being found every year for these machines.

It is characteristic of Mr. Tesla that he has developed and actually built an astounding variation of these machines, and we regret that we can publish only a very few of the more important models.

Most of the Tesla coils shown have never been publisht before. —EDITOR.

These oscillators are expressly intended to operate on direct and alternating lighting circuits and to generate damped and undamped oscillations or currents of any frequency, volume and tension within the widest limits. They are compact, self-contained, require no care for long periods of time and will be found very convenient and useful for various purposes as, wireless telegraphy and telephony; conversion of electrical energy; formation of chemical compounds thru fusion and combination; synthesis of gases; manufacture of ozone; lighting; welding; municipal, hospital, and domestic sanitation and sterilization, and numerous other applications in scientific laboratories and industrial institutions. While these transformers have never been described before, the general principles underlying them were fully set forth in my publisht articles and patents, more particularly those of September 22, 1896, and it is thought, therefore, that the appended photographs of a few types, together with a short explanation, will convey all the information that may be desired.

The essential parts of such an oscillator are: a condenser, a self-induction coil for

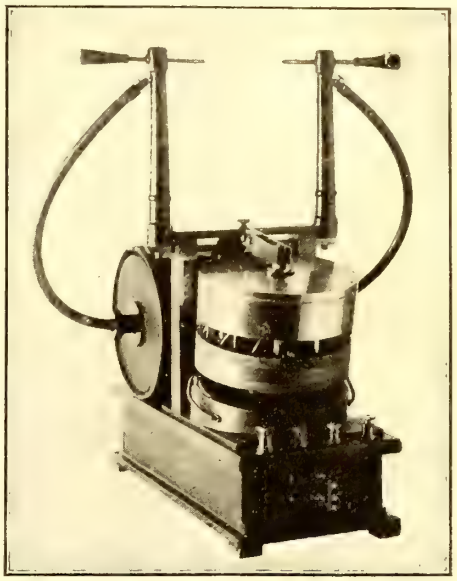


Fig. 15—Tesla Transformer with Gravity Controlled, Sealed Mercury Interrupter.

charging the same to a high potential, a circuit controller, and a transformer which is energized by the oscillatory discharges of the condenser. There are at least three, but usually four, five or six, circuits in tune and the regulation is effected in several ways, most frequently merely by means of an adjusting screw. Under favorable conditions an efficiency as high as 85% is attainable, that is to say, that percentage of the energy supplied can be recovered in the secondary of the transformer. While the chief virtue of this kind of apparatus is obviously due to the wonderful powers of the condenser, special qualities result from concatenation of circuits under observance of accurate harmonic relations, and minimization of frictional and other losses which has been one of the principal objects of the design.

(*Continued on page 259*)

SPECIAL NOTICE

Last month we announced another special feature article by Mr. Tesla, which altho made in good faith by us was not authorized by him. Due to very important duties of Mr. Tesla, it was impossible for him to furnish his historical article this month, so the special feature article publisht on this page takes its place. An important historical article will appear in the August issue.—Editor.

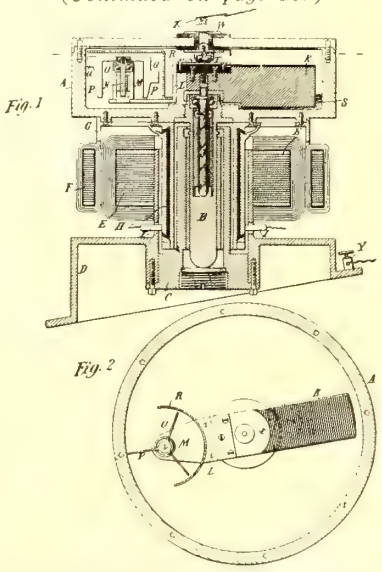


Fig. 16—Electrical Oscillator, Illustrated in Fig. 15, Showing Details of Motor and Break Mechanism.

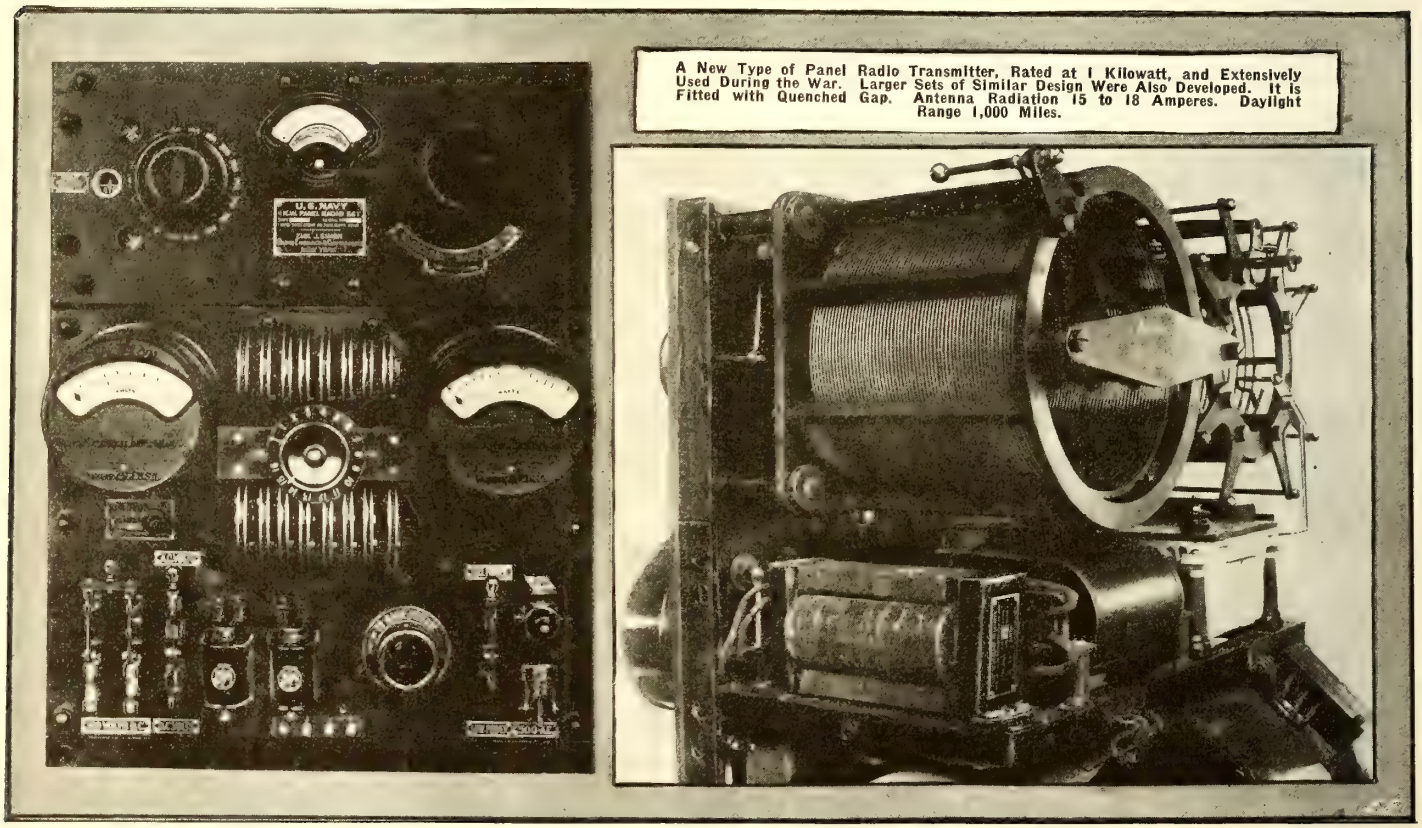
RADIO DEPARTMENT

New 1 K.W. Panel Radio Transmitter

By LESTER F. RYAN

THE great war has wrought tremendous changes in the design of radio apparatus. Among these designs is the 1 K.W. panel transmitting set used by the U. S. Navy on a great many of their vessels during the war, and in use at the present time on a great many of the U. S. Shipping Board vessels.

The 1 K.W. set is one of the most efficient sets in use, being constructed for both efficiency and durability. The panel consists of two bakelite-dilecto pieces mounted vertically, the top panel carrying the hot-wire ammeter as well as the unique-wave changing devices.



A New Type of Panel Radio Transmitter, Rated at 1 Kilowatt, and Extensively Used During the War. Larger Sets of Similar Design Were Also Developed. It is Fitted with Quenched Gap. Antenna Radiation 15 to 18 Amperes. Daylight Range 1,000 Miles.

The lower panel consists of the A.C.-D.C. voltmeter, wattmeter, the latest design of quenched gap, also the control switches. The panel is 0.5 inch thick. Back of this is the framework upon which the panels are securely fastened. At the bottom is a tray constructed of rigid iron cross-pieces upon which the motor-generator is securely bolted. The motor-generator is driven counter-clockwise from the motor end by D.C., at 120 volts, and is rated 2.1 H.P. at the motor. The generator is rated at 1.25 KVA, or 1000 watts at 80 per cent. power factor. It is of the inductor type, and has 15 poles, and is a 500 cycle machine.

The motor-field strength is controlled by an 18-point rheostat, which varies the frequency between wide limits. The D.C. service switch is rated at 20 amperes, 250 volts.

The automatic starter consists of five distinct parts, two solenoids and two contact discs which are carried by plungers working in the solenoids, also a common resistance box. The right-hand solenoid has two separate windings, the first being a *current* winding in series with the motor-generator and starting resistance. The left-hand solenoid has this type of winding solely. The extra winding on the right-hand solenoid is connected across the service line as shown in diagram. This is termed the *potential* winding. The generator field rheostat is a single plate of the iron-clad type, 6 inches in diameter, giving a total resistance of 300 ohms. The control of the rheostat is effected by a handle which is operated from the front of the panel.

The meters are of the Weston type, the A.C. and D.C. voltmeter being of the double-scale design. The resonance inductance which is furnished with this set is of the iron-clad type. It has two windings, one being for full power operation, the second, which is larger inductance, is for low-power operation. Actual operating tests show that the natural period of the A.C. armature, resonance, inductance and transformer primary is 425 cycles. The operating frequency ranges from 450 to 550 cycles.

One of the most unique parts of this set is the combination flame-proof Morse key and antenna switch. The key is made with large contacts for carrying audio-frequency currents at low potential. It is encased in a gas-tight housing of black Japanned sheet brass, this housing making the "live" parts of the key free from all electrical contact with the power circuit. The connection between the key and the panel is made by two lengths of flexible cable, each five feet long. By means of the antenna switch, both the generator armature circuit and also the generator field circuit are broken when the switch is in receiving position.

The transformer used in connection with this set is of the closed-core, dry type, and is rated at 1000 watts, 500 cycles and 150 volts at the primary winding terminals. The ratio of transformation is 38 to 1. The transformer is insulated for dielectric stresses of 30,000 volts. The protective gap consists of three balls in shunt with the secondary, forming an inverted triangle, the lower ball being grounded to the frame of the transformer. They are set to stand a potential of 50 per cent above the maximum secondary voltage. The losses in this transformer due to hysteresis and eddy currents are less than 50 watts at full rated load.

The two condensers used are of the Dubilier type of .004 M.F. capacity, and connected in parallel. These condensers are made of select mica, and were tested to show minimum dielectric resistance and hysteresis. Each condenser is mounted in an aluminum housing. This is to insure durability.

The quenched-spark-gap switch is one of the most efficient yet developed. It is in

(*Continued on page* 254)

How European Radio "Sigs" are Photographed Here

Messages Can Be Taken at 600 Words Per Minute. Deaf Persons Can Receive Them

PHOTOGRAPHIC receiving and recording of wireless messages as a matter of regular daily routine is now being carried on by naval engineers at the Otter Cliffs receiving station near Bar Harbor, Maine. They use an instrument invented by C. A. Hoxie.

The use of this invention permits the eye to either supplement or replace the ear in reading wireless messages. In fact, a totally deaf man could be a wireless receiving operator in a station so equipt.

It is stated that messages have been deciphered with its assistance, when operators were unable to get a single word of it by ear alone. From now on receivers do not hear by their ears alone.

Thus the outstanding obstacles to accuracy in wireless receiving have been eliminated, except for severe static interference.

Receiving 600 Words a Minute.

As to speed in receiving, this machine has frequently recorded at the rate of 400 words per minute, as fast as a machine gun shoots, and recently in a test made by Mr. Hoxie, the machine recorded a low power message at 600 *words a minute!* Up to this time the most rapid method of recording radio signals has been by the phonograph, but this must still be transcribed by the ear and not the eye. Moreover, no permanent visual record is made. The phonographic method has never yet approached the rate of 600 words per minute, so the new instrument has hung up a new speed record. An interesting sidelight on this feature of the invention is that high speed messages are *secret messages* to all who are not equipt with this device.

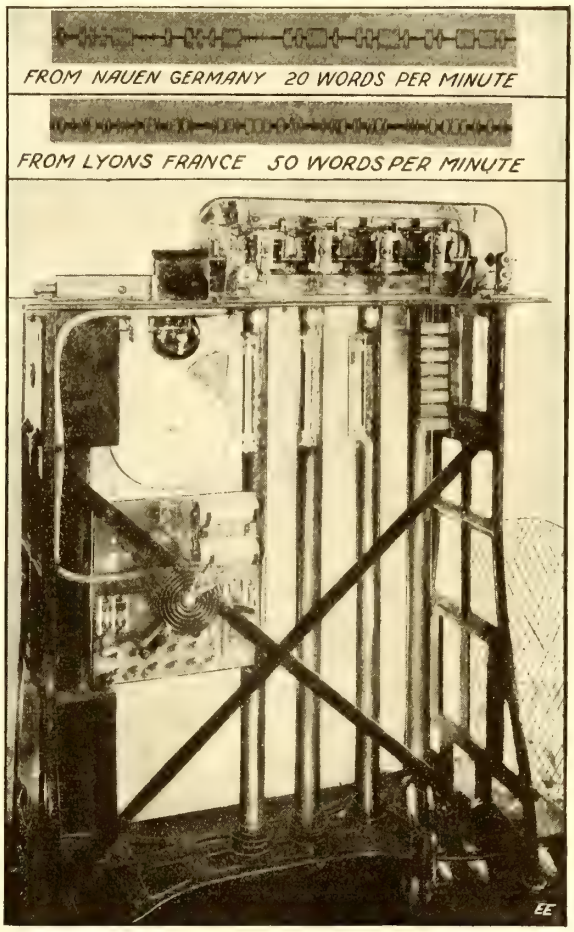
A commercial phase of the speed question is peculiarly linked up with the atmospheric-electric phenomena of the northern temperature zone. For years it has been found that the best time for transmitting all wireless messages between here and Europe was from 4 A. M. to 10 A. M. Speedy sending and receiving can condense the traffic into this most favorable period, or a greater volume can be sent with a minimum number of stations. When it is remembered that a pair of stations—one in Europe and one here—can easily cost $2,000,000—the item of keeping down overhead charges by rapid sending will be easily appreciated.

Expert operators have been known to receive 35 words per minute for a short time under perfect conditions, but average reception up to this time has been 15 to 20 words per minute—or 1,000 words per hour.

It has been a race between sending and receiving speeds. Prior to this invention it has been possible to send the message faster than it could be received, but now the situation has been reversed.

The photographic recorder has been in daily operation at Bar Harbor, Maine. It has repeatedly recorded regular traffic schedules ranging from 1,000 to 7,000 words without interruption; and at a speed of 40 to 55 words per minute every word is perfect and easily and quickly read. It is used supplementary to the ordinary type of receiving set.

Not only is the message permanently recorded on a tape of special photographic paper, but a fleeting visual image of the signals can be seen on the ground glass of the machine at the same instant that the electric impulses arrive from the antenna.



Visual Radio Receiving Device. Tape Starts at Extreme Right and After Being Exposed to Flashes Corresponding to the Wireless Dots and Dashes, is Developed and Dried in the Four Tubes in Center, and Then Runs Off End at Extreme Left Into Basket, the Same as a Broker's Ticker Tape. The Upper Tape is a Reproduction of a Message Sent from Nauen, Germany, to Bar Harbor, Maine, at the Rate of 20 Words a Minute. The Lower Tape is that of a Message Sent from Lyons, France, to Bar Harbor at the Rate of 50 Words a Minute.

Important Articles in this month's "Radio Amateur News"

The Audion and the Radio Amateur
By Dr. Lee de Forest
How I Became a Radiobug
By Thomas Reed
Design of Rogers Ground Antennae
By J. Stanley Brown
Radio Translator
By Major Chas. A. Culver
Announcement of a $100.00 Radio Prize Contest
Building a Sustained Wave Radio Telephone Transmitter
By Samuel D. Cohen
New Type of Electron Tube
By H. F. Donle

And even more than this—an audible reception can also be made simultaneously by the regular telephone method.

How the Recorder Works.

The mechanism is based on a comparatively simple electrical engineering principle. A light-weight mirror "flutters" in electromagnetic tune with the minute electric impulses coming from the receiving antenna. The duration and extent of the mirror's oscillations vary according to the dot, dash or silence of the sending station. This mirror reflects a beam of light on the moving sensitized tape. This tape, propelled by an electric motor, progresses up and down thru the vertical pipes which contain the developing and fixing chemicals.

Automatically the tape enters the developing fluid and then the hypo fixing bath; then it is washed in running water, and is dried by electric heat assisted by forced draft—all invisibly effected inside this single machine. Like the tape from a stock-ticker, the message pours out of the wonderful device and into a basket. In rapid receiving there is an average of *one word for every inch of tape.* The receiving operators can read the record at a speed of 50 to 100 words per minute.

The time to record, develop, fix, wash and dry the tape is from *two to four minutes.* The rolls of tape are 1,000 feet long and a continuous message of 10,000 words can be recorded without reloading the machine.

A remarkable performance of this machine only recently promises great things. As told by Mr. Hoxie:

All On One Aërial.

"Two simultaneous messages from different sources were coming in to one receiving circuit connected to the new photographic recorder. One of these messages was sent at a train frequency of 1,000 cycles per second, and the other at 975 cycles per second. Ordinarily two frequencies so close to each other would have interfered with reception, and I was pleased that I could receive one of the messages. But by a slight adjustment of the machine I was able to receive the other message; then back to the first; then switched off to the second—receiving either message without interference from the other.

"I hope to perfect the instrument so that in the not far distant future several photographic recorders can be attached to a single antenna and simultaneously receive messages from Rome, Lyons, Carnarvon, Wales, Nauen, Germany, and San Francisco! This may be called simultaneous multiplex receiving from one antenna.

"When this is accomplished, an international receiving station would have but a single antenna; and in a room inside the station there would be a row of machines with tapes pouring into baskets. One could pause at the first basket and read of the new president of Germany; stepping to the next basket he would read of a volcanic eruption in the Philippines, and only a few feet further on will be the baskets marked 'London,' 'Paris,' 'Rome,' 'San Francisco,' 'Sydney' and 'Shanghai.'!"

It has long been the dream of radio engineers to realize a perfected device for recording accurately wireless signals.

The Pliotron Oscillator

By WILLIAM C. WHITE

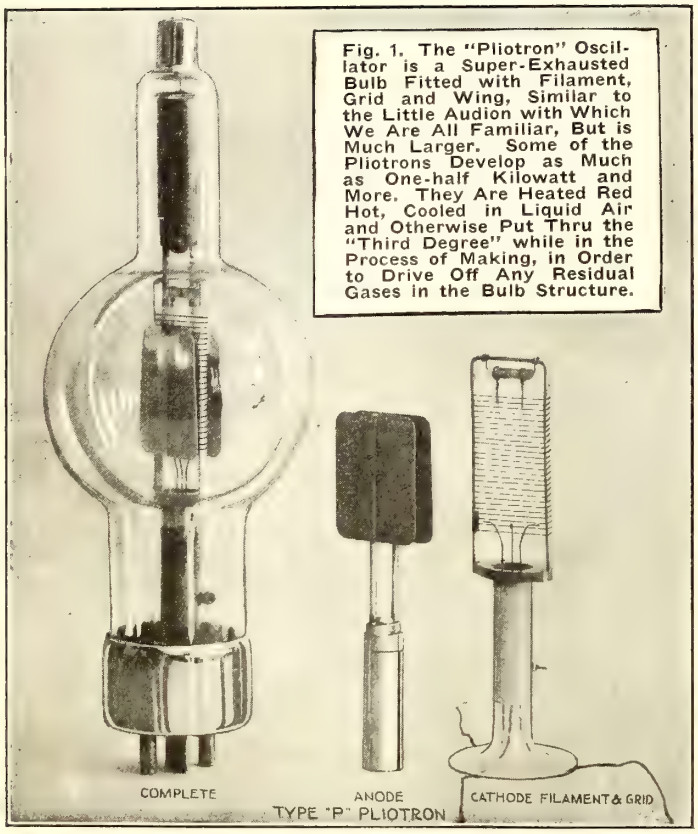


Fig. 1. The "Pliotron" Oscillator is a Super-Exhausted Bulb Fitted with Filament, Grid and Wing, Similar to the Little Audion with Which We Are All Familiar, But is Much Larger. Some of the Pliotrons Develop as Much as One-half Kilowatt and More. They Are Heated Red Hot, Cooled in Liquid Air and Otherwise Put Thru the "Third Degree" while in the Process of Making, in Order to Drive Off Any Residual Gases in the Bulb Structure.

THE *pliotron* vacuum tube when used as an oscillator for the production of alternating current from a direct-current source of energy, has the characteristics of an amplifying relay. That is, the wave shape of any variable electromotive force applied between the electron emitting cathode and the grid (or controlling member) will be faithfully reproduced by the currents in the main anode to cathode circuit.

Therefore, the input of a small amount of alternating-current energy will set up a relatively larger amount, identical in frequency and wave shape. Now by utilizing a small proportion of the alternating-current energy thus produced to feed back to the input circuit, the system can be made self-exciting. Alternating-current energy can thus be obtained from a direct-current source, the pliotron and its auxiliary apparatus forming a type of converter.

The type of pliotron utilized in the arrangements to be described is shown in Fig. 1, and is of the same design as used for the circuits referred to in previous articles.

In this article, two pliotron oscillator arrangements for high-frequency will be described, the first for the production of relatively large current and the second for the production of relatively high voltage. In each case the amount of energy involved is comparatively small, of the order of 150 watts or less.

In a resonance circuit the current will rise until the losses become equal to the input energy. With practical circuits the lower limit of power-factor obtainable is about one-half of 1 per cent., unless unusual precautions are taken. This means that the maximum resonance current produced is about two hundred times the value of the true energy current fed into the resonance circuit.

Therefore, where large currents are desired from a small quantity of energy, the total volt-amperes of the circuit must be kept small; and this condition requires that for such a resonance circuit a large capacity and small inductance must be used.

There is another principle which must be kept in mind. If the amount of electrical energy which can be furnished by a certain source is limited by the definite amount of primary power available, or by the losses in transmission, it is important to so adjust the resistance of the load to the voltage of the supply that the energy is most economically utilized. In the present case this means that the resistance of the heavy current circuit must be given the apparent value most suitable for insertion in the pliotron circuit. This adjustment of apparent resistance is accomplished by electro-magnetic coupling or transformer action.

The diagram of an arrangement to produce currents of from 10 to 25 amperes from one pliotron tube at frequencies between 100,000 cycles and 1,000,000 cycles is shown in Fig. 2.

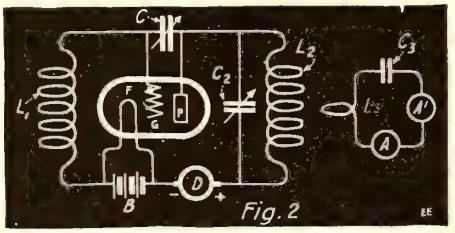


Diagram Showing Arrangement of Circuits to Produce Currents of from 10 to 25 Amperes from One Pliotron Tube at Frequencies Between 100,000 Cycles and 1,000,000 Cycles. Energy Amounts to About 150 Watts.

Suppose it is desired to calibrate a hot-wire ammeter by means of direct comparison with a standard. These two ammeters are represented by A and A_1 and are connected in series as part of a resonant circuit, the inductance and capacity of which are shown at L_3 and C_3 respectively. The product of the values of L_3 and C_3 to be used for any particular case is found by the usual resonance formula:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

As mentioned in a previous paragraph, a low power-factor and volt-ampere product is desirable; and therefore the inductance value of L_3 is made the minimum possible, consisting usually of only one or two turns of heavy conductor. With the range of frequencies specified, this gives values for C_3 of the order of about 0.1 microfarad. In this heavy-current circuit it is of course very necessary to use condensers of low energy loss and to reduce the ohmic resistance of the conductors to a minimum.

The inductance L_3 obtains energy by electromagnetic coupling from the coil L_2 which is located in the plate circuit of the pliotron.

By means of an adjustment of the values of L_1, L_2, and C_1, the pliotron system can be made to set up a high-frequency current corresponding in period to the tuned heavy-current circuit.

Owing to the relative values of L_2 and L_3, the apparent resistance in the plate circuit of the heavy-current load circuit is greatly multiplied, but still is not of a sufficiently high value to absorb all the available energy. To further increase this apparent resistance, a variable capacity C_2 is shunted about the inductance L_2. Then, by simultaneous variation of these two factors, the apparent resistance of the load can be adjusted to give the largest energy output available.

The heavy-current output is dependent upon the voltage of the direct-current source D, a useful range being between 200 and 750 volts.

Pliotrons may be operated in parallel to produce a load current larger than that obtainable from one tube.

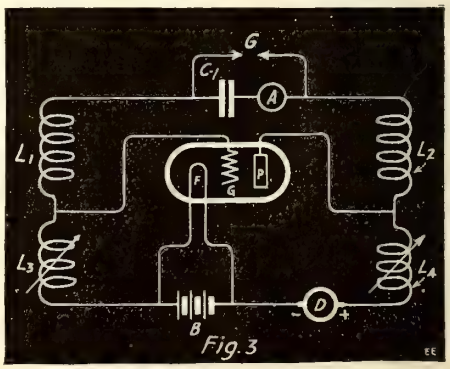
For the production of *high-voltage* in a resonance circuit, the conditions are almost a reverse of those in a heavy-current circuit; that is, with a fixt value of inductance and capacity to give the desired frequency, the capacity must be small and the inductance large, relatively speaking. There is a practical limit, however, to this increasing of inductance and lowering of capacity; and it is reached when the distributed capacity effect in the inductance becomes comparable to the capacity of the condenser used for resonance.

A pliotron oscillator arrangement for the production of high voltages is shown in Fig. 3. The high voltage is obtained across the condenser C_1, and may be tested by the gap G. A condenser in the form of two metal plates suspended in air* is the most convenient, and it may have a capacity value between 20 and 200 microfarads for a frequency of 100,000 cycles. By means of a hot-wire ammeter A in circuit with the condenser and by knowing the frequency, the voltage produced across C_1 may be simply calculated.

The inductances L_1 and L_2 are similar and each has a value of about 8 millihenries. The inductances L_3 and L_4 are also similar to one another and each has a

* Two metal plates, each 10 in. by 10 in. and spaced ½ inch apart, give a condenser having a capacity of approximately 40 micro-microfarads.

(*Continued on page 287*)



Pliotron Oscillator Arrangement for the Production of High Voltages. The High Potential is Obtained Across the Condenser C1, and May be Tested by the Spark Gap G.

Musical Radio-Telegraphic Sets

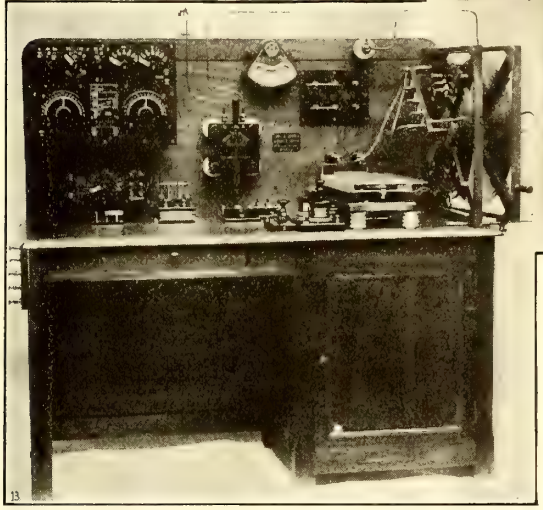
By Jacques Boyer

Paris Correspondent, ELECTRICAL EXPERIMENTER

THE French Radio Telegraph Co., "C. G. R.," during the war has perfected a series of very interesting apparatus which it was not possible to describe heretofore on account of the censorship. The apparatus described here are those for sending and receiving by means of audions, particularly for underground work by means of the Rogers system and which were used by the French army. The author will describe for the benefit of ELECTRICAL EXPERIMENTER readers, little by little, several remarkable inventions and telegraphic apparatus used during the war.

The musical sending apparatus described this month comprises two types of 1 and 2 K. W. capacity. The 1 K. W. set here described was used a good deal by the French submarine chasers, and proved highly efficacious. The antenna is energized by shock excitation. The principal property of this excitation is that the antenna gives out a unique wave, its length and amortization (dying out period) being independent of the excited circuits. The musical emission which gives rise to a very high tone is obtained by charging the condenser from a "shock circuit," using alternating current of a frequency of 500 periods per second. This spark frequency of 1000 periods per second produces a very high musical tone at the receiving end.

Top View—New 1 K. W. French Musical Note Radio - Telegraph Transmitter. The Apparatus Is Mounted in a Cabinet Resembling a Desk. A Rotary Spark Gap Is Used Having Adjustment from 0 to .04 m.m.





View of 2 K. W. French Musical Spark Radio - Telegraph Transmitter, Including Receiving Set, Mounted in Cabinet. Note the Spiral Oscillation Transformer.

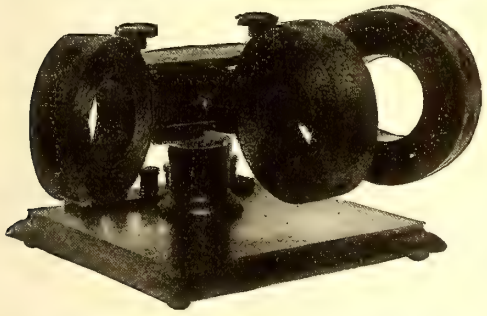
The sending machinery comprises a monophase alternator of 1,820 volt-amperes under an intensity of 7½ amperes, coupled directly with the direct current machine. The inductor of the alternator is fed by a little excitation dynamo which is built right into the alternator. The usual switchboard arrangement is shown in our illustration.

The normal speed of the group is 3,000 revolutions per minute, which gives to the alternator a frequency of 500 periods per second. The transformer employed is of the usual type and is placed in a vessel containing a special grade of oil. The sending condenser is located in a bath of petroleum. The rotary spark gap, which has ten points, is a very accurately built instrument which can be regulated from .04 mm. to 0. Regulation is made

(*Continued on page 278*)

New Honeycomb Inductance

Now that amateur wireless is fast getting back onto a pre-war basis, some very interesting new apparatus is being brought out. Of particular interest to the amateur is a new type of inductance coil developed



The Latest Thing in Radio Coils — the "Honeycomb" Inductance. Maximum Inductance, Banked Winding, and Nil Distributed Capacity.

by Mr. R. F. Gowan, of New York City. It has been well named the "Honeycomb Coil," as can be seen by the illustration.

This new coil winding was designed to reduce *distributed capacity* to a minimum and at the same time to concentrate a winding with a large value of inductance, in as small a space as is practicable.

A great amount of research work was done on these coils to determine the most efficient size and spacing of the wire, capacity of the windings, etc. The distributed capacity has been reduced to a minimum and to as low a value as practicable.

By actual measurements it was determined that the high frequency resistance of these coils was only 20 to 28 per cent greater than the D. C. resistance against the usual 100 per cent of the average inductance coil. The coils are remarkably small compared to their inductance values. For instance, a coil one inch wide and about four inches in diameter has a wave length of over 15,000 meters when shunted by a capacity of less than .001 mfd.

Various mountings are furnished for these coils. When properly mounted as a coupler, they make an instrument which cannot be surpast in efficiency and selectivity. Dead end or open winding absorption losses are entirely done away with.

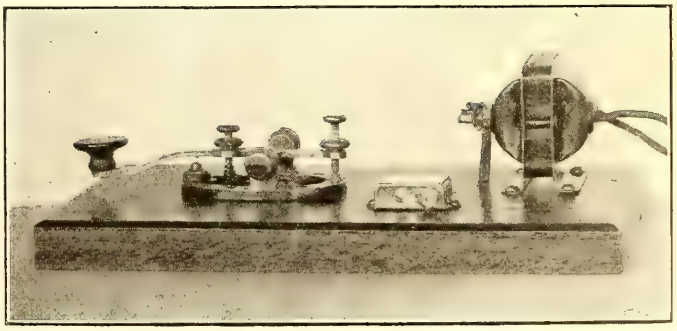
The three coil mounting is shown in the photograph. Here the three coils are used as primary, secondary and tickler. The writer had the pleasure of listening in on a set using this combination with a variable condenser of .001 mfd. maximum capacity in the primary and secondary circuits. The antenna used was a single wire with a natural period of 185 meters. All types of signals from the lowest wave spark set to the extremely long wave undamped stations were received. The sharpness of tuning and amount of regeneration possible on all wave lengths was remarkable. This form of coil is being adopted for many commercial radio outfits, owing to its great space economy.—*Photo Courtesy De Forest R. T. & T. Co.*

New Buzzer Set

An inexpensive outfit for buzzer practise may be easily constructed by any amateur from material obtainable from any electrical supply dealer.

The outfit illustrated is very neat and compact and consists of a bell-ringing transformer, a standard telegraph key and high-pitch buzzer, all wired and mounted on suitable base.

The use of a small transformer eliminates dry cell troubles and produces a note more nearly like that of the large stations. This form of buzzer code practise set, operated as it is from an alternating current step-down transformer, should commend it particularly to schools and colleges where the radio code is taught. For one thing, the tone of the signals given off by the buzzer is more even and regular, and thus resembles more accurately, actual commercial radio signals than is the case where batteries are employed. The operating cost is infinitesimal.—*Photo G. E. Co.*



New Code Practise Set Comprising Key, Buzzer and Step-down Alternating Current Transformer. No Batteries to Bother with and No Operating Expense.

Operate Your Audions on A. C.

By ELLIOTT A. WHITE

FORMERLY INSTRUCTOR IN RADIO, AIR SERVICE SCHOOL FOR RADIO MECHANICS, CARNEGIE INSTITUTE OF TECHNOLOGY

I OPENED my Radio Receiving Station with a sensitive regenerative receiving set using vacuum tubes, but with **no storage battery for the filaments or dry cells for the plates,** running my tubes entirely on ordinary 60-cycle **Alternating Current** tapt off the electric light fixture. The accompanying figure shows how it is done.

Altho any regenerative hook-up will serve, the one I am using with good results for receiving both damped and undamped waves has the antenna circuit C1 L1, and the secondary circuit L2 C2. The secondary circuit is connected on one side to the plate, and on the other side to the detector grid, thru a stopping condenser C3 of .00015 microfarad capacity. This is a familiar hook-up thus far. The new wrinkle is in substituting A. C. (alternating current) for the storage battery to light the filament, and *rectified* A. C. for the high voltage dry cells to operate the plate circuit.

A transformer is necessary to furnish the low voltage for lighting the filaments of the receiving tubes, detector V1 and amplifiers (not shown), and also the filaments of the rectifier tubes V2 V3; and to furnish high voltages for the plates. The windings of the complete transformer are as follows: the primary T1 connected to the 110 v. or 220 v. A. C. lighting circuit; a secondary T2 to step this down to 4—6 volts for the detector (and amplifier) filaments; a secondary T3 T4, to give 20—30 volts from each half (or 40—60 between end terminals) for the plate; and another secondary T5 T6, to give 2—4 volts or more from each half (or 4—8 or more between end terminals) for the filaments of the rectifiers, the voltage required depending on whether they are connected in series or in parallel, as either connection is satisfactory. It is seen that windings T3 T4 and T5 T6 have taps taken off the middle, and that T3 T4 must have a total voltage *twice* that necessary for the plate.

Altho the transformer may be purchased in the form of two toy or bell-ringing transformers for the filaments and one 110—55 volt transformer for the plate (with tap in middle of 55 volt winding), all the primaries being connected in parallel, it is easy and convenient to wind a single transformer to run the whole set, as the low voltages and small currents permit the use of small wire and few turns. In a closed-core transformer the windings may easily be computed from the familiar equation

$$E = 4.44\ \phi\ f\ N\ 10^{-8} \text{ or } N = \frac{E}{4.44\ \phi\ f\ 10^{-8}}$$

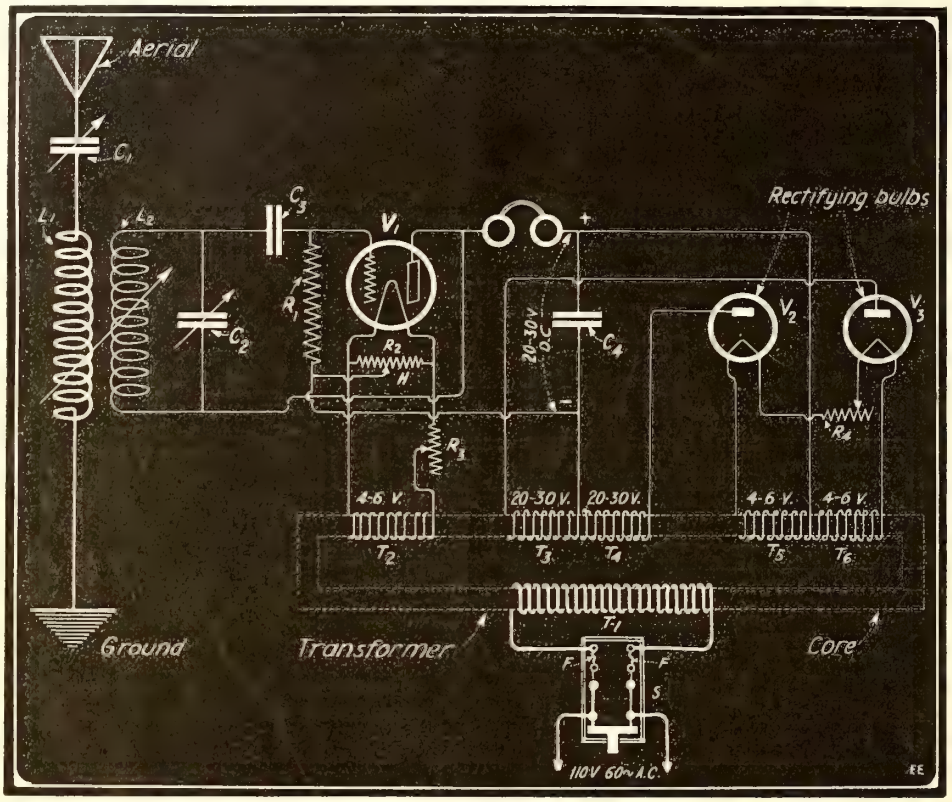
where E is the voltage for that particular winding, ϕ the flux per sq.in. of core which may here be put at 60,000, f the frequency, here 60, N the number of turns required per sq.in. cross section of core, and 10^{-8} is 1/100,000,000, giving

$$N = \frac{.625 \times E}{A}$$

where A is cross sectional area of core in sq. in. In other words, to find the number of turns needed in any winding, divide the voltage of the winding by the area of cross section of the core and then multiply by .625; that is, the number of turns needed for 60-cycle current and a flux density of 60,000 lines per sq.in. is six and a quarter times the required voltage divided by the area of the core. For example, if the core is say 1 in. by 3 in. (the one I used), the area is 3 sq.in. and the number of turns is therefore approximately twice the voltage, or *half a volt to a turn.* For the winding T1, which is connected to the supply, this gives 220 turns for a 110 volt supply (or 440 turns for 220 volts); for T2, 12 turns for 6 volts, and so on. In such a transformer, small and of low power and intermittent service, it is not necessary to be exact, so long as *the ratio between turns on primary and secondaries is always the same as the ratio of their required voltages.* Any core area can easily be substituted in the formula mentioned above—

$$N = \frac{.625 \times E}{A}$$

The size of wire depends only on the current carried. As each filament draws a little over an ampere, any size which will carry this will do for T2, unless the winding supplies amplifiers as well, in which case they must be allowed for: V2 V3 will draw about 2 amperes if in parallel or about 0.5 ampere if in series. It is therefore convenient to use ordinary No. 18 bell wire for the windings T2 T5 T6, if no larger wire is on hand. Wire as small as No. 30 cotton or enamel covered is good enough for windings T3 T4, as the amount of current is negligible, tho No. 24 cotton or enameled wire or larger is better as it is not so likely to break. As the whole transformer will draw 3—5 amperes at 4—6 volts on the low side, depending on the number of amplifiers used on the set, we can allow 35 watts as the maximum power consumption (running over 3 hours for a cent), or say 0.5 ampere on the supply side, allowing for the magnetizing current. In spite of the small current, however, it is best to use wire as large as No. 18 or No. 14 for winding T1 as well as for T2 T5 T6. My transformer, for example, is wound as follows: T1, 220 turns No. 18; T2, 12 turns No. 18; T3, 45 turns No. 24; T4, 45 turns No. 24; T5, 8 turns No. 18; T6, 8 turns No. 18 (rectifier filaments in series). Of course these details depend on the materials on hand, such as core and wire. The taps and terminals can be brought out to ten binding posts on a small board or piece of fiber clamped to the core, and the whole put inside an iron transformer case or tin cracker box to avoid "cross talk" with the set, as will be mentioned later.



The Greatest Advance in Audion Operation Yet—Run Them with Alternating Current. The Accompanying Text Tells How to Build the Step-down A. C. Transformer which Supplies the Proper Potential Current for the Filament and Plate. Tungar Rectifier Bulbs or Even Old Audions Serve to Rectify the A. C. for the Plate Circuit.

The detector V1 is an ordinary 3-electrode audion receiver tube, but preferably of the new *high vacuum* type manufactured during the war, which requires no close adjustment of filament current or plate voltage but operates on 1—1.1 amperes for the filament and, for the plate, approximately 20—25 volts as *detector,* and approximately 40—45 volts as *amplifier.* If the high vacuum type is used, a grid leak R1 is required, of about 1 megohm (1,000,000 ohms) when oscillating or 2 megohms when not, if the grid circuit insulation is good. The leak may be a pencil line drawn on card or fiber and may vary considerably in resistance.

For the rectifiers V2 V3 ordinary receiving tubes may be used, again preferably *high vacuum,* with grids connected to plates; or, if obtainable, two-electrode tubes may be used, such as the Kenotron or Tungar *rectifier tubes* now available on the market. There is no reason why the experimenter may not construct them by inserting a disk in a tungsten filament light bulb and re-exhaust with a vacuum pump.

Besides the transformer and rectifier

(*Continued on page* 266)

The Design, Pumping and Testing of Audion Tubes

By C. MURRAY

THE purpose of this article is to bring out some of the salient points which might be of interest to the amateur radio experimenter on the design, pumping and testing of the vacuum tube detector and amplifier, or so-called *Audion*. All of these tests I have conducted in my laboratory and I have plotted curves to show the exact relations one element has to another.

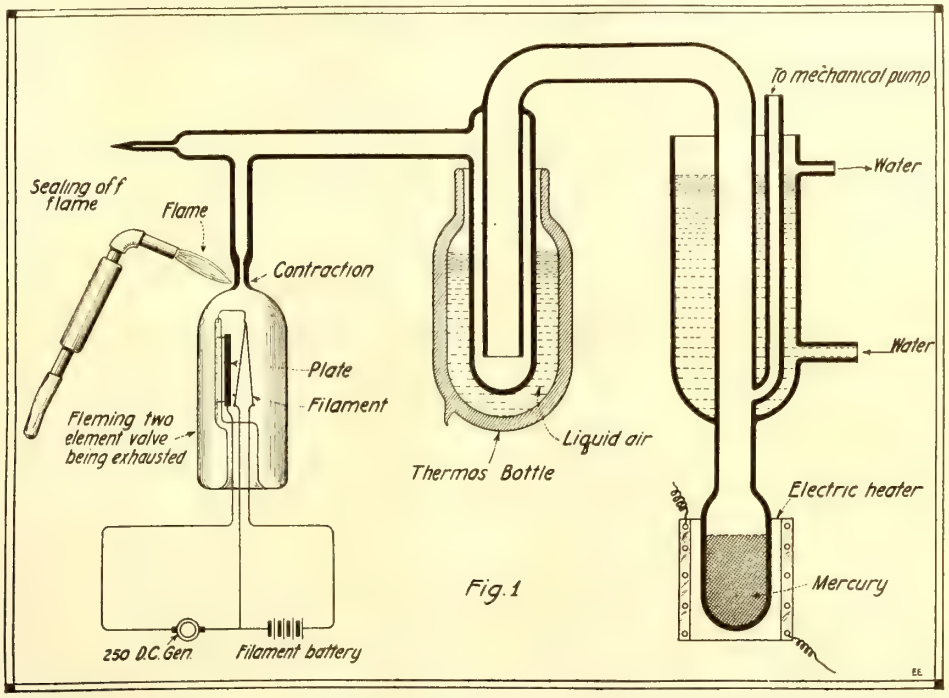
The *Fleming valve* is the true rectifying detector, but Dr. de Forest, by inserting the *third element* in a vacuum tube, created a genuine relay, or energy control detector, which gives it a great many advantages over the two-electrode Fleming valve. The three-element Audion can be used as an oscillator, amplifier, and a detector of both damped and undamped waves; also it can be used as an undamped wave generator for use in either radio-telegraph or telephone transmission, whereas a two-element tube can only be used as a detector of damped waves or the ordinary spark signals.

The characteristics of a given three-element tube depend almost entirely on the grid, its surface area and its distance from the plate and filament.

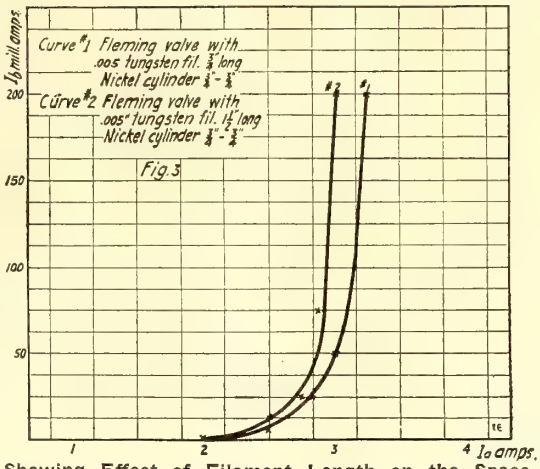
The dimensions of the three elements vary according to the uses of the tube, altho all designs are interchangeable to a certain extent and will work with a fair degree of efficiency in any rôle.

There are several abbreviations that are used in the testing of vacuum tube detectors and amplifiers, and I have used some of them in plotting the present curves:—

Ea = voltage across the filament.
Ia = current consumed by the filament.



Apparatus Used to Produce Super-Exhaustion in Audion Bulbs by Means of the Liquid Air Trap. This High Degree Vacuum Pump Is Backed Up by a Regular Mechanical Pump as the Diagram Shows. This Is the Regular System Used Commercially During the War in Turning Out Thousands of Audions Daily.



Showing Effect of Filament Length on the Space Current Passing Between the Plate and Filament. The Longer Filament Can Be Run at a Lower Temperature to Give the Same Results with a Longer Life.

with various chemical compounds, such as calcium oxid, barium, strontium nitrat, sulfur and lime. Many other mixtures have been experimented with, yielding good results.

The coated filament gives the best results and has one advantage over tungsten; it consumes less filament current to produce the same results, as can be seen by referring to the curves plotted for two Fleming valves, Fig. 2. Both filaments are the same length and Eb is kept at 200 volts during the test.

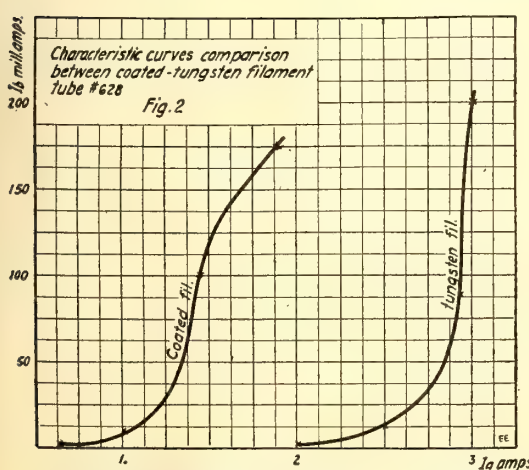
Tungsten emits very few electrons at a low temperature. The value Ib increases very rapidly as the filament temperature is raised.

The length of the filament also has some effect on Ib, as can be seen in Fig. 3. One tube has a tungsten filament ¾ inch long and the other 1½ inches long. It is seen that the longer filament can be run at a lower temperature and it will give the same results, besides giving it a longer life.

The proper length of filament to be used is determined by the voltage of the filament battery; also we must take under consideration the size of the plate, the amount of plate current to be past and its voltage.

By using too small a plate or too short a filament we will be limited in the amount of plate current we can pass, as by referring to Fig. 6 we will find a point of saturation; that is, if we raise the filament temperature still higher the valve Ib will remain at a certain point. Likewise it is true of the plate; suppose we design a tube to work at 150 volts Eb and a space current of 30 milliamperes; we can raise the Eb even to 200 and the Ib will remain the same.

(*Continued on page* 264)

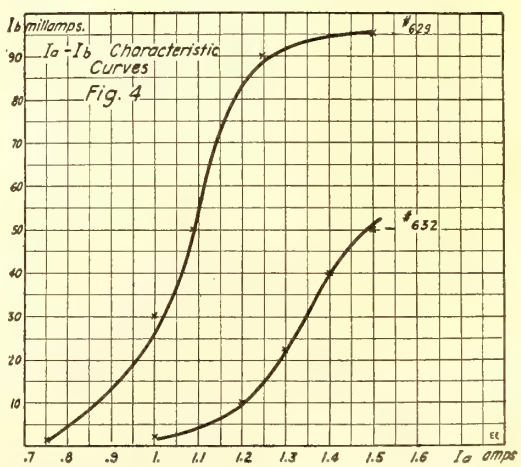


Comparison Between Filament Currents of Coated and Plain Tungsten Filaments for Audions, Showing the Smaller Current Taken by the Treated Filament.

Eb = voltage imprest on the plate.
Ib = current passing between plate and filament.
Ec = voltage imprest on the grid.
Ic = current passing from the grid to the plate.
Io = current in the oscillating circuit.

The filament plays a very important rôle in vacuum tube work. It must be of such material that when heated to incandescence it will give off electrons, which form a conducting path; or, in other words, a current of electricity will pass thru the space (in one direction only) from the hot to the cold electrode.

The filaments used most extensively to-day are tungsten wire and platinum ribbon coated



Characteristic Curves for Two Fleming Valves with Different Size Cylinders. During the Tests Eb Was Kept at 200 Volts and Ia Was Varied Until a Saturation Point Was Reached.

How Don Flashed the "S. O. S."

By MABEL M. DAVIS

DONALD JOHNSON'S mother says she feels sure the careless nursemaid they had when "Don" was a baby must have mixed an *electro-lytic solution* with the milk he was fed. She cannot believe that otherwise any boy could be so permeated with electricity. He could not have caught it from his family as he was an only child, and his mother could not tell a fuse-plug from a dry battery, and his father's abilities in electrical matters were all confined to paying the electric light bill on time each month.

It was different with Don's chum Will Merton. He was the youngest of a large family, all of whom were wound up and went by electricity, and that was their sole motive power.

The story of all the weird and wonderful inventions and imitations of inventions that were produced by these two boys in Don's "Lab." would fill a book. One worth while and early accomplishment was the mastery by both boys of the International Morse code and they often flashed or tapt out signals to each other from various points in the neighborhood.

One evening near dusk "Don" was hurrying home from their favorite resort, the dumping grounds of the Ajax Electrical Company's factory. He heard a faint mewing that seemed to come from overhead and looking up he finally located a cat at the very top of a nearby electric light pole. The nine-lived feline was crying pitifully and Don's sympathies were touched. Being a senior in high school, Donald was rather ashamed of showing any fondness for cats. But he glanced this way and that and not a soul was in sight. So he made a jump and a scramble, hoping to shinny up to the first spikes on the pole. He did not make it and realized for the first time how heavily he was loaded. In the pockets of his mackinaw he only had a piece of zinc rod, a large magnet for a telephone magneto, some brass rod, copper tubing, a pocketful of assorted screws, bolts, nuts, washers, another pocketful of lengths of iron core wire, and nearly a pound of miscellaneous binding posts. So he cast his treasures from him—coat and all and went to the rescue.

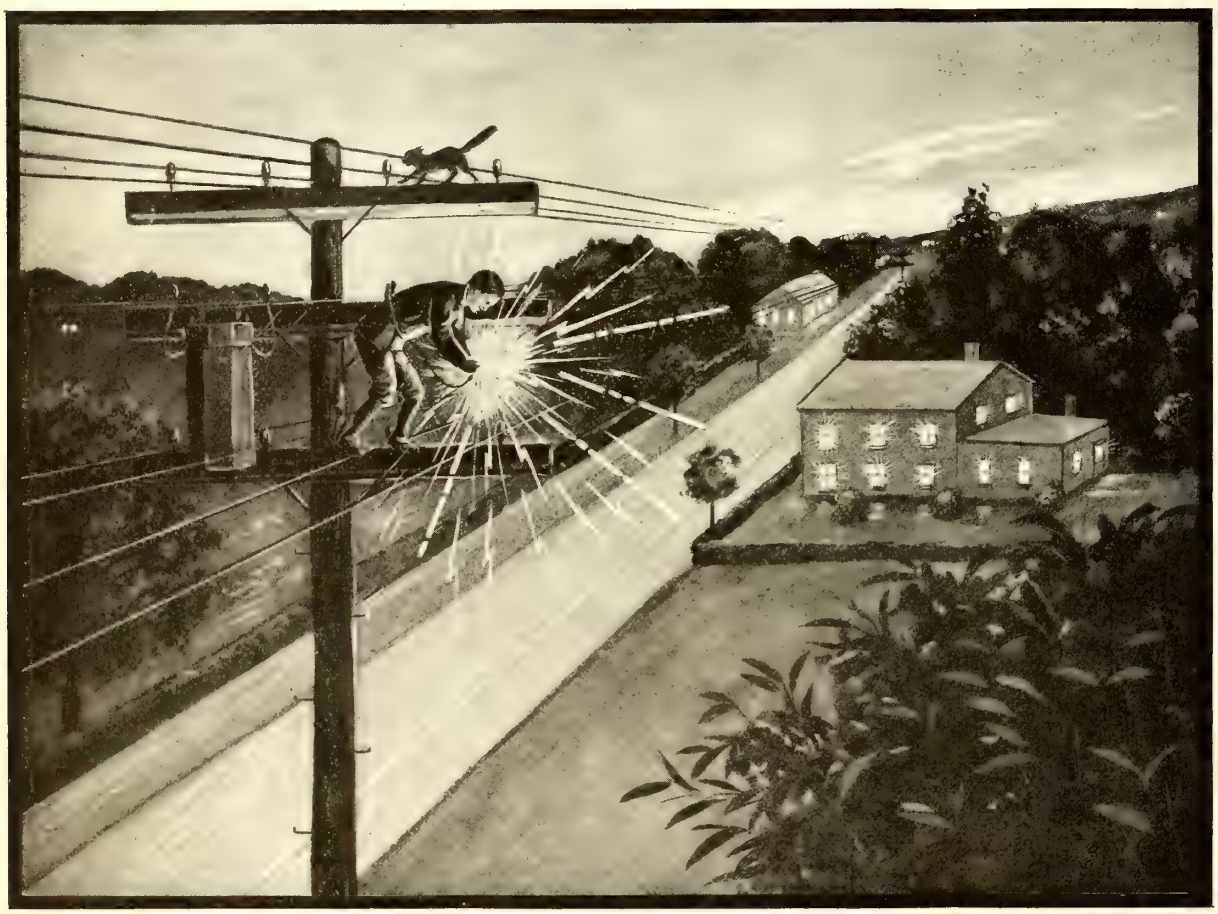
After a hard scramble he gained the spikes and climbed quickly up. Standing on the lowest cross-arm he tried to persuade "Pussy" to come down within reach, but she was suspicious of the proffered help and remained fast at her post. He gained the next arm and his persuasiveness brought her down a little way. He reached for her but she backed out to the end of the arm, over his head. Donald followed along to the end of his cross-arm when horrors, his foot slipt and he started to fall. Donald never could tell just how it all happened, but he suddenly found himself with his two feet on the cross-arm below and the peg of the arm above hooked thru the belt of his Norfolk coat. In falling his foot had struck the glass, broken it, released the wire, and, as his body slid by the peg it had hooked him. Luckily, his belt had held until his feet found the arm below and relieved the strain a little. He was in a very awkward and uncomfortable position. He tried cautiously to squirm about and get the belt off the hook, tho he was very much afraid that if he succeeded he might not be able to hold on to the cross-arm without the support of the stout peg under his belt.

Fortunately his belt was securely buckled in front, not buttoned. He twisted and tried to turn, finally fingering his belt to see if he could unbuckle it in case he got up his courage to try it. But that question was not to be put up to him to decide as the buckle had slipt around to the back and with all his squirmings he could not get it within reach of his fingers.

He rested with one arm over the cross-arm, his feet very insecurely placed on the cross-arm below, and the pole too far away to reach. He tried a few yells for help but they cracked in delivery, so he gave that up.

He had come across lots from the factory and struck into his own street near the end of it, where there were no houses for a long distance and rarely a passerby.

Another factory recently built on a side street had caused the electric lighting company to put up a transformer for that neighborhood. "Don" and "Will" had watched and assisted at the installation of that transformer. The cat had chosen to ascend the very pole that held the transformer. As it began to get dark "Don" noticed the humming of the transformer increasing. He could see Will Merton's house away down the street. Their lights appeared and "Don" could imagine the family all gathered about the supper-table.



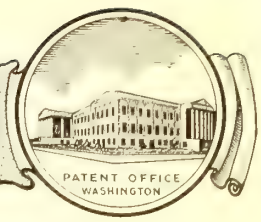
The Cat Had Chosen to Ascend the Very Pole that Held the Transformer. As it began to Get Dark "Don" Noticed the Humming of the Transformer and He Could See Will Merton's House Lighted Up Down the Street. Try as He Might, He Could Not Extricate Himself from the Cross-Arm. Suddenly a Bright Idea Flashed Across His Mind—Why Not Cut the "Secondary" Low Voltage Wire and by Interrupting the Light Current, Signal His Dilemma by Dots and Dashes, to His Friend Will Merton.

The transformer was humming louder now. An idea suddenly came to Donald. After a terrific squirm he succeeded in getting the fingers of his free hand on the chain of his wire-cutters which, out of school hours, he always carried attached to his person. With the wire-cutters clasped firmly in his right hand he reached for the secondary lead of the transformer which hung in a loop over his head. He knew that it was safe enough to tackle that wire without gloves, as it carried only 110 volts. It was hard work and took a long time, but the trusty wire-cutters did the trick. There was a blinding flash and the loop was cut. Donald could see that the Merton's house and others nearby were dark. He grasped one wire in his right hand, then by touching this to the other, which hung loose, he caused a short flash of light in all the houses, then followed this by two long flashes, which was his chum's private wireless call. He repeated this carefully, then

(*Continued on page* 275)



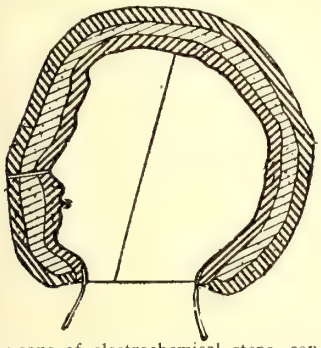
LATEST PATENTS



Process of Galvanoplasty.

(No. 1,296,453, issued to Blasius Bart.)

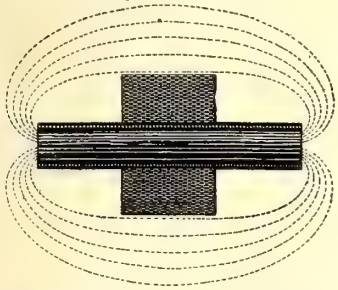
By means of this new development it is possible to obtain by



means of electrochemical steps, copies in all sizes, reproducing every feature and detail of the model. The copies can be made entirely in one piece having uniform thickness. A matrix is placed upon the model and so fixt that it will reproduce each detail. This matrix is composed entirely of a metallic substance of high electrical conductivity to receive the electrolytical deposits. A means is also provided whereby a non-conductive covering can be applied on the matrix where no electrical deposits are required. One wire is then connected with the matrix and the other to a sprayer or atomizer, whereby a metallic composition is used to cover the surface of the metal.

Spark Coil.

(No. 1,296,963, issued to George A. Jacobs.)

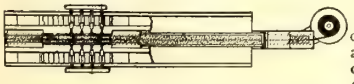


Most spark coils are dependent on the air for return magnetic circuit between both ends of the core. To overcome this difficulty of the high magnetic resistance of the air, the inventor employs soft iron wires for the secondary winding, thereby helping to partially close the external magnetic air circuit. It consists essentially of the usual core over which insulation is placed and then a primary coil of heavy copper wire; on the insulating tube over the primary is a winding of fine insulated iron wire, forming the secondary.

Apparatus for Sherardizing.

(No. 1,291,866, issued to Herbert Champion Harrison.)

This invention consists of a new and simple method of sherardizing articles which are of narrow width and great length, such as wire or ribbon material or small cross-section bars, etc. It consists essentially of an elongated chamber containing the sherardizing powder. A second

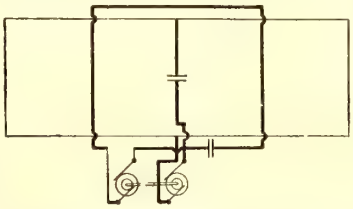


chamber also contains this powder. The third chamber contains an air seal and substantially cold sherardizing powder adapted to gradually reduce the temperature of the article after the sherardizing re-action. The second chamber containing the sherardizing powder also has a hopper above it, so that the sherardizing powder can float freely into the chamber. A movable system of taking up the long ribbon or wire for carrying it thru the various chambers is provided and an electric pyrometer is used.

Aërial for Radio Signaling.

(No. 1,296,177, issued to Charles Franklin.)

Makes use of two equal rectangular or frame aërial circuits erected in the same vertical plane so that they have one vertical edge common to both (or parallel). The two circuits will have no mutual inductance or coupling effect on one another if they are properly proportioned; that is to say, alternating currents ex-

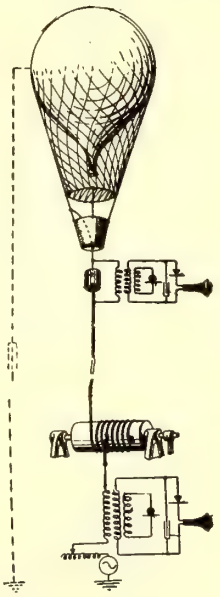


isting in one will not affect alternating currents existing in the other. Under these conditions each circuit tends to produce its own radiation independently of the other circuit. The radiation will then have a maximum value in one direction only, gradually diminishing in value to zero at 90 degrees on either side of this maximum direction, and being practically zero thruout the other 180 degrees.

Signaling from Balloons.

(No. 1,296,687, issued to Harold W. Nichols.)

A unique method for signaling to and from captive balloons over the single steel cable by which the balloon is anchored to earth. No additional wires are necessary in this scheme. This invention employs the conducting qualities of the single

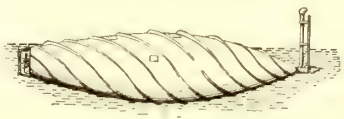


cable connecting the balloon to earth as one side of the circuit, and the circuit is completed by virtue of the electrostatic capacity between the balloon and the ground. To enhance this effect, the balloon may be covered with tin-foil for a portion of its area, or the rubber covering otherwise metallized.

Submarine Destroyer.

(No. 1,296,646, issued to George H. Georgelis.)

The craft illustrated has an exterior hull so that it is continuous and adapted to rotate about the car or body of the craft and which

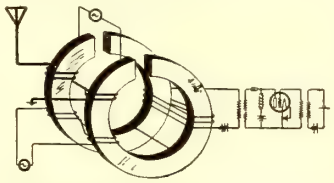


is driven for propelling the craft thru the water at a high rate of speed due to exterior spiral fins mounted on the hull. A sharp steel prow or ramming point is provided at the forward end of the submarine destroyer, as well as periscopes for locating enemy craft, subsea and wireless telegraph apparatus, anti-submarine guns, etc. The hull may rotate about the shaft and periscope plug without disturbing the position of the periscope. The hull is mounted upon a plurality of rollers which constitute bearings between the hull and the shaft. A suitable motor or engine is employed for propelling the craft.

Modulating System.

(No. 1,287,982, issued to Ralph V. L. Hartley.)

The quality of the speech transmitted by ordinary magnetic modulators is relatively poor, as the modulated high frequency wave form is distorted by the hysteresis of the magnetic core used in the modulator. In the present modulator this hysteresis of the magnetic core is reduced by subjecting the core to a relatively weak but rapidly alternating "cross-magnetization," which

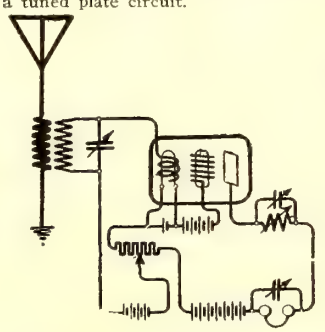


keeps the molecules of the iron in a constant state of agitation, rendering them more susceptible to changes in the longitudinal magnetization produced by the modulating speech currents.

Radio Receiving System.

(No. 1,291,527, issued to Albert W. Hull.)

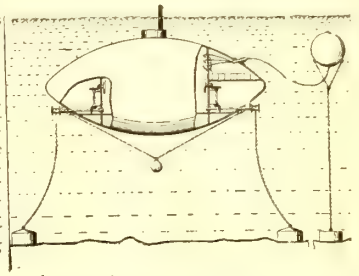
A vacuum tube device intended for amplifying variable currents, particularly received radio signals. This patent covers an improved circuit arrangement in which a four-electrode audion may be utilized for receiving radio signals, whereby the sensitiveness and selectivity of the receiving circuit may be greatly increased. By this arrangement undamped wave signals may be received by means of the "heterodyne" or beat method. A special telephone circuit is utilized in connection with an inductance and capacity, giving a tuned plate circuit.



Submersible Mine Controller.

(No. 1,296,816, issued to Jan A. and Albert Krecioch.)

The submersible feature of the outfit permits the unit to submerge and thus protect itself should the occasion demand it. The operating devices include a switchboard, to which are connected the various circuits connecting with the mines lying in different numbered sections of the adjacent water. When an enemy ship lies within the numbered square corresponding to the mine of that number, then the officer in

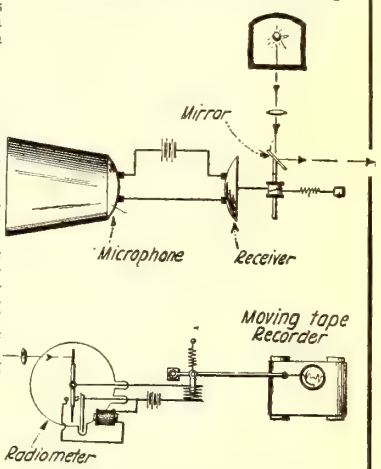


charge closes the switch and that mine or any group of mines instantaneously explodes. Observation may be carried on by a periscope.

Apparatus for Recording Sounds.

(No. 1,294,861, issued to Lindon W. Bates.)

This idea mainly consists of a means of using the oscillations produced in the receiver by the sound waves to produce oscillations of light waves, which in turn will break an electric circuit. The time of breaking of the circuit is recorded by a standard recorder and also its duration. These several operations are practically instantaneous. The time of breaking may be taken as the time for the receipt of the sound in the detector. A horn or microphone is used for collecting the sound waves and directing them to a microphone attached to the diafram of the receiver, on which a thread of silk passes around a drum, after which it is attached to a very delicate spring. With this arrange-



ment vibrations imparted to the diafram and microphone will cause the compression of the granules of carbon, the microphone thereby setting up a current in the receiver. This in turn pulls the fine silk thread on the drum, and to the spindle of the drum is attached a mirror with a light shining on it. This pulling back and forth of the drum causes the changes in the light waves which are taken up by a radiometer, and by means of relays the current so set up actuates the drum stylus and records the sound waves.



WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $3.00 each month for the best photos. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $3.00 PRIZE WINNER—R. L. FRIESS

I GIVE herewith several photographs of my laboratory. My laboratory measures 8 x 12 feet, and is fitted with gas, running water and electric lights. I have one corner fitted up for study work, which has a 2 x 3-foot top table and drawer, which I made myself; two card files; cabinets for books, which are only soap boxes, and about $250.00 worth of books on mechanics, chemistry, mathematics, electricity, and four volumes of the Universal Dictionary of the English language; twenty-nine volumes Encyclopedia Britannica; also many other books of use in my studies.

In my laboratory I have about 200 chemicals, a good line of chemical apparatus which netted me about $300.00. I have some electrical apparatus, some of which I made myself. I have an electrical as well as a gas furnace which I made, giving a temperature of about 3,000 degrees Fahrenheit. I am taking a course with a correspondence school, covering general chemistry, and do a good deal of analytical work in my laboratory, besides magneto and coil repair work. I have performed a number of interesting experiments in electricity and chemistry.

Am going to fix up my radio station in the near future and bring the antenna up to date (a la Rogers). I heartily request any amateur to write me with regard to any trouble he may have in mathematics, chemistry, electricity, etc., and I will help him to the best of my ability.—R. L. Friess, 148 S. Summit St., Bowling Green, Ohio.

HONORABLE MENTION (One Year's Subscription to the ELECTRICAL EXPERIMENTER) —JEROME SACKHEIM

I HAVE been for a number of years a close student of electricity and chemistry and the newer art, Radio. During this time I have carefully followed many of the important new advances described in the ELECTRICAL EXPERIMENTER, of which I am a constant reader. I am sending herewith photographs which show my combined electrical, chemical and radio laboratory, and in which I have spent many pleasant hours conducting new experiments and listening to signals. Owing to the war, I have devoted more of my time to chemistry than to any other subjects, which you will note by the large array of chemicals, also many important pieces of chemical apparatus. I am 16 years of age, a high school student and greatly interested in the scientific arts. In my radio set I have several variometers, 2,000-ohm head sets, receiving condensers, detectors, loading and tuning coils; also a small transmitter which I cannot use as yet, 1" spark coil, condenser, oscillation transformer, spark gap, key, etc. In my little workshop and radio laboratory I have all forms of knobs, switches, tools, telephone condensers, and all the "beloved junk" dear to the heart of every dyed-in-the-wool Amateur.—Jerome Sackheim, 516 West 74th St., New York City, N. Y.



Science in Slang

By EMERSON EASTERLING



THE x-ray is no longer an X, that is, an unknown," remarked Jazz the other day. "At least, we think that we have the dope on it. The lack of disproving evidence on our hypothesis of the penetrating beam renders our conjecture legally, at least, O. K."

"I can jerk the liver out of an automobile or a motorcycle and do my profession justice by sticking the thing back where it belongs—and the thing will rattle along like it had never even had liver trouble," put in Harry Smith, with a shrug of his shoulders. "But I don't seem to have the workings of this x-ray business under my katy. Is it anything like ignition?"

"Yes," returned Stokes, "it is in this respect: To produce x-rays, the guy who is going to do the stunt has to have a static machine or a spark coil to produce the little string of fire that plays between the anode and cathode in the bulb, and also plays the role part of the stunt.

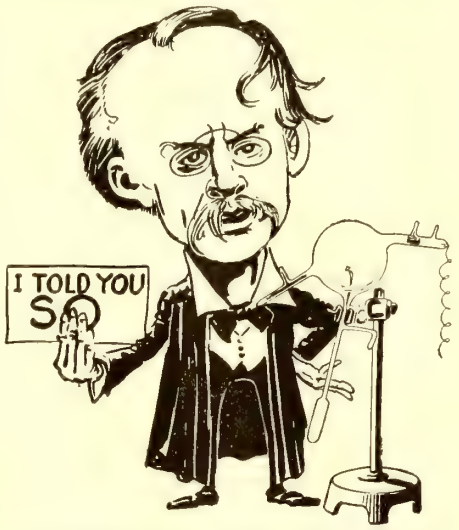
"The dope goes like this: An almost exhausted tube or bulb has in it two terminals—the anode, or positive point or pole, and the cathode, or negative, same thing. The discharge shoots from the anode to the cathode. This action sets up certain vibrations, or rather a stream of infinitesimal hunks of electrically charged particles of something—almost nothing—waltzing along at the rate of 40,000 miles per second. (One speed ahead, and no reverse. However, that one speed varies.)

"Now the idea is that if these particles are brought to rest all of a sudden by an impact on a solid wall, there will be necessarily an immense change in the electrical and magnetic properties of the ether at the point where one of the particles of the cathode rays strikes the reason for all this sudden termination of the cathodic journey. At this point the disturbance will send a pulse into the ether.



Mr. Signor Herr Röntgen, the Cuckoo Who Pulled the X-Ray Out of the Pile of Unknowns.

Getting Down to the Bone



J. J. Thompson, the Duck Who Put Us Wise to the Dope That X-Rays Ionize the Air.

"So you see the real x-ray is not sent off the cathode terminal but off the platinum plate that is put up to catch all of the stream of almost nothing that flies off the negative pole. Röntgen, the bird that pulled the x-ray out of the pile of unknowns, found out that the vibrations that are known as the cathodic rays were not kicked off the cathode itself, but reflected from points of the tube, so he inserted the platinum plate.

"The way it all came about was this way: A guy by the name of Sir Bill Crookes, an English physicist (not medically speaking) who was at that time an authority on sanitation and sewage problems, unloaded most of the atmosphere from a tube—and right there was born the Crookes Tube. Even to-day—historically, of course—we read of his methods of obtaining high or extreme vacua.

"Then in 1895 Rönty fools around with a pile of stuff that people thought he had no business with and handed us the ray that bears his name. Then Prof. J. J. Thompson of Cambridge, England, figured out that our whiskered friend did not have all the dope in the new stuff, so he sits in and shows his hand to the effect that besides showing up the internal man—that is, laying a guy open for inspection—that the rays would cause electrified bodies to lose their charge. It was discovered that both + & — charged bodies showed a test of 0 in potential after being in the proximity of an x-ray machine. J. J. wrinkled his brow and then lifted his forefinger and spake as follows: 'Gentlemen of the jury, etc. We (that is, I) have arrived at the verdict that our defendant, Mr. X Ray Beam, is charged guilty (that would indicate a positive charge, but the fact of the matter is that neither polarity is indicated) of causing dissuasion among the elements of the very air. The gases themselves are divided into positive and negative electrifications. Components are reduced to opponents. It is almost shocking!' From then on we were on to the fact that x-rays ionized the air.

"Old J. J. started something. He lifted the lid for a lot of scientific researches that have put us wise to a gob of things that we would probably have been ignorant of had not the old boy reasoned in the manner that he did, and arrived at the conclusions that he pulled up at.

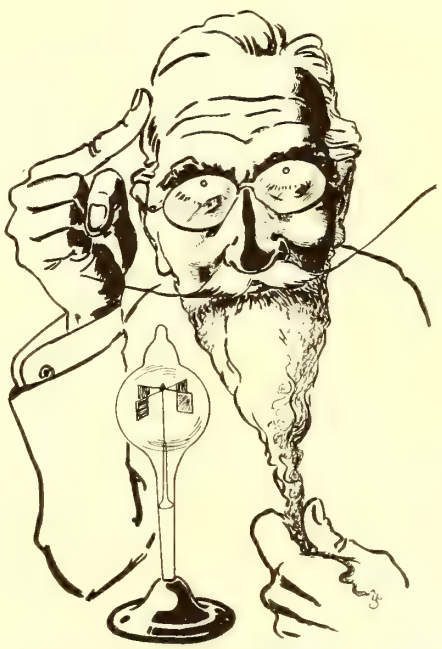
"The old ducks have it down in their note-books that the funny rays are not subject to reflection, refraction, defraction, interference or polarization. The rays pass in straight lines through anything that does not absorb them. They are not due to trains of waves, otherwise they would be made to defract and experience interference.

"The nice part of it in the surgical profession is that the density of the object that the ray is trying to penetrate is the only thing that hinders the penetration. By study, the photographer—the rays effect the photographic plate, like actinic rays—can determine the internal structure of bodies with great certainty.

"The fluorescent action that x-rays have on certain substances render it possible for the operator to see the bones of your head without resorting to the photographic procedure. Certain substances modify the rays and render them visible—not in the real sense of the word, but produce shorter wave length vibrations that are perceptible to the human eye. The eye can detect waves that the photographic plate cannot, as red, the light that we use in our dark rooms, while the photographic plate records vibrations that are out of our reach the other way up the spectrum. With the mechanical eyes and our orbs we see a little better than did our predecessors, but even the scientists of to-day have hunches that there lies both ways a lot more vibrations that we are not cognizant of. In the invisible spectra some place the electric vibrations, x-rays, and other things that can only be explained by vibratory illustration. Some have all of them doped out as such-and-such a one wiggling at a certain rate per instant, and being in row A, B or C, etc., and some more, etc. They have sound stuck down in the other end of the spectrum, below dark light. I don't know where they have the icy stare classified—it must belong in the spectrum. It don't belong anywhere else."

"You said that the rays did not suffer reflection, or refraction," broke in Punk.

(*Continued on page* 242)



Sir Billy Crookes, Who Unloaded the Atmosphere from the Crookes Tube, and Right There Was Born the—Crookes Tube.



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

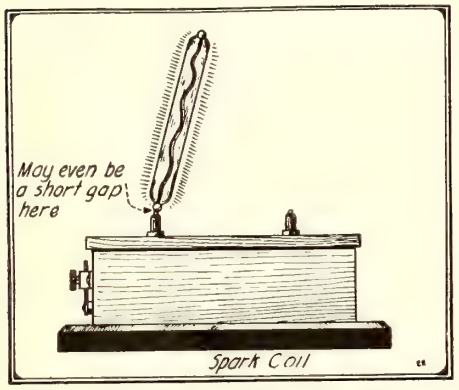
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

TESLA COIL AND GEISSLER TUBE HOOK-UPS.

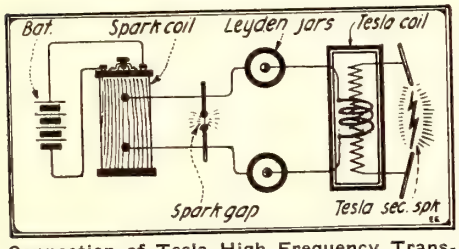
(1012) A. Terkel, Reedley, Cal., asks:

Q. 1. For a diagram of connections for Tesla coil, Geissler tubes, etc.

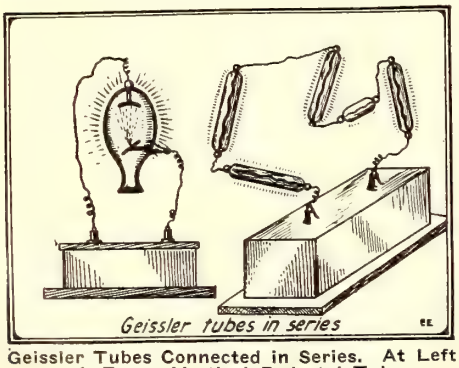
A. 1. We are pleased to give you herewith the diagram of connections for two inch spark coil, Tesla coil, Leyden jars, Geissler tubes, etc.



Lighting Geissler Tube from One Terminal of Spark Coil.



Connection of Tesla High Frequency Transformer, Leyden Jars, Spark Coil and Gap.



Geissler Tubes Connected in Series. At Left —A Fancy Vertical Pedestal Tube.

CHANGING SPEED AND VOLTAGE OF DYNAMO.

(1013) M—, Telephone System, Michigan, writes:

Q. 1. We have a 240-volt, 12.5-ampere, 4-pole, 1,250 R.P.M. dynamo. The four high resistance windings were in series with each other and the complete resistance connected to each feed; also the fields have another low resistance winding which carries all of the current going to the main line. In other words, it is *compound wound.*

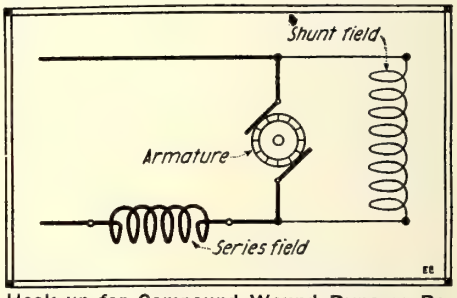
We have altered it by connecting the four high resistance field windings in multiple with each other and the armature, but have left the low resistance winding of the compound field unaltered.

We are using it at 40 volts, at which we seem to require to run it at 450 R.P.M.

Kindly state what the amperage, voltage and speed in R.P.M. should be when used thus, and if the dynamo is as efficient when so used.

A. 1. Considering that the dynamo when operated at 1,250 R.P.M. produces 240 volts, and that it has four field poles fitted with four shunt field coils, then, as is the case with practically all classes of dynamos, the voltage will vary directly with the speed, and if a dynamo is to be operated to produce 40 volts, then the speed should be approximately 1/6 of 1,250 R.P.M., or 208 R.P.M. For this voltage the four field coils should be connected in parallel, which would adapt them to operation at the reduced voltage, but the speed of the machine might have to be run up to between 300 and 400 R.P.M., owing to the fact that you could not obtain a sufficiently low resistance in your shunt field for 40-volt operation by connecting the four coils on parallel.

Originally, each of the four shunt field coils took 60 volts, and thus under ordinary conditions when you connect the four shunt field coils on parallel, you adapt them to operation on that potential, viz.: 60 volts, and not 40 volts. As these field coils will require, in accordance with Ohm's law, more than 40 volts, to force the necessary current thru them in order to produce the same number of ampere-turns and magnetic flux per pole, as becomes evident, it will be seen that the dynamo will have to be operated at a greater speed than 1/6 of the original value.



Hook-up for Compound Wound Dynamo Referred to in Rewinding Query No. 1013.

With regard to the amperage of the machine, this would be less than that in the original output, as there would be higher ohmic losses in the armature and field due to the reduced voltage, in proportion to those present when the machine was originally operated at the higher potential, or 240 volts. Roughly, the amperage would be probably about one-half of the original value.

The "August" Electrical Experimenter

"Bombs—How to Handle Them"—by Owen Eagan, Bomb Expert, Department of Combustibles, New York City Fire Department. A complete authoritative article with remarkable photographs by America's greatest expert on bombs and explosives, which tells you what to do should you receive a bomb by mail.

"A New Hydrostatic Wheel-less Railway"—by H. Gernsback. A Railway which has seen actual service. Without wheels it runs on a "film of water."

"Insanity from the Teeth?—What the X-Ray Shows"—by Dr. Henry A. Cotton.

"Electrical Refrigeration"—by Grace T. Hadley.

"Hot-Air and Other Engines"—by John J. Furia.

"Sir William Crookes' Researches on Psychical Phenomena" by Herewood Carrington, Ph.D.

"My Inventions" Part 6—by Dr. Nikola Tesla himself.

"Changing Nature's Face"—How Dynamite, plus Electricity, is used for clearing stump and rock-strewn property, blasting irrigating ditches, and changing the course of rivers.

"Experiments in Physics"—A new series. No. 1, perpetual motion, and popular fallacies concerning it exploded. By John J. Furia, Department of Physics, New York University.

"Loop Antennae"—An article of interest to all "Wireless Bugs." By Prof. Lloyd M. Knoll.

"Invention of the Crystal Detector"—by Greenleaf Whittier Pickard.

TESLA AND OUDIN COIL DATA.

(1014) E. W. Thatcher, Oberlin, Ohio, wants data:

Q. 1. For building Tesla and Oŭdin coils.

A. 1. We refer you to copy of this magazine wherein you will find the complete construction of a Tesla high frequency coil, also the Oŭdin coil. The article in question appeared in the May, 1917, issue of the ELECTRICAL EXPERIMENTER.

(*Continued on page* 242)

To Practical Men and Electrical Students

THE BURGESS BLUE BOOK is a pocket size note-book which was compiled especially for practical men, and those who are taking up the study of electricity. It contains drawings and diagrams of electrical machinery and connections, over two hundred formulas for calculations, and problems worked out showing how the formulas are used. This data is taken from my personal note-book, which was made while on different kinds of work, and it will be found of value to anyone engaged in the electrical business.

The drawings of connections for electrical apparatus include Motor Starters and Starting Boxes, Overload and Underload Release Boxes, Reversible Types, Elevator Controllers, Tank Controllers, Starters for Printing Press Motors, Automatic Controllers, Variable Field Type, Controllers for Mine Locomotives, Street Car Controllers, Connections for reversing Switches, Motor and Dynamo Rules and Rules for Speed Regulation. Also, Connections for Induction Motors and Starters, Delta and Star Connections and Connections for Auto Transformers, and Transformers for Lighting and Power Purposes. The drawings also show all kinds of lighting circuits, including special controls where Three and Four Way Switches are used.

The work on Calculations consists of Simple Electrical Mathematics, Electrical Units, Electrical Connections, Calculating Unknown Resistances, Calculation of Current in Branches of Parallel Circuits, How to Figure Weight of Wire, Wire Gauge Rules, Ohm's Law, Watt's Law, Information regarding Wire used for Electrical Purposes, Wire Calculations, Wiring Calculations, Illumination Calculations, Shunt Instruments and How to Calculate Resistance of Shunts, Power Calculations, Efficiency Calculations, Measuring Unknown Resistances, Dynamo and Dynamo Troubles, Motors and Motor Troubles, and Calculating Size of Pulleys.

Also Alternating Current Calculations in finding Impedance, Reactance, Inductance, Frequency, Alternations, Speed of Alternators and Motors, Number of Poles in Alternators or Motors, Conductance, Susceptance, Admittance, Angle of Lag and Power Factor, and formulas for use with Line Transformers.

The "Burgess Blue Book" is published and sold by the Burgess Engineering Company for one dollar ($1.00) per copy, postpaid. If you wish one of the books, send me your order with a dollar bill, check or money order. I know the value of the book and can guarantee its satisfaction to you by returning your money, if you decide not to keep it after having had it for five days.

THIS BOOK IS RECOMMENDED BY PRACTICAL MEN.

It is surprising how much information, drawings, etc., can be concentrated into a pocket size book. These books should sell fast as when practical men who have any ambition to go ahead, wants one as soon as he sees it. I wish you every success, and will do my best to interest my brother workers in this work.
Yours truly,
J. J. Hanhauser, L. U. No. 98, I. B. E. W.

Received your BLUE BOOK, showed it to a friend, presto, I have no BLUE BOOK now. Enclosed find check for which please send me three more copies.
Yours very truly, E. F. Leisy, Tacoma, Washington.

The concise form of the BURGESS BLUE BOOK should appeal to the men on the job. It is 100 per cent information.
J. L. Sleeper, Santa Ana, California.

Received your "BLUE BOOK" and must say it is the best book I ever saw. I showed it to a friend of mine and he refused to give it back to me, but he paid me a dollar and told me to get another. Rather than be without this book I am sending Money Order for three of them so I can show them to two more of my friends and have one left for myself. Wishing you would mail them at once, I am Joseph Braith, Electrician, Madison, Wisconsin.

Your "BLUE BOOK" received and it is just the book I have been looking for. Please mail me three more by return mail for which I am enclosing Money Order.
Respectfully,
V. E. Johnson, Western Union Tel. Co., Marion, Ohio.

Have received the copy of the "BURGESS BLUE BOOK" and am very well pleased with the easily found formulas and data contained in it. I am enclosing Money Order for four additional copies.
Yours very truly, Thure C. Anderson, Ridgeway, Pa.

BURGESS ENGINEERING CO.
Yorke Burgess, *Consulting Engineer*
750 East 42nd Street Chicago, Illinois



ELECTRICITY

Taught By A Practical Man

And In Your Own Home

Put Part of Your Spare Time To A Good Purpose

A HOME STUDY COURSE FOR AMBITIOUS MEN

My Home Study course is actually an extension of a consulting engineering experience, which gives my students an opportunity of becoming familiar with electricity as applied to everyday work, and to understand how to manufacture, maintain, test, locate troubles and repair electrical apparatus and machinery.

MY PURPOSE

This course was designed and written by me with a view of reaching those who do not have a lot of time and money to devote to an electrical education. Some of my students are beginners, some have had a little experience, some have been in the game for years, but all are ambitious and trying to get ahead and realize that the SERVICE I am able to give is valuable and of such a nature that they have been unable to obtain it in any other way.

NOT A CUT AND DRIED BOOK PLAN

In addition to my practical and consulting experience, which covers a period of seventeen years, I have designed instruction courses for various educational institutions which has given me an unusual opportunity to study the teaching business from the standpoint of a practical man. I certainly would be a chump if I did not understand the situation and realize what was needed, after the opportunities I have had through which to learn what men need in order to make good in the electrical industry. For years, I made notes of small jobs, large jobs, and big installations, including maintaining, troubles, testing and repairing, and laying particular stress on the unusual things. This information is included in my regular lessons and anyone engaged in electrical work knows it is the kind of information he needs and wants.

BEGINNERS AND EXPERIENCED MEN

My course of study and SERVICE suit both beginners and experienced men, but they must have backbone and work with me as I work with them. This I insist on, as my SERVICE is my bread and butter and I will not waste it on one who will not be a credit to me. Anyone with an ordinary education and a good knowledge of the English language can successfully complete this work and make good in the electrical field, if he attends to business and follows my instructions. I do not tell you that I will fit you to qualify as an Electrical Engineer in a couple of months, because it cannot be done. Neither do I say you can earn fifty or one hundred dollars a week when you complete this work with me, as I, or any other man cannot correctly estimate the earning capacity of a student. How much you may earn depends on you as much as it does on me and my service. Many men I have taught are earning very large salaries and there are men who have doubled their earning capacity in a very short while, through my help, but how good *you* become, IS UP TO YOU. If you are in earnest, look into this proposition and send for my catalog, which tells the whole story in a plain, simple way, and in a way you cannot misunderstand and expect something you will not get.

RESULTS OF MY SERVICE

Practical Men Recommend My Course to Others.
My Students Are Invariably Promoted and Get Better Salaries.
Over 65 Percent of My Students are Engaged in the Electrical Business.
Over 11 Percent of My Present Enrollment was Obtained Through Satisfied Students.
Beginners are Able to Get Employment in Electrical Work After Taking My Course a Short While.

FIFTY-FIFTY

I work absolutely on a fifty-fifty basis with my students. You pay me the comparatively low price I ask and I give you the instruction and other help as detailed in my catalog. No student is permitted to pay for his course in full on starting, the payments being made in monthly installments. Students have the privilege of discontinuing the work if they find it is not just what they wish, and their payments stop at the same time. This is my way of doing business and a part of my fifty-fifty plan, as I do not want money from men whom I am not helping.

APPARATUS, INSTRUMENTS, MATERIAL, ETC.

Certain electrical apparatus, instruments, charts, drafting materials, etc., as described in the catalog, are included as a part of the course for which there is no extra charge as it is covered by the regular monthly payments.

Fill Out Coupon or

Write me and I shall promptly send you one of my catalogs which contains full information regarding my course and the service I offer.

Burgess Electrical School
745 East 42nd Street
Chicago, Illinois

YORKE BURGESS,
BURGESS ELECTRICAL SCHOOL,
745 East 42nd Street, Chicago, Illinois.

Gentlemen:—
Send me catalog describing your course in Electricity and Drafting.

NAME .....

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CITY .....

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Health-Beauty-Power

Treat Yourself in Nature's Way

The Therapeutic White Rays of the Sterling Lamp are a scientific adaptation of the marvelous healing properties of the sun's rays. The warm, soothing, soft, white rays penetrate and vitalize every cell and tissue; new cell growth is stimulated; the body is refreshed and vitalized.

It brings you a clear, unblemished skin, rose-tinted cheeks, bright eyes; quickens the sluggish blood, rebuilds firm new muscle, and clear, new skin.

STERLING THERAPEUTIC LAMP

"The Light That Heals"

Relieves pain without destroying vitality. Absolutely safe; no vibration, shock or pain. Does away with use of harmful drugs. Relief from pain results the moment you snap the electric switch. Rheumatism, neuralgia, sore throat, earache, goitre, headache, nervous conditions, and innumerable other ailments, are instantly eased and relieved. Invaluable in the treatment of skin diseases. Physicians endorse and recommend Therapeutic Light to you.

Send Coupon for Free Book

Nothing vague or mystic in the Sterling Lamp. Our free book tells of its uses and many benefits – deals with the simple, fundamental laws of health and beauty. Tells you how to treat yourself at a few cents in cost, relieving you of pains and ailments and awakening your energy; how others in hospitals, sanitariums and thousands of private homes have benefited. Don't suffer headaches and other pains needlessly—let Nature and Science help you to health, beauty and greater vitality.



STERLING THERAPEUTIC LAMP CO.
Dept. 13, 546 Garfield Ave.
Chicago, Ill.

Use This Coupon

STERLING THERAPEUTIC LAMP CO.,
Dept. 13, 546 Garfield Ave., Chicago, Illinois.

Please send me, without cost or obligation, your fully illustrated booklet describing the Sterling Therapeutic Lamp, its uses and benefits.

Name .....

Street & No. .....

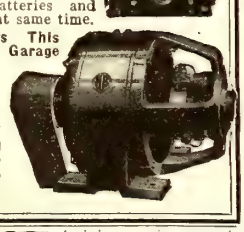
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Brilliant Lights and BIG PROFITS in BATTERY CHARGING with this HB LIGHTING and CHARGING SET



This sturdy, dependable outfit makes electric lights at lowest cost, and besides brings the BIG PROFITS that battery charging pays. Operates from your line shaft or engine. Trouble proof, economical, no wear-out. Charges auto batteries and furnishes electric light at same time.

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Balance on easy terms. Pays for itself as it runs. Absolute Money-Back Guarantee. Write TODAY for information and prices. Let our Service Department recommend size to use in your garage. Pin ad to your letterhead and mail **now** for full information

HOBART BROTHERS CO.
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Successful Mfrs. since 1898.

ELECTRICAL training again open to civilians. Over 3000 men trained for electrical industries in experience of more than a quarter of a century. For men of ambition and limited time. Condensed course in Electrical

ENGINEERING enables graduates to secure good positions and promotions. Theoretical and Practical Electricity, Mathematics, Steam and Gas Engines, Mechanical Drawing. Students construct dynamos, install wiring and test **IN ONE YEAR** electrical machinery. Course with diploma, complete.



Thoroughly equipped fireproof dormitories, dining hall, laboratories, shops. Write for catalog. 27th year opens October 1, 1919.

BLISS ELECTRICAL SCHOOL
260 Takoma Avenue, Washington, D. C.

The Oracle

(*Continued from page 240*)

HOW AND WHY OF RADIO APPARATUS SERIES.

(1015) Salvador C. Bayani, Manila, Philippines, writes this Department:

Q. 1. For a list of the "How and Why of Radio Apparatus," and in which issues the various installments appeared.

A. 1. Below we give a list of these:

No. 1. The Induction Coil, Page 493, *November,* 1916.

No. 2. The Transformer, Page 656, *January,* 1917.

No. 3. Condensers, Page 735, *February,* 1917.

No. 4. Spark Gaps, Page 113, *June,* 1917.

No. 5. Radio Transmitting Inductances, Page 537, *December,* 1917.

No. 6. Radio Receiving Tuners, Page 685, *February,* 1918.

No. 7. Radio Receiving Condensers, Page 766, *March,* 1918.

No. 8. Detectors, Page 30, *May,* 1918.

No. 9. Telephone Receivers, Page 176, *July,* 1918.

Radio men everywhere will undoubtedly like to obtain the complete set of these specially prepared papers on the "How and Why of Radio Apparatus." Also the following three important and timely papers on the "Calculation and Measurement of Inductance," by Secor and Cohen.

Nos. 1, 2 *and* 3 *"Calculation and Measurement of Inductance," appearing in the March, April and September,* 1917, *issues.*

Those interested in these valuable papers can obtain prices of individual back numbers containing them by writing to the "Circulation Department."

SCIENCE IN SLANG.

(*Continued from page 239*)

"But your explanation of the etheric disturbance against the wall seems to me that the etheric vibrations disturbing the ether in the place where it came in contact with an object would send pulses into the air that would be equivalent to reflection or refraction. You know what I mean, don't you? I can't explain it exactly."

"Yes," replied Jazz, "I believe I do. If the stream of cathodic rays were regular that condition would be possible, but for the fact that they are not regular I don't see but why they would not myself. Then, too, the etheric vibrations would not effect like the cathodic discharges.

"However, there is a condition that was explained by J. J. and a bird with my name, but no relation of mine, of Cambridge, and Prof. Lehmann, of Karlsruhe, and seems not such bad dope. They all bounced up with the conclusion that bodies that absorb x-rays have power to create other rays likened to the x-rays to such an extent that the old static machine could not tell them apart—if there was any diff at all. They called it 'secondary radiation'—but, for that matter, the x-ray is that.

"What made them get onto that stuff was that they found indications of their 'luminiferous ether' behind objects that absorbed all the light, and if the rays were not reflected or refracted how in the —— did they get there? Stokes (no relation of mine) figured it out mathematically that such pulses, or extremely short disturbances of ether would act in that way and be acted upon in that way."

"What all do the doctors tell with the x-ray?" asked Bender.

"Well," began Jazz, with a smile, "they are able to detect the presence and the extent of tuberculosis, pneumonia, pleurisy, hydrothorax, emphysema, empyema, and other such disorders and ailments——"

"Yes, and water on the brain, lovesickness and obesity," added Punk.

Advertising Talks

NUMBER 4

LAST month, I showed you how advertising made a firm spending many thousands of dollars a month keep up the high quality of its goods or whatever it has to sell. I gave you good proof of how every dollar advertisers spent in the ELECTRICAL EXPERIMENTER was your assurance that what you bought from them must be up to the standard so that the advertiser might hold your trade and stay in business.

Naturally the thought comes "who pays for this advertising? Can the advertiser really pay out a small fortune each month without going 'broke,' or does he add a certain percentage to the price of his product to pay for the advertising, and do I in the long run really pay his advertising bills?" **No, indeed, far from it.** True it is that the advertiser must get back in profits what he spends for every expense connected with his business. But nevertheless you really save money by dealing with advertisers as you can readily understand by studying the matter carefully for a few minutes.

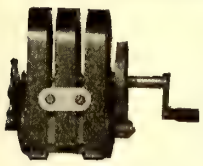
It stands to reason that the more business a concern does, the cheaper it can conduct its affairs. The small firm handling only a few orders each day and trusting to luck that customers will find their way to its doors, must make a fairly big profit on each transaction. The live, up-to-date firm, doing a business all over the country (and sometimes the world, if it advertises in the "Experimenter") systematizes its operations so thoroughly and with the use of the latest and best machinery, can turn out better products at a lower cost than its slow, unprogressive competitor. The larger the production of any one article, the lower the cost of manufacture of each individual piece, as any keen business man will tell you. Furthermore, with a large volume of orders a firm can afford to make a very small profit on each order and still, in the long run, make as much profit as the non-advertiser. And then, as an attractively low price (quality considered) is necessary to get and hold your trade and so make their advertising really effective, all far-sighted advertisers are in the habit of marketing their goods at the smallest profit they can successfully do business on, relying on a big volume of orders to keep going.

So you see that not only can an advertiser make what he sells more cheaply, but he can run his business at less expense, and he can afford to cut his profit on each order to a very small figure. This means that you get what you order from an advertiser at a cheaper price than possible elsewhere, and yet the advertiser makes enough profit *by advertising* to pay his advertising bills.

Advertising Manager.

EXPERIMENTERS!

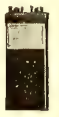
Read every word on this page. Note the wonderful goods we are offering at rock-bottom prices. Read the details of our offer of $10.00. Don't miss anything or you will lose money.



High grade telephone magnetos—guaranteed quality; strong and substantial; output 80 to 110 volts A. C. 4 bar, 8 lbs.....$2.25
3 bar, 7 lbs.... **1.75**



Telephone ringers, or bells, of same type sold to telephone companies all over world. Perfect shape. With gongs—1000 ohm (like cut), 1 lb. $1.25
1000 ohm other styles, 1 lb.. .75
80 ohm, 1 lb. .... **.50**



Fixed telephone condensers. All capacities from ½ to 2 M.F. Tin foil and rice paper. Excellent condition.
2 M.F., 2 lbs. $.60
1 M.F., 1 lb. .50
½ M.F., 1 lb..... **.40**



Telephone Switchboard, keys or switches. German silver springs. Two switches mounted on one escutcheon. A wonderful and useful addition to your laboratory. 1 lb. .. **1.50**



Watch case receivers, double pole permanent magnet 75 ohms. composition shell. Very handy for experimenting and wireless, 12 oz. $1.25
Single pole, like cut, metal shell, very sensitive. 12 oz. **1.00**



High grade telephone receivers used on all telephones. Very sensitive. With cord, New.$1.25
Other styles 1 lb. 1.00
Stromberg-Carlson fool proof metal type. 1 lb. .. **.80**



Headband receivers, with long cord attached. 75 ohms. Very good for wireless. Extremely sensitive and more handy than plain watch case. 1 lb. .. **1.75**



Sensitive transmitters and arms complete as shown with Skinderviken transmitter button. 2 lbs. $1.75
A very convenient mounting for a transmitter. Adjustable. With other make transmitters, 2 lbs. **1.50**

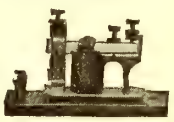


Local battery or magneto induction coils provide a very desirable instrument. Make fine medical coils. Steps up sound in telephone. A cheap but effective amplifier, 6 oz. ..... **.40**

When ordering any of the equipment shown here, be sure to remit enough for postage. Any excess will be refunded. All apparatus is guaranteed high grade commercial type the same as supplied to largest telephone companies all over the country.



Here is a low priced commercial telegraph key. Strong and substantial, neat in appearance. Excellent contact points and bearings. Works very easily, with just the right touch. Adjustable springs. 1 lb. **1.25**



A large neat sounder, with a sharp "click." Aluminum lever, solid brass base, 20 ohm rubber covered magnets, large adjusting nuts, mahogany base and large binding posts. 1½ lbs. A bargain at..... **2.00**

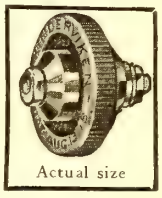
Want Ten Dollars?

SINCE we began advertising the SKINDERVIKEN TRANSMITTER BUTTON about six months ago, we have supplied thousands to experimenters not only in this country, but in Canada, Australia, Europe and South America.

It is interesting to note the various uses to which these Buttons will be applied. The question is—"What are you doing with your button?" We would like to know, as there are thousands of other experimenters who would like to use it for the same purpose.

We will make it worth your while to submit your ideas. We are going to pay $10.00 cash for the best idea. All others, accepted by us, will be paid for in proportion. Now then, get busy, you fellows.

Any idea you may have of using a SKINDERVIKEN TRANSMITTER BUTTON will be all right. However, try to make it original.



Actual size

THE SKINDERVIKEN TRANSMITTER BUTTON is an improved compact microphone. It is extremely sensitive, easily adaptable to telephones, detectiphones, deaf phones, radio telephones and electrical experimenting. We have received dozens of letters from experimenters telling us of "its wonderful work." We furnish a booklet of instructions and diagrams for experimenting, also with outlines of suggested experiments.

We know from experience that you will find the Button a very interesting piece of apparatus. It is so very sensitive and it only needs one dry cell for its operation. Lots of fun can be had from its use.

Skinderviken Telephone Equipment Co.

2134-2136 No. Clark Street, Chicago

335 Broadway, New York

USE THIS COUPON

STECO E. E. 7-19

I enclose $.... for which please send me the following:

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Signed .....*Address* .....



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Enters the Electrical Field as a High-Salaried, Industrial Specialist.

If you desire to qualify as a Power Plant Superintendent, Electrical Draftsman, City Technician, or Supervisor of Electrical Equipment Maintenance—

Study Electrotechnics:

The time to start is right **now**,—when the field is unlimited—uncrowded. Industrial organizations everywhere are demanding the services of trained Electrotechnicians.

At This School Only

can you prepare especially for the field by taking the special, condensed course in Electrotechnics. The system of combined work-shop, laboratory, drafting and recitation room instruction quickly and thoroughly equip you to assume positions of importance in the industrial world.

Open to all Grammar School graduates. High School or College work credited to give you advanced standing, enabling you to shorten course from 6 to 18 months

"Earn While You Learn" if you like.

New Term Opens July 2d.

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95-373 Broadway, Milwaukee, Wis.

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School of Engineering of Milwaukee,
95-373 Broadway, Milwaukee, Wis.

Gentlemen:—Without obligation, send me catalog and full particulars regarding the Electrotechnician Course.

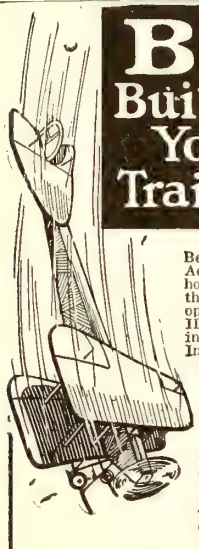
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Age ..... Education .....

School of Engineering of Milwaukee
Institute of Electrotechnics
95-373 Broadway Milwaukee, Wis.



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Build and Fly Your Own Training Plane

Train yourself in Aviation. Be an Amateur Aviator with an Aeroplane of your own. Learn how Aeroplanes are built; learn the principles of construction, operation and control. We sell IDEAL Accurate Scale Drawings, and Building and Flying Instructions which show you how to build a perfect Model Aeroplane, 3 ft. size, that will rise from the ground by its own power and fly like a big one. Send now for the Drawings and Instructions for the one you want to build.

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Bleriot Monoplane
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Curtiss Flying Boat
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25c EACH
Set of Seven $1.50 postpaid

Ideal Model Aeroplane Catalog 5c—None Free

Tells about Model Aeroplanes, Racing Aeroplanes, Flying Toys, and parts and supplies to build them with. 48 pages. Sent only upon receipt of 5 cents.

IDEAL AIRPLANE & SUPPLY COMPANY
159-161 Wooster St., New York City

Be a Mining Engineer

A great profession, not overcrowded, offers the diligent and ambitious student assured and exceptional rewards. *Located in the heart of one of the greatest copper mining districts in the world,* the College offers a unique combination of theoretical instruction with practical experience in all phases of mine development and operation. Four year course can be completed in three. Vast mines, mills, smelters, electrolytic and power plants of the most modern type, are practically a part of the College equipment and constitute a factor of enormous value in the courses of instruction. Every opportunity for specialization. A state supported college not conducted for profit. Established 1886. "M. C. M. Men Make Good." For descriptive book address Administrative Officer, Houghton, Michigan.

Michigan College of Mines

A Dash to the Clouds

(*Continued from page* 206)

cars themselves are spanned with large wings, measuring eighteen feet from tip to tip. In addition to this spectacle, several other new features are being added to the great list of amusements for the public during the season. Principal among these is the "Witching Waves," a delightful ride in the imitation of an ocean trip. An added feature is a new pony track for those who like the hobby horses. Another novel innovation will be the "U-Boat Dodger," being a ride in a small submarine boat carrying passengers and chasing another submarine. The "Tub Race" is also a new novelty. In addition there will be a new gigantic "Roller Coaster" with a 3,000-foot ride with eight of the biggest dips ever constructed, which will be equal to some of the nose dives now made famous in plane flying. This new roller coaster will cost about $25,000. The "Canals of Venice" is another interesting attraction; cost of construction, $5,000. A very interesting addition to the Park will be a large scale model of a coal mine, showing a cross-section down thru the entire region, also the street above. Here small figures automatically will go thru hundreds and hundreds of different moves, people on the street hurrying back and forth from stores to their homes, trolley cars in action, automobiles, shaft elevators in the coal mine, running up and down with men, little coal cars will go back and forth with their loads and rise to the surface and every little intricate detail of coal mining operation will be faithfully reproduced in this miniature model.

The building which was devoted last year to foreign buyers' markets and interesting collections from the world over has been turned into a skating rink this season, due to the fact that the unforeseen circumstances of the war made it impossible to get sufficient exhibits from foreign countries to run the exhibition hall this season. It is to be hoped that within the next twelve months or so conditions will have so settled themselves that by next year there may be many interesting trophies from the fields of battle. As it is, this giant roller rink can accommodate hundreds of people. Fancy skaters, those who can't skate so well or not at all, with the aid of the big band and cheery music will forget their little bumps and keep smilingly on.

Perhaps the greatest feature of all amusement resorts, fairs, parks and expositions, is the tremendous amount of electrical equipment necessary to keep all these things in motion, and which is seldom realized by the visiting public. Hundreds of horsepower are consumed hourly by these amusement devices. The power is taken directly from the New York Central Railroad, which passes the grounds, and this power at 660 volts is brought into specially constructed damp-proof vaults, where four 100 K.V.A. large oil transformers shoot the juice to all parts of the grounds. In addition there are several smaller transformers, for special purposes supplying different sections. In this case a tremendous amount of money was saved by installing the 660-volt system to every part of the grounds. These cables are carried thru underground conduits and manholes to points where the power is needed, and there the power is transformed to 220 and 110 volts. The saving in cable alone amounts to thousands of dollars, as by using 660 volts a cable approximately one-third the size is required. This gigantic system of transformers, switches, underground cables, man-holes, etc., has cost $100,000.

An immense fire alarm system has been installed to cover the entire grounds. Should a fire occur at any point, simply the pulling of a hook in a box will cause a large bell centrally located in the park to strike a certain signal, which will indicate to all the employes the location of the fire.

Also, as last year, we have the wonderful bathing pool, with its artificial waves, probably the largest in the world, where hundreds may daily disport themselves in its waters, not forgetting the kiddies with their sand pails and shovels, the big band stand with its towering jewels and sympathetic music.

The Oyster's Autograph

(*Continued from page* 207)

sumption of oysters that have drunk in disease germs in the plumping process.

The trick as carried on by the oyster dealer or grower is that he takes the oysters from their natural depths where they mature, and places them in coves and harbors where fresh water streams terminate. Being less saline, the water is less dense, and hence there is an interchange of the fluids thru the walls of the bivalve. When the oyster opens his shell for feeding or for any purposes, the tissues swell. The oysters are not placed in absolutely fresh water, for this would kill them, but in water somewhat fresher than that where they are grown.

The nutritive value which is lost in this process is quite marked. The fluids which are past out from the tissues of the oyster carry with them salts and some fats, chemical experiments showing that the oyster, tho larger after plumping, has lost 13 per cent. of its original nutritious substance, proteins, fats, carbohydrates and mineral salts. This has been found to be true by experiments conducted by Dr. H. F. Moore, of the U. S. Bureau of Fisheries. He states that with the loss of these fluids passing out from the oyster, sufficient water will have been taken up, however, to increase the total weight of the oyster from 12 to 20 per cent. Therefore, it can be seen that what the oyster has really gained is simply water, which is of no food-giving value at all.

Altho scientists are at a loss to agree upon the precise food that oysters eat, whether the beautiful diatom, a vegetable organism, or other microscopic animalcules, it has been found that in experiments recently conducted oysters planted in the sewage-laden waters of Jamaica Bay, near New York, that the oysters can become marketable after a period of eighteen months. Whereas, normally it takes three years before oysters are of sufficient size for the table. Cutting the growing period in half indicates that oysters are not exclusively partial to the natural foods of the water, but, on the contrary, they have an especial fondness for the city's sewage disposal. When Dr. Nelson finishes his experiments, he will furnish the U. S. Bureau of Fisheries, with whom he is coöperating, a constructive program on the general improvement in the culture of this important food. One of the most important phases of his investigation will be that of studying carefully the relation between environment and propagation. Authorities estimate that a single oyster spawns from sixteen million to sixty million eggs in a year, but not-

withstanding this enormous fecundity of the individual oyster, the propagative power of the beds is not so vast as might be supposed. The oysters may be planted on the bottom, especially prepared by clearing it of all refuse material, and a bed so formed of good clean gravel and shells, in order that the young "spat" will have some object to cling to, as otherwise, in a muddy bottom, they would soon be covered over. Yet with many of these precautions some beds will prove greatly fruitful, whereas others prepared in the same way and in adjacent waters result with very poor crops. Certain locations in various waters are particularly abundant in diatoms, the minute organisms on which the oyster is supposed to feed. Yet it is not the generally accepted fact that the diatom is the main article of the oyster's diet, as can be evinced by the quick growth of the oysters in waters polluted with sewage. Generally speaking it is to be hoped that when Professor Nelson finishes his experiments he will have such an array of data and abundance of far-reaching discoveries that thru artificial feeding and environment a variety of oyster may be produced that will excel any heretofore sold on the market and in addition to its phenomenal size it will be healthful and free from all disease germs. It probably will be possible thru Dr. Nelson's researches on the culture of the bivalve to produce such a type as will rank with the discoveries of Burbank's wonderful achievements in producing new and better varieties of fruits and vegetables. —*Photos Courtesy Star Company.*

Flying Across the Atlantic

By H. Winfield Secor

(*Continued from page 214*)

and increase the speed of the machine about 10 miles per hour. The illustration, A, shows some of these points on Lieut. Hawker's ill-fated 'plane, and among other considerations we would mention the following: Only one engine was used, a Rolls-Royce 375 H.P. airplane engine—and very few aviators would care to start off on such a trip with a single engine where continuous flying may have to be kept up from 22 to 28 hours. If the slightest thing goes wrong with this engine and it stops, it may spell disaster, or at least the failure to make the trip in nonstop form. Lieut. Hawker counted on saving himself if obliged to land in the water by the fact that the fuselage of his 'plane was made water-tight, and he also counted on the buoyancy of the gasoline tank as well as a life-saving suit which he wore. But the ocean is known only to those who have crost it and seen the waves roll up forty feet high. The weather was very uncertain, and a storm was said to be blowing up in mid-ocean when he started from New Foundland.

Among other weak points in this type of 'plane, we find that no pontoons were used, thus giving small chance of the 'plane staying afloat, at least for any length of time beyond a few hours. Also the 'plane was very small and frail. Added to this, we have the almost incomprehensible difficulty of navigating such a long flight over an uncharted course. The aviator would have to fly thru the night and rely only on a compass and a sextant to guide him by the help of the stars, if the clouds did not obscure them. But no pilot vessels or chart marks such as buoys, not even radio compass signal directions, were provided or arranged for. It would seem nothing short of superhuman, under these conditions, for the two intrepid fliers to ever reach the far distant coast of Ireland, as they had hoped to.

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Superiority of the Seaplane.

Fig. B shows the second type of aircraft which has been tried and tested with great success by the U. S. naval flying men for trans-Atlantic work. Not only are these 'planes fitted with large roomy pontoons which are about the size of the usual unsinkable life-boat found at all coast guard stations along the seaboard, but the 'planes have been designed with every possible engineering consideration in mind, particularly any failure of the engine plant. It should always be possible, or let us say feasible, especially when small 'planes are to be used for such trans-Atlantic or trans-Pacific travel, to provide them with an engine plant consisting of more than one engine. But there is no doubt about it that for any form of heavier-than-air machine, such as sea- or airplanes, more than one engine should be installed. With some of the twin-engined biplanes used several years ago it was found possible to keep the 'plane airworthy, and flying on one engine when the other engine, for any reason, failed. The same logic applies to the Navy-Curtiss seaplanes, or "N C" 'planes, as they are familiarly called. Four 400 H. P. Liberty engines are fitted on each seaplane, and if one of these engines should fail, three would be left to maintain the 'plane in the air. However, at least three engines are normally required to keep these heavy ships in the air, as seaplanes are much heavier than land-type 'planes, size for size; the "N C" 'planes weighing with load about 28,500 pounds when they took the big "hop-off" for Europe.

Thus far we see that the Navy's flying boats have two great advantages which should not be overlooked in designing any machine intended for trans-oceanic flight, and among other features which were made available for the flight of the three 'planes on their history-making journey across the broad Atlantic we find the following: Radio-telephone apparatus operating from 'plane to shore or ship stations, and between other 'planes, with a range of 30 to 40 miles; also radio-telegraph apparatus capable of transmitting and receiving up to 150 miles. A new record was made in airplane radio transmission during the seaward flight of the "N C" 'planes, when an unrelayed message was picked up from the NC-4 at a distance of 400 miles, at the Otter Cliffs radio station in Maine. Not only was the regular radio communication made available at every turn, but the U. S. Government exercised special precautions to render certain that the aviators, in case they should have to descend on the ocean, should not lose their lives unnecessarily. It placed warships, including cruisers and destroyers, in a complete chain from the American coast to the Azores, as well as from the Azores to Lisbon, Portugal, the official terminating point of the trans-Atlantic flight by the seaplanes. These vessels were placed about 75 miles apart and closer together in the regions where night flying occurred.

The vessels along the route could communicate by wireless with the 'planes and get their bearings, weather conditions, etc., from the ships of the air as they sped along overhead. At night the war vessels used their searchlights and were otherwise marked with electric signal lamps. On the decks appeared the ship's station number in electric lights, so that the 'planes could see at a glance as they flew ahead just what position on the route they were at. Provision was also made for receiving directive radio compass signals. These considerations and provisions would perhaps seem overdrawn or overimportant to the lay reader, but each and every one of them represents a fine piece of applied engineering and they comprise elements of technique which were not picked out at the eleventh hour and simply slapt on the 'planes, but all of these points were under constant consideration, and in the hands of competent Navy engineers and experts for over two years. By comparison it is seen that no expense of money and brains was spared to make this trip successful—at least, if not successful, "safe" so far as humanly possible. This plan was carried out, thanks to the U. S. Government, to the extent of costing $1,000,000 before the gigantic naval 'planes "hopped off" at Trepassey Bay, on Friday, May 16, in an attempt to cross the Atlantic Ocean thru the air for the first time in history.

The Dirigible.

The illustration Fig. C shows a probable development of trans-Atlantic aircraft which has been mentioned frequently in connection with trans-oceanic travel *via* the air—i. e. the *dirigible*, or gas balloon. The U. S. Naval dirigible C-5 made one of the most beautiful non-stop aërial flights in history, when it covered the distance between Rockaway Beach, near New York City, to St. Johns, New Foundland, a distance of over 1,000 miles, in 26 hours, flying continuously night and day. The naval authorities have announced that they hoped to have another dirigible airship ready shortly to attempt the trans-Atlantic flight. England is hoping to startle the inhabitants of New York City some bright and early summer morning by a visit of one of her 5,000,000 cubic foot, giant dirigibles. With fair weather conditions, it would seem that the modern dirigible, when given a fair chance, will prove a powerful competitor of the seaplane for crossing the ocean. However, the gas balloon possesses, along with some of its advantages, a number of marked disadvantages, and we shall now consider them.

Among the advantages of the gas balloon "lighter-than-air" type of airship, especially when considering long distance flights of 1,000 to 2,000 miles or more, over water, as in crossing the ocean, we are imprest by one predominant fact, and that is that, no matter if the engines all come to a stop on the dirigible, she will still retain her buoyancy in the air and the crew is safe as long as it remains afloat in the air. Under such circumstances there are two major things which may and can happen: first, the winds would blow the balloon along at a fairly high speed and usually the crew is safe in the air and not resting on the waves. The latter, when the sea is rough, often rise to heights of 30 to 40 feet or more, and if the engines or necessary apparatus cannot be repaired, then the dirigible can hail or radio a steamer, and the crew taken off. This could be accomplisht by means of a rope ladder, as has been successfully tried by the U. S. Navy off the coast of Florida, as described in the article on page 108 of the June issue. Secondly, while the dirigible had her engines stopt, the mechanics would be endeavoring to repair them and get them in working order again. The speed of the new type of dirigible such as used by the U. S. Navy, is fairly high, viz: 50 to 60 miles an hour, and these airships have great lifting power, so that they present a very logical answer to the aërial passenger ship requirements of the future. Another advantage which they possess, and due primarily to their great lifting power and buoyancy, is their long range of operations—it being possible for them to take on board sufficient engine fuel to accomplish trips of several thousand miles. Another advantage of such an airship is that, if the engines suddenly stop, the steering gear can be maneuvered and other arrangements made whereby she can be brought to earth gently and in good order; contrary to the usual tactics when the engine of the ordinary airplane stops, which has caused many accidents, owing to the sudden loss of buoyancy of the 'plane and the rapid dive earthward, which may or may not end disastrously.

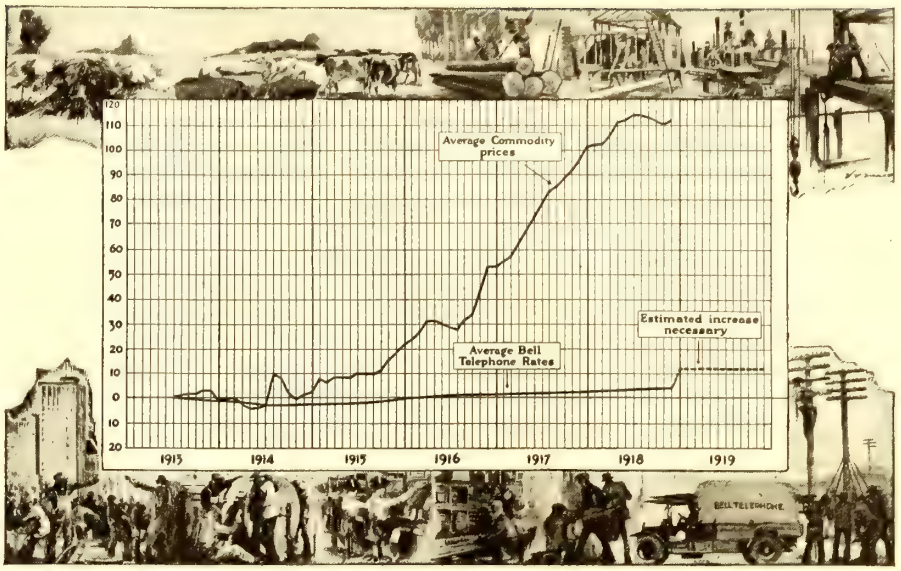
The disadvantages of the dirigible are several, and among the first and foremost we are forced face to face with the fact that they are distinctly difficult to manage and maneuver in stormy weather or high winds. It will probably take some years for our aëronautical engineers to devise means, such as by sub-dividing the gas bag of the dirigible, or by other design tactics, so that the great resistance now offered to the wind will be circumnavigated. If you have ever been up in a "blimp," such as the observation balloons used extensively during the war are called, then you will be in a position to know just what these dirigibles are up against with a heavy wind blowing against them. Even if you are up in a blimp about a thousand feet above the earth, on such a trip as the writer has in mind and which took place at Rockaway Beach about a year ago, you will be surprised, and not altogether pleasantly either, when on a clear day, with the giant gas bag floating lazily in the air, you almost have your feet fly up and shake hands with your face, for all of a sudden—woof!!! Old Mr. Blimp jumps diagonally—or was it vertically?—about fifty feet! No, fellow scientists, it was not magnetic or electrostatic attraction for another blimp which you perceive about one-half mile away, but simply the *irresistible force of the wind* exercising its full wallop against the vast hulking form of the blimp "gas bag."

Therefore, not only is the dirigible a tricky machine in high winds or storms, as was experienced countless times by Count Zeppelin, the erstwhile investigator of Zeppelin tactics when his giant cigar-shaped dirigibles 600 to 800 feet in length were destroyed one after another in storms, but they also have the disadvantage of *slower speed* as compared to the seaplanes, owing primarily to the greater bulk of the gas container or bag which has to be driven thru the air with a consequent great displacement thereof. When it comes to a forced landing on the sea, most aviators would undoubtedly rather take their chances with a seaplane of the Navy type, rather than with a dirigible of any size. For they may, if the weather is quite calm, land in a detachable life-boat carried by the dirigible and by means of a rope ladder descend into it while on the surface of the ocean. This, with the chances under ordinary conditions that they would have to make an attempt at lowering the altitude of the dirigible herself. In this case they would remain in the gondola attached underneath the dirigible, with the possibility that the "elephant of the air" would attempt to set down on them and smother them. At any rate it would require extremely skillful seamanship to carry out such a maneuver successfully. The question of fire in dirigibles has been made practically obsolete, in view of the fact that the U. S. War Department in the past few years has developed the new balloon gas "helium" to the stage where it is available at small cost, and this new gas is absolutely non-inflammable. Its lifting power is 85 per cent of that of hydrogen, the gas heretofore used in blimps and dirigibles, but which possesses the disadvantage of being inflammable.

Radio Equipment of the NC Seaplanes.

Details of the radio installation of the NC seaplanes engaged in the attempt to make the transatlantic flight, as given out by Acting Secretary Roosevelt of the Navy Department, follows:

The radio on the NC seaplanes involves two transmitters. One is a ½ K. W. spark transmitter, the main element of which is a streamline generator and accessory apparatus, which is driven by an air propeller and is mounted on the deck of the boat aft. This set weighs only forty-five pounds, but is used for the regular telegraph communications between the seaplanes and stations up to a distance of 250 nautical miles. Since this set is driven by a



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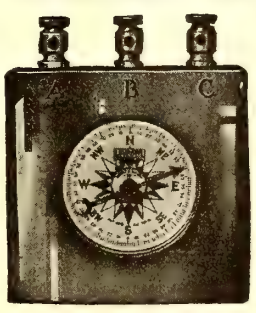
The activities of reconstruction which are now upon the nation have put a great burden upon the telephone. This condition has made necessary an advance in telephone rates.

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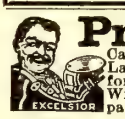
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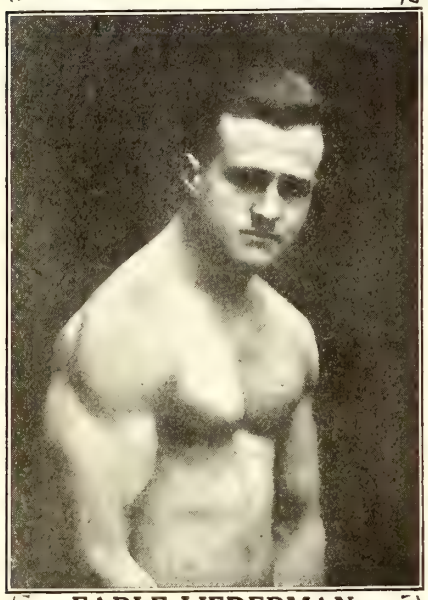


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propeller, it can only be used while seaplanes are in flight. The antenna used for this set is a single trailing wire leading from the tail of the boat for a distance of 250 feet down and to the rear. A streamline lead weight holds the lower end of this wire down.

With this transmitter it is possible for the commanding officer to send messages from time to time regarding the progress of the flight, to be retransmitted by the nearest shore station to the Navy Department. Also communication can be held with destroyers or other craft and radio compass signals or other information requested.

The other transmitter is a combined telephone and telegraph transmitter, and operates on a small 12-volt storage battery. It is used on an antenna consisting of wires permanently stretched on the skid fins on the upper planes so that it may be used while the seaplane is in flight or on the water.

The Anti-Noise Microphone.

It is this set which is used for telephoning between the 'planes, arrangement being made so that either the radio operators or the commanding officers themselves may communicate directly by telephone while the 'planes are in flight. Such interplane telephoning may be carried on up to a distance of twenty miles. While on the water this set may be used for telegraphing or telephoning a distance of about thirty miles.

A special feature of the telephone sets is the *anti-noise microphone,* which is so constructed that the engine noises are not heard. This is accomplisht by having the back of the microphone open. The exterior sound waves strike the back as hard as the face of the diafram, and therefore the effect is neutral. The voice waves strike only the face of the diafram, and even tho the operator cannot hear his own voice, the radio sets receive enough effect to modulate the transmitted wave.

This single item has been the deciding factor in success or failure in long-distance transmission by telephone by airplane. It is easy enough for short distances to get communication with an ordinary microphone, but for long ranges it is impossible without the anti-noise transmitter.

Radio Compass Installed.

One of the most important of the radio installations on these seaplanes is the radio compass. This consists of a set of revolving coils mounted in the tail of the machine, on which are mounted many turns of enameled copper wire. The radio waves are picked up on these coils by revolving the coils until the radio signals obtained on two methods of connection are of the same strength.

The operator then knows the direction of the incoming waves. By then reading the position of a pointer on a scale on the coils, the bearing of the transmitting radio station is determined. This bearing is then communicated by the radio operator to the navigating officer by means of the intercommunicating telephone, which consists of telephone receivers built into the helmets, and the same type of microphone used by the operator.

Using the same inter-communicating telephone system, the navigator can telephone to the pilots, giving them the proper direction in which to steer the 'plane. He may inquire of the engine room regarding the condition of the engines, or he may hold radio telephone conversation with the navigating officer on one of the other 'planes.

In other words, the inter-communicating telephone makes possible constant communication between all members of the crews in spite of the terrific noise caused by the engine and the wind rush, and in spite of the fact that they are located in separate parts of the seaplane. In addition to this the radio telephone makes it possible for the commanding officer and navigators to talk directly with each other, altho their seaplanes may be flying at a distance of 20 miles apart.

The radio compass signals may be received from a destroyer at a distance of 75 miles, or from large land stations at a distance of 600 miles.

The regular receiving apparatus on the seaplanes will permit of reception from land stations of high power at distances of several thousand miles, thereby permitting the seaplanes to copy weather reports or orders directly from the Navy Department at Washington.

The main striking fact regarding this radio equipment is that, completely installed, it weighs only 200 pounds.

Radio Reply in Three Minutes.

As an example of the efficacy of the seaplane's radio communication the following will serve:

The Navy Department communicated with the seaplane NC-4 after she started on her flight to Halifax, received a reply from Commander Read, and had broadcasted to Europe and the west coast of the United States the plane's position in *three minutes* elapsed time.

The message filed by the Navy Department at 11:18 A. M. was as follows:

> What is your position? All keenly interested in your progress. Good luck.
> (Signed) ROOSEVELT.

At 11:20 A. M. this answer was received:

> Thank you for good wishes. The NC-4 is twenty miles southwest of Seal Island, making eighty-five miles per hour.
> (Signed) READ.

At 11:21 A. M. the substance of Read's message was sent broadcast from the Annapolis (Md.) and New Brunswick (N. J.) radio stations, reaching Europe, South America, the west coast of the United States, and Honolulu. At 11:26 A. M. the radio stations at Balboa, Canal Zone, and San Diego, Cal., had confirmed receipt of the message.

New Navigation Instruments.

Three new and novel instruments for airship navigation have been invented and employed for the first time by the NC-1, NC-3 and NC-4 in the trans-Atlantic flight. They are an *aërial sextant,* a drift and *speed indicator,* and a *course and distance indicator.*

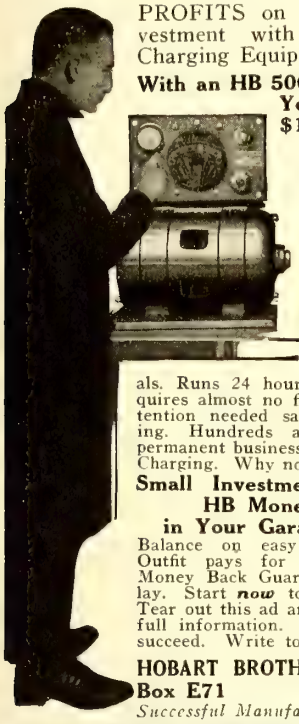
No airplane has ever flown far enough out to sea to warrant the use of the sun, moon and stars for fixing a geographical position, stated the Navy Department in announcing the use of these instruments. An instrument has been designed that will enable the air navigator to locate his position, regardless of the state of weather and regardless of the very fast speed of the airplane. An equal feature of the aërial sextant, known as the *Byrd sextant,* invented by Lieutenant Commander H. L. Byrd, is that a bubble in a tube takes the place of the sea horizon and observations. A specially constructed lens is used in sighting the bubble, which is reflected in a mirror. The sun is reflected in another mirror. The observer brings the sun tangent to a line at the same time he brings the bubble tangent to the line. That gives the altitude of the sun. This is of especial value, as the aviator is often above the clouds, and even when flying at low altitudes the horizon is too dim to be seen clearly. With this new aërial sextant the curvature of the earth does not have to be taken into consideration in calculating position. *The bubble is lighted at night, so that night observations may be taken.*

New Chart Saves Time.

New methods of astronomical calculations also have been devised which enable the navigator to make his calculations in a fifth of the time that was formerly neces-

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sary. A projection chart of the Atlantic Ocean has been specially constructed for this purpose. This chart, a new invention, does away with difficult mathematical calculations, enabling the aviator to determine his position in a few minutes.

Another great problem of the sea-air navigator is the calculation of the speed and direction of the wind, both day and night. In spite of the reliability of the compass it can only give the course upon which the craft heads, and in determining the true course proper allowance must be made for the sidewise drift caused by the wind. For example, a wind blowing thirty miles an hour towards the side of the 'plane will blow it thirty miles an hour out of its course. This fact alone makes the navigation of the air far more difficult than the navigation of the sea.

To overcome this difficulty bombs have been invented which ignite upon striking the surface of the water and give a dense smoke and bright light for ten minutes. An instrument is used in conjunction with this bomb which enables the navigator to determine the velocity and direction of the wind by sighting on the smoke in the daytime and the lights at night. This instrument, *called the speed and drift indicator, has proved successful.* This instrument is illustrated in one of the accompanying photographs.

When the navigator has found the speed and direction of the wind, he must then be able to calculate the course to steer towards the Azores to allow for this wind. To do this an instrument has been designed to solve the triangle of forces, thus doing away with intricate mathematical calculations.

In the Navigator's Cockpit.

The navigator's cockpit is in the forepart of the boat and is equipt with a chart board, a chart rack and lights. He also has a specially designed headgear for telephone communication with the pilots, so that he can direct them when to change course. The noise from the four big motors is so great that it is impossible to hold conversation except with specially designed telephonic apparatus.

The navigator also has instruments which show him the altitude of the 'plane and the time the sun keeps with the Greenwich meridian, because in going to the eastward so rapidly it is difficult to keep the correct time. In going from Newfoundland to the Azores over two hours is lost in a period of twenty hours, so that the navigator must be very expert in order to allow for this loss in time in making his astronomical calculations. In aërial navigation positions must be determined very quickly. The navigator sits down to work out his "sights," to fix his position, and will be far from his calculated position unless he works out his calculations very rapidly, which these instruments enable him to do.

Ocean Station Ships Bear Numbers.

Each ship had her number painted in large letters upon her deck so that the fliers can tell at a glance just where they are and how far they have progrest, since the positions of the destroyers and battleships were fixt in advance, and on one of the many charts which the aërial navigators had before them these positions were carefully marked.

When the word was flasht by wireless from Trepassey that the NC's had started off the nearest destroyers put out great black smoke smudges which the commanders of the flying boats were able to see for many miles.

At night the guiding surface ships were grouped much closer together.

The vessels had their searchlights directed aloft, had their identification numbers or the decks illuminated, and from time to time threw up star-shells of the sort which the combatants in the late war used to illuminate no man's land.

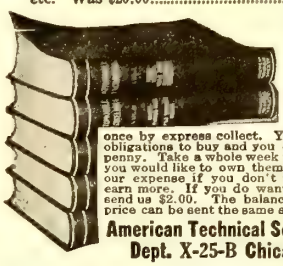
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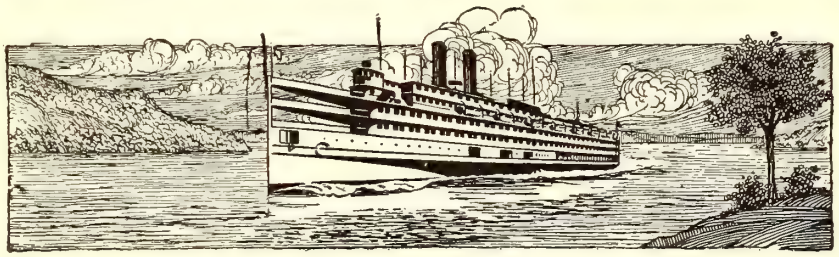
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The NC's carried flares, which could be dropt to light up the surface of the water in case a landing became necessary at night, and their commanders had "rocket-pistols," which threw out balls of varicolored fire for signalling purposes.

Electric Self-Starters Used.

The Bureau of Steam Engineering was able materially to improve the performance of the boat by the application of new propellers, designed in that bureau. The NC-1 was originally fitted with standard navy low compression Liberty engines, which were found to be entirely satisfactory, but during the period that the NC-1 was being tested with these engines the Bureau of Steam Engineering, at the experimental laboratory at the Washington Navy Yard, perfected carbureter adjustments on the high compression Liberty engines which materially improved its economy.

Since the high compression engine gave greater power than the low compression engine, such engines replaced the original installation on the NC-1. With the new propellers and the new engines, the boat got out of the water and flew easily, with a total weight of 24,700 pounds. The designed load was 22,000. Besides providing propellers and engines for the boat, the Bureau of Steam Engineering supplied a remarkably efficient *electric self-starter* to each engine.

This style of self-starter weighed only 35 pounds, and by means of this improvement it was possible for the pilot to start any engine without leaving his seat. It is believed that this constitutes the first application of an electric self-starter to the Liberty engine.

Wing span from tip to tip, 126 feet.

Upper wing from tip to tip, 114 feet.

Aileron projections beyond wing tips, 6 feet on either side.

Lower wing span, 94 feet.

Width of wings, 12 feet.

Distance between wings, 14 feet at center and 12 feet at outer tips of lower wing.

Over-all length from front end to the rear end, 68 feet 3½ inches.

Length of hull, 44 feet 9 inches.

Wing area, 2,380 square feet.

Weight full load flying condition, 28,500 pounds.

Weight carried per square foot of wing surface, 12 pounds.

Estimated speed at full load, 79 nautical miles per hour.

Estimated speed at light load, 84 nautical miles per hour.

Horsepower of four Liberty engines, 1,600 horsepower.

SAWING A 74,000-Lb. STEEL INGOT.

(*Continued from page* 208)

It is an interesting fact that in cutting steel beams and ingots with these cold saws that *the saw proper never touches the steel* or iron stock; the cutting is done by a film or layer of comprest air just in front of the teeth. This comprest air layer is formed due to the high velocity of the saw blade, which is often several thousand revolutions per minute.

Some most interesting tests were recently made with these inserted tooth saws under regular working conditions. A 24-inch diameter blade cutting rails, peripheral speed 51 feet, lateral feed 27/32 inch per minute showed, before sharpening, a total of 424 cuts; after sharpening, a total of 502 cuts.

In an endurance test of a 40-inch saw with the lateral feeds on .45 carbon machinery steel, 12-inch round stock was cut in 5 minutes and 9-inch round stock cut in 35 seconds. The lateral feed guaranteed in the latter case was 2 inches per minute.

—*By Frank C. Perkins.*

Practical Chemical Experiments

By Albert W. Wilsdon

(Continued from page 220)

with Turpentine, Benzine, Naptha, or Gasoline, but old paint spots must be softened with oil or grease, and may then be removed by the appropriate solvent. Pitch, tar, or varnish may be treated with oil, and then be dissolved out with turpentine.

Sugar spots are soluble in warm water. If acids have destroyed the color of the goods, this may usually be restored by ammonia, and dilute alcohol may be used in the same way for the stains from fruits.

Removing Ink Stains.

It would be a much simpler task to remove ink spots if we only knew the composition of the ink in advance. Fresh ink usually dissolves in cold water, tho sometimes sour milk is more efficient. Ink stains may also be removed with blotting paper or some other absorbent. On marble, these stains may be treated with turpentine, baking soda, or strong alkalies, or a paste may be made with the alkali and turpentine, and this may be left for some time in contact with the spot, and finally washed off with water. A dilute solution of oxalic acid may often be used successfully to remove either ink stains or iron rust spots.

If there is much iron in the water supply, this may be removed from bowls or other porcelain ware by the use of hydrochloric acid, then rinse with water, and finally with a solution of soda.

It has probably often been noticed that silver is readily tarnished by sulfur, either from eggs, or from rubber bands or elastic, or sometimes from the sulfur compounds in the illuminating gas. The sulfid of silver thus formed is in color from grayish to black. Silver thus tarnished should be rubbed with moist common salt before washing, thus forming a chorid of silver, which may then be washed in ammonia, in which it is soluble.

For cleaning and polishing brass and copper, nothing is better than oil and rotten-stone, and most of the good polishes on the market are made from these materials, with alcohol, turpentine, or soap. Kerosene is useful in keeping metals bright, as well as glass and wood. Aluminum may be cleaned by the use of whiting or any silver polish, but alkalies should not be used upon this metal. As aluminum does not tarnish readily, and does not rust, it is an ideal substance from which cooking utensils are made.

Iron-Rust Stains.

To remove an iron-rust spot from a piece of goods, stretch the cloth over a dish containing hot water, then as the steam arises and the goods become moist, drop a little hydrochloric acid upon the rust spot with a medicine dropper. See Fig. 3. After a moment or two lower it into the water. If the spot is not removed, repeat the operation, then rinse in clear water, and finally in a dilute solution of ammonia to neutralize any acid that might remain and injure the goods.

Iron-rust stains may often be completely removed from delicate fabrics by the use of lemon juice and common salt.

QUESTIONS AND ANSWERS

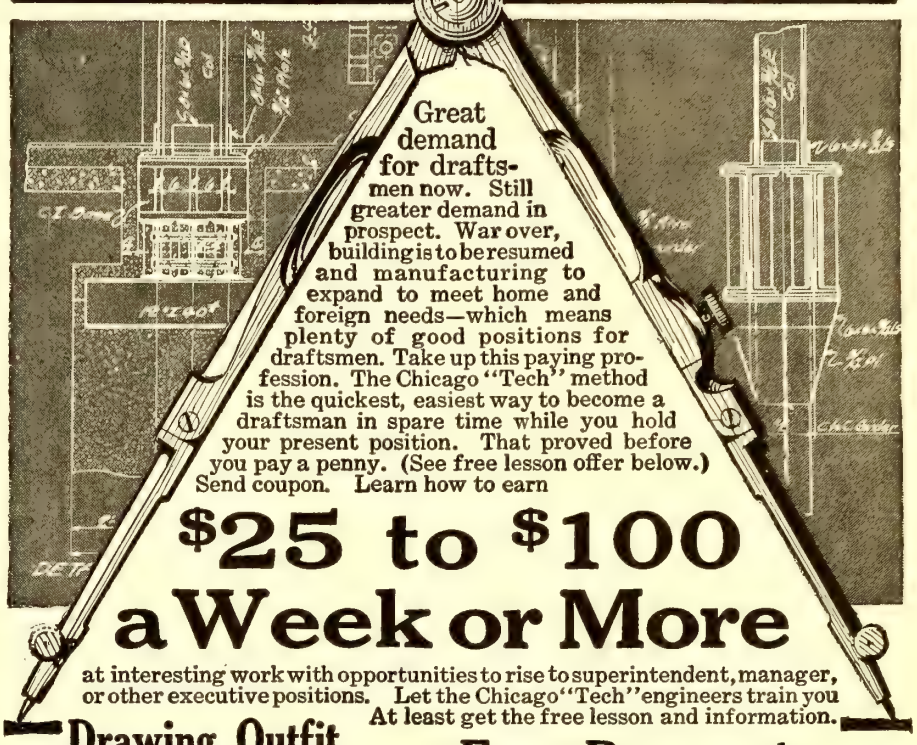
Detecting Saccharine.

Q. 10. Werner Kretschmer, of Demarest, N. J., wants to know:

(1) The test for Saccharine, and (2) Method of detecting Glycerine in foodstuffs. (3) If the "Fuller's Earth" method of testing butter for coal-tar dyes can be applied to foodstuffs.

A. 1. Saccharine is a very sweet substance prepared from coal-tar, and has been used largely for sweetening purposes in the place of sugar. It also possesses some preservative power, but is never used

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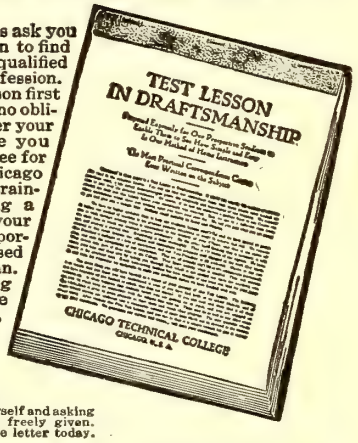
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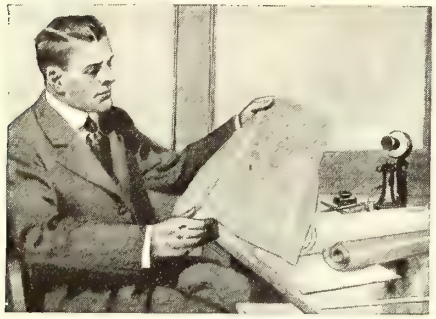
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solely for this purpose, the preserving influence being only incidental. In the detection of saccharine the substance containing it, which is usually a liquid, is shaken with chloroform, which settles to the bottom and is removed by means of a medicine-dropper. The saccharine enters into solution with the chloroform while sugar if present does not. The chloroform solution is then evaporated by heating gently on the water bath, and if saccharine has been present the residue has a distinctly *sweet* taste. This method is not applicable to substances whose chloroform layer contains a flavor that would mask the sweet taste of the saccharine, for instance, ginger ale.

(2) You fail to state what foodstuffs you desire to test for the presence of glycerine. It is essential that this be given as the methods of procedure to test for this substance is too varied to give a condensed test which would be applicable to all foodstuffs.

(3) The Fuller's Earth test which you mention may be used for the detection of coal tar dyes in foodstuffs other than butter.

MUSTARD GAS

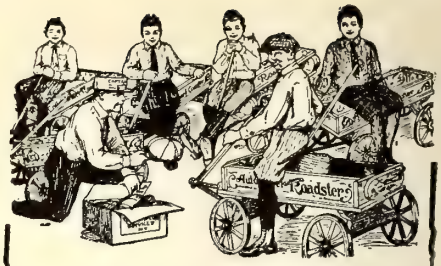
Q. 11. Clayton Doolin, of Decatur, Ill., desires information regarding "Mustard Gas" and how it is obtained.

A. Mustard Gas is obtained by volatilizing Mustard Oil (Allyl Isothiocyanate). This is prepared by distilling macerated black mustard seeds with steam. Mustard seeds contain a glucoside "potassium myronate," which is soluble in water; its solution gradually undergoes fermentation (owing to the presence of an enzyme, "myrosin"), mustard oil, glucose and potassium hydrogen sulfate being produced. Allyl Isothiocyanate may be obtained synthetically by heating Allyl Iodid with Potassium Thiocyanate; it forms a liquid slightly soluble in water, of irritating odor, inciting to tears and producing blisters upon the skin.

ATMOSPHERIC NITROGEN

Q. 12. James G. Peck, Elmira, N. Y., has heard that a mixture of Nitrogen and Oxygen, when subjected to a succession of electric sparks will form *Nitric Oxid*. He wants to know if the same result will be obtained by using a mixture of the two gases as they occur in the air; in other words, by subjecting ordinary air to a powerful electric discharge in an enclosed chamber.

A. The subjecting of Atmospheric Nitrogen to a succession of electric discharges is at the present time successfully operated, for the formation of Nitric acid and Nitrates. Fig. 4 depicts the Birkeland and Eyde furnace of a later type. The individual furnace may be described as a low, wide cylinder resting upon its side and placed between the arms of an enormous horseshoe magnet. The cylinder is made of heavy iron plate and consists of similar halves, which are bolted together. The interior is lined with refractory brick, so arranged that in the middle there is a narrow circular chamber, over 6.5 feet in diameter and about 3.9 inches in width. In this circumscribed space the reaction takes place. The huge terminal poles of the wrought iron electro-magnet, beveled at the extremes, are embedded in the chamotte lining, and are about 9.8 inches apart, their axes corresponding with that of the chamber. The electrodes are of copper, with internal circulation of water, and are .59 inch in diameter. They enter the chamber from opposite sides, and are separated from each other at its center by an interval of about .31496 inch. Air under pressure is admitted to passages between the external shell and the chamotte lining, and enters thru numerous small inlets in the latter, into the reaction chamber. The gaseous current issues, thru openings in the periphery of the chamber, into a conduit which leads to the absorption apparatus. A small



Adventures of the Auto-Wheel Coaster Club

"The Free Caps Arrive"

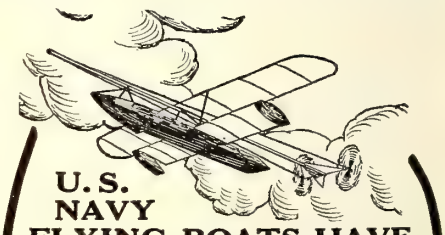
"We formed the Club last week. The caps came today and they're real class—racy looking, like the Auto-Wheel. Jim's is a special one, because he's captain.

"Any kid who has an Auto-Wheel Coaster or an Auto-Wheel Convertible Roadster can join, and get one of these caps.

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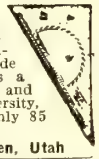
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window of mica in the front of the furnace allows inspection of the operation. A direct current feeds the coils of the big magnet located immediately outside the iron shell, and an alternating current is connected with the electrodes. This current is one of 5,000 volts, 50 cycles to the second. The most striking features of such a furnace are its simplicity and its durability. There are no movable parts. When in uninterrupted operation the electrodes are changed every three or four weeks, while the refractory lining is removed once or twice a year. Repairs are easy to make.

When in operation, a glance thru the window reveals the intensity of the reaction going on at a temperature of over 3,000° C. The result of the process is measured by the percentage of nitric oxid contained in the air issuing from the furnace.

Chemically, the reaction in the furnace between the oxygen and the nitrogen of the air is represented by the equation

$$N_2 + O_2 = 2NO$$

That is, one molecule of oxygen unites with one molecule of nitrogen to form two molecules of nitric oxid, a colorless gas.

The nitric oxid unites readily with free oxygen, at temperatures below 620° C., to form nitrogen peroxid, a brown gas, with the formula NO_2, at temperatures above

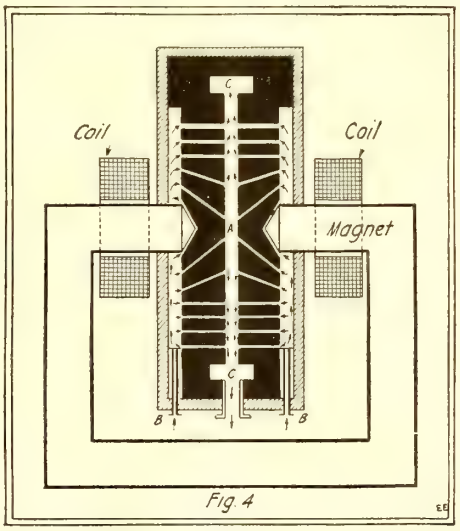


Fig. 4

Sectional View of Birkeland-Eyde Electric Furnace Used in Fixation of Atmospheric Nitrogen.

140° C., and the formula N_2O_4, at low temperatures. The peroxid condenses at 22° C. to a liquid which at —30° C. congeals to a mass of colorless crystals. As the temperature falls from 140° C. the number of molecules of N_2O_4 in a given volume steadily increases, as shown by the increase in density and the change in color from a deep brown to a reddish brown, and then to a yellowish brown. At 60° C. half of the molecules in the gas are of the formula N_2O_4. At 28°C. they constitute 80 per cent.

When the peroxid comes in contact with water it is dissolved and reacts, forming nitric acid and nitrous acid, thus:

$$2NO_2 + H_2O = HNO_3 + HNO_2$$

With an excess of peroxid the nitrous acid is oxidized to nitric acid and nitric oxid is liberated:

$$NO_2 + HNO_2 = NO + HNO_3$$

The net result of these two reactions is that two-thirds of the nitrogen peroxid is transformed into nitric acid, according to the equation:

$$3NO_2 + H_2O = 2HNO_3 + NO$$

The liberated nitric oxid, in the presence of oxygen and water, repeats the cycle of changes given above, so that theoretically it is possible to change to nitric all the nitrous oxid in the current of gas issuing from the nitrate furnace.



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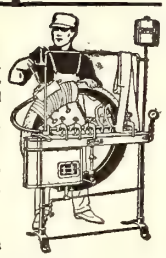
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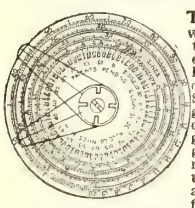


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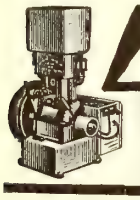
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New 1 K. W. Panel Radio Transmitter

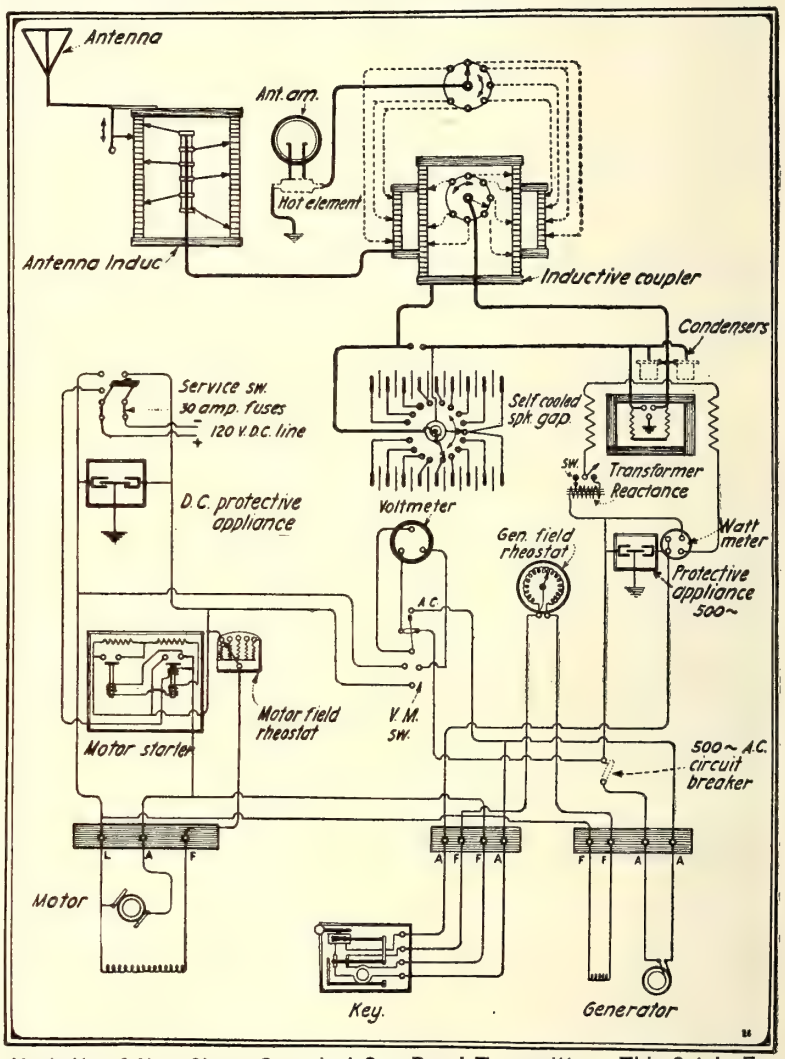
(*Continued from page 230*)

principle an insulated, two-pole circular switch for controlling 16 gap units. It permits the quenched discharge to take place between any number of gaps from 1 to 16, but allows the group of gaps used to be selected at any available part of the series of gaps, and shifted by the simple rotation of two hand wheels at once, as a unit. Each gap unit is air-tight, self-contained, and may be renewed independently of the rest by hand. The circuit is automatically and instantly closed after the break made by removal. Each gap is mounted in a vertical plane, in two horizontal rows of eight gaps each. Each gap unit consists of two brass discs with highly polished silver annular rings which are soldered to the discs. They are separated by fish-paper gaskets, each gap being set to spark at 1000 volts. One of the most important pieces of apparatus on the panel is the coupler and wave changer, consisting of a fixt primary coil and movable secondary coil. They are designed to have corresponding turns as tuning points in each, making simultaneous contacts with two rotating selector arms.

The three openings at the left-hand side of the coupler in Fig. 1 show the wave lengths, the correct wave length being read only at the center or bottom opening.

The thermo ammeter is used in connection with the Weston shunt-block, one end being grounded to the panel frame. It reads from 0 to 15 amperes.

From actual operating tests at full power, this set will radiate from 15 to 18 amperes antenna curent and has a daylight transmitting range of approximately 1000 miles, under normal conditions.—*Photos courtesy Emil J. Simon.*



Hook-Up of New Simon Quenched Gap Panel Transmitter. This Set Is Extensively Used in Naval and Commercial Ship Stations as Well as Land Stations.

AN ELECTRIC SHOOTING GALLERY

(*Continued from page 222*)

rection of rotation, thus hauling the target carrier to the rear of the range. Of course, behind the target there may be arranged the usual plank in which the bullets can imbed themselves. A piece of two-inch plank is very serviceable for the purpose, and where there is the least danger of any one passing behind the partition or behind the targets, the planking should be made about five feet high and three to four feet wide, and this in turn backed up by 1/16 to ⅛ inch steel sheeting.

Where hard-shooting pistols or rifles are used, it sometimes becomes necessary to back up a plank target such as this, backed with a wall of sand about 2 to 3 feet thick. —*Photo courtesy General Electric Co.*

GENERAL SQUIER WINS FRANKLIN MEDAL.

At a meeting of the Franklin Institute held on Wednesday, May 21, Major General George Owen Squier, Ph.D., Chief Signal Officer of the U. S. Army, was presented by the Institute with the Franklin Medal for important work which he has done during the war in the Signal Corps Branch of the Army.

In addition to this a Franklin Medal was also presented to Major General James Douglas McLachlan on behalf of His Britannic Majesty's Government for Sir James Dewar, Jacksonian Professor of Experimental Philosophy, University of Cambridge; Fullerian Professor of Chemistry, Royal Institution, London, for important work which he had done for the British Government in the World War.

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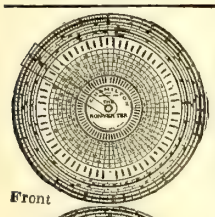
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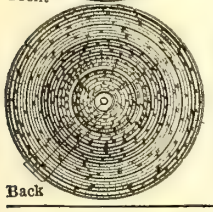
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Front



Back

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(*Continued from page 212*)

speaker. Each afternoon the Navy Department at Washington sends by wireless the correct time to ships at sea. This message was picked up on several occasions and transmitted to the crowd at the "Way."

The loud speaker equipment employed at the "Way" was the same as that used aboard ships of the U. S. Navy during the war to make orders heard in every part of the ship.

The speakers' stand at "Victory Way" was in the center of the "Way." On this stand there was a small and extremely sensitive transmitter—so sensitive that it was not necessary for the orator to talk into it. It comprised a battery of three microphones. He merely talked in front of it, and the sensitive transmitter carried the electric current, whose variations represented his enunciations to the control room at the rear of the speakers' stand. There the amplification apparatus boosted the sound waves 7,500,000,000 times and shot it out to the *loud speaker* receivers, *one hundred and twelve* of which were strung above the heads of the audience, twenty feet apart, up and down the whole length of the "Way." The amplifiers comprised a large number of Audions or so-called *talking bottles.* These receivers were very sensitive telephone receivers of special design, with large megaphones or horns, to make the speech audible to those standing below. The area covered by the loud talkers was about 60,000 square feet.

The transmission of the speech from Washington, however, involved much more. The speakers at the National Capitol used a special telephone set and, of course, they also had a *loud speaker* receiver, so that they might hear the applause from New York.

In the case of the message from the Dirigible C-4, the transmitter on the speakers' platform was connected, not only with the loud speaker receiver, but with wireless as well, which transmitted waves to the radiophone aboard the dirigible.

The antennae for the radiophone communication were stretched between the Hotel Avignon and the Railroad Y. M. C. A. Building, which are on opposite sides of "Victory Way," with a wireless apparatus in the latter building, from which the messages were wired to the control room and the loud speaker circuits.

The control room was elaborate and contained a mass of wires and switches and special electrical devices, developed by engineers of the Bell Telephone System. This room contained the amplification apparatus, means for generating the electric current use, and switching devices used for connecting with the long distance wires to Washington and the wireless.

Electric locomotives past beneath the street in the tunnel of the New York Central Railroad. To avoid electrical disturbances from these, the control room was completely covered with sheet iron, which was grounded, so that the control room was isolated electrically. Also the amplifier bulb cabinets were suspended from the ceiling on rubber cords.

No loud speaker receivers were placed within eighty feet of the speaker on the platform, because in that case the speaker's voice, as it came from his throat, and as it poured down thru the loud speaker receivers, would play a race in which the sounds from the receivers would reach the auditor first, because of the fact that electrical waves travel at a far greater rate of speed than mere sound waves. If loud speaker receivers were near the orator, the result would be a bedlam of sound, as the words overlapt one another.

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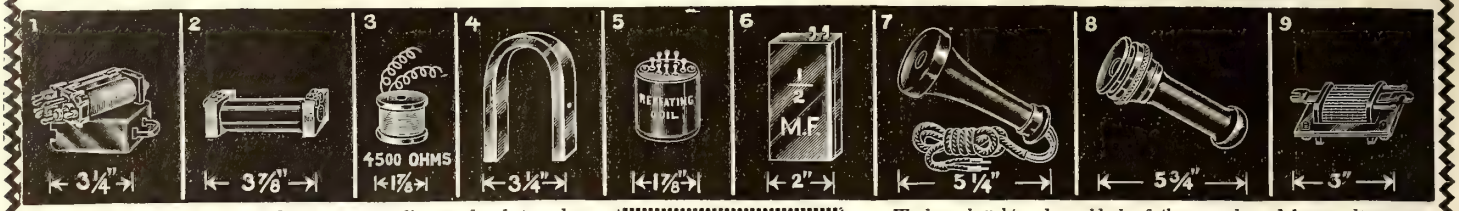
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NO. 2 STANDARD TELEPHONE Induction Coil, primary 1 ohm, secondary 55 ohms. Used wherever you need a good induction coil. Has primary and secondary and iron wire core; fibre heads.
No. 2 Induction Coil as described—shipping weight, 2 lbs. Price..... **$0.50**

NO. 3 STANDARD RESISTANCE wound with German silver wire—4,500 ohms, can be used as a choke or plain resistance, and has many other uses that readily suggest themselves to the experimenter.
No. 3 Standard Resistance as described—shipping weight, 4 oz. Price..... **$0.40**

NO. 4 HORSESHOE MAGNET, size 3¼ inches wide x 5 inches high. Will lift about 1 lb. Quality such as used on magnetos, which means the best.
No. 4 Horseshoe Magnet — shipping weight, 2 lbs. Price..... **$0.30**

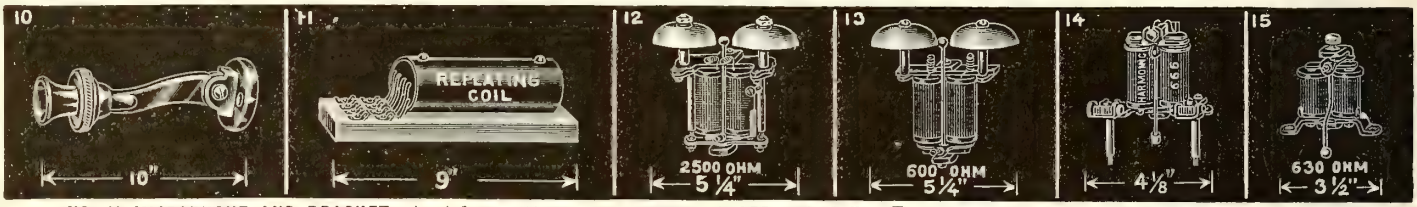
NO. 5 REPEATING COIL (Transformer). This is a standard small repeating coil and is used by all telephone companies. It has 4 different windings and eight contacts. Entirely enclosed in iron. The resistance being respectively 72 and 120 ohms, and 90 and 100 ohms. Diagram is furnished. Can be used for wireless, for boosting signals, etc.
No. 5 Repeating Coil—shipping weight, 2 lbs. Price..... **$0.50**

NO. 6 ½ M.F. CONDENSER. This is a standard telephone condenser and has ½ microfarads. Condenser comes in neat metal casing. This condenser is used in connection with spark coils to absorb the vibrator spark. Invaluable for test buzzers to absorb spark and make the sound of buzzer more steady. Is also used by every experimenter in connection with wireless where a fixed capacity is needed. Several of these condensers should be in every experimenter's laboratory.
No. 6 Condenser, ½ M.F.—shipping weight, 1 lb. Price..... **$0.50**

NO. 7 DOUBLE POLE BELL TELEPHONE RECEIVER—hard rubber casing with 4 ft. cord and tips. Standard 75 ohms—very powerful magnets. This receiver can be used in connection with any ordinary telephone work, and you will even find it sensitive enough for short distance wireless work.
No. 7 Bell Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.80**

NO. 8 STANDARD TELEPHONE RECEIVER with Metal Head. This receiver is made by Stromberg Carlson Co., with genuine hard rubber handle and ear cap. A very good fool-proof as well as sensitive receiver that cannot be put out of order if you try. Used for the same purpose as No. 7 Telephone Receiver.
No. 8 Standard Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.75**

No. 9 IMPEDANCE COIL (Close Core Transformer). This is a very fine little transformer and is used extensively in connection with telephone work. It is in reality an A.C. transformer for which you would pay $5.00 if you had it made to order. The primary has 0.15 ohms, secondary 2000 ohms. It can be used for a variety of purposes that will suggest themselves to every experimenter. Can be used successfully to boost wireless signals. Also in connection with audions, etc. An A-1 instrument. Size 3 x 3 inches.
No. 9 Impedance Coil—shipping weight, 2 lbs. Price..... **$0.65**



NO. 10 MICROPHONE AND BRACKET. An A-1 sensitive microphone of the carbon grain type. Has hard rubber mouthpiece and enamel steel bracket, the instrument being 10 inches long. This microphone, in connection with our No. 7 or 8 Receiver, will constitute a complete telephone outfit, good to speak 50 miles or more, at a remarkably low price.
No. 10 Microphone and Bracket—shipping weight, 5 lbs. Price..... **$1.00**

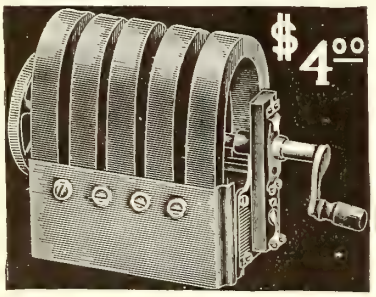
NO. 11 REPEATING COIL (Transformer). A standard repeating coil used for telephonic work. The coil windings are encased in an iron tube 2¼ inches in diameter. There are eight terminals for the four windings to connect to and the instrument is invaluable in connection with radio work to boost up signals, audion work, etc. Many interesting uses will be found for this coil. Resistances are: 100, 120, 145, 175 ohms.
No. 11 Repeating Coil—shipping weight, 8 lbs. Price..... **$2.00**

NO. 12 POLARIZED RINGER with Bells. The resistance of the two coils is 1250 ohms each. The armature is perfectly adjustable. Bell will work on any magneto. We also furnish blue print with ringer showing how *a first class polarized relay* can be made by anyone using only a few pieces of metal and screws.
No. 12 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.50**

NO. 13 POLARIZED RINGER with Bells. This is the same kind of ringer as the No. 12, except that it is not adjustable and that the resistance is less. First class in all respects. Blue print furnished with this to *make polarized relay* same as with No. 12. Solenoids on this ringer are worth more than the price we ask for the entire ringer, and do not forget a powerful magnet that goes with it.
No. 13 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.00**

NO. 14 HARMONIC RINGER. This ringer is also polarized and has a powerful magnet. It works on 66.6 cycles and any magneto will operate it if run at a certain speed. A very finely built instrument. Resistance of each coil being 200 ohms. Can be converted into a polarized relay by substituting a very fine leaf spring instead of the heavy one furnished. A most interesting instrument with which to experiment.
No. 14 Harmonic Ringer — shipping weight, 4 lbs. Price..... **$1.60**

NO. 15 RINGER without Bells—630 ohms. This also is a polarized ringer and has an adjustable armature. The adjustment is done by means of the top screw. A beautiful little instrument. With this instrument, too, we furnish a blue print showing how a *polarized relay can be built.* You should have several of these beautiful little instruments. They are worth their weight in gold; the powerful magnet alone being worth more than the price we ask for the entire instrument.
No. 15 Ringer—shipping weight, 2 lbs. Price..... **$0.80**



No. 55 5-bar magneto, 110 Volt A. C. Generator

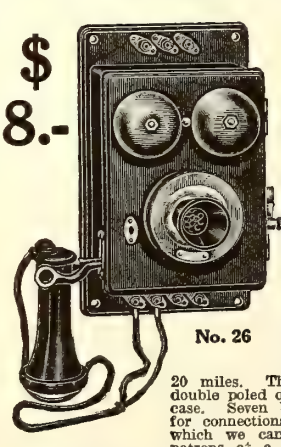
This is one of the most powerful magnetos ever built, when manufacturers could afford to put good stuff into them; equipt with transmission, make and break, etc. Transmission wheels are all brass, crank handle furnished. This magneto, as well as the other ones listed below, will light a 110-volt lamp merely by turning the crank handle slowly. While this magneto gives alternating current only, it can be rewound so it will light up a number of four, six and 10-volt lamps, all depending upon the thickness of the wire you wind on the armature. As we furnish these magnetos, they will give a powerful alternating current and you will not be able to stand the current when grasping hold of the terminals. This makes an ideal shocking machine. All our generators can be transformed into a direct current machine by equipping it with a home-made commutator. Machines are **A-1 in all respects and every experimenter should have one of them in his shop.** Many other experiments which can be performed with this machine will readily suggest themselves to any experimenter. The magnets furnished with these generators are very powerful, each one being able to lift one pound easily.

NO. 55 5-BAR MAGNETO GENERATOR as described—shipping weight, 25 lbs. Price..... **$4.00**

NO. 33 3-BAR GENERATOR, same as described above except that it has only 3 bars, and is somewhat smaller.
No. 33 3-bar Generator—shipping weight, 10 lbs. Price..... **$2.00**

NO. 44 4-BAR GENERATOR, same as No. 55 except that it has 4 bars, and is somewhat smaller.
No. 44 4-bar Generator—shipping weight, 15 lbs. Price..... **$3.00**

NO. 66 6-BAR GENERATOR, same as No. 55 except that it has one more magnet and the armature is somewhat larger and more powerful. This is the biggest type made and is extremely powerful.
No. 66 6-bar Generator—shipping weight, 30 lbs. Price..... **$4.50**



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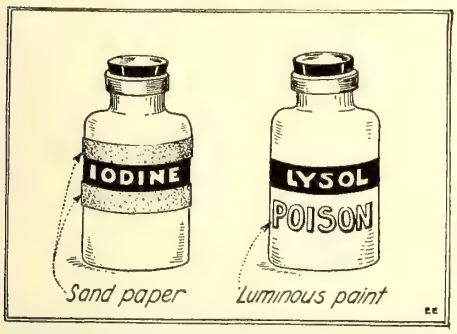


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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.



Safeguard Against Taking Poison in the Dark Unknowingly, Comprising Luminous Letters and Sandpaper Ring Around the Bottle.

Safeguard for Poison Bottles.

(327) Floyd Hoskins, Pine Bluff, Ark., writes: "Many people have killed themselves with poisons taken in a dark room by mistaking them for medicine bottles. I have an idea to safeguard the bottles by putting sand paper around them as per illustration. I also think that by having the word 'Poison' placed upon the bottle by means of illuminated paint, this would be an additional safeguard. Are these ideas patentable?"

A. The sand paper idea is quite an old one which has been described in the technical press many times. Sand paper has also been placed on stoppers as a safeguard. The idea of using illuminated paint, however, is new as far as we are aware, but we doubt very much if a patent can be obtained upon it. Applying luminous paint to various articles does not make a patentable combination so far as we know. It would be a good idea to get in touch with a patent attorney.

Electric Clock.

(328) Ernest Bostwick, Louisa, Ky., says: "Please advise me whether or not you think I could obtain a patent on a clock driven by electricity register hours, days, months and years."

A. Without having the details it is impossible to state if a patent could be obtained. There are at the present time a good many clocks in existence which indicate seconds, minutes, hours, months as well as the year. Unless you have a fundamentally new device, we doubt very much if a patent can be obtained.

Aerial Torpedo.

(329) E. F. Prucha, Howells, Nebr., wants to know if his idea on an aërial torpedo and aërial bomber and navigator which he has submitted with many illustrations and drawings is patentable.

A. After carefully looking over the drawings, we have come to the conclusion that there is nothing new involved in this invention, nor do we think it is practical. There are several features shown which may be patentable, but we doubt the practicability of the invention.

Demountable Rim Tool.

(330) S. W. Snelling, Newark, Ohio, has to say the following: "I have a little device that I think would be fine for automobilists. With this tool, you can take off and put on the demountable rim more quickly than it could be done today."

A. This seems to be a very good idea, and there also seems to be a good market for a tool of this kind. We think a patent can be obtained.

IN OUR NEXT ISSUE:

"How to Develop Your Inventive Ability" By Jay G. Hobson. Author of "How to Finance and Manufacture a Patent," publisht in our June, 1919, issue.

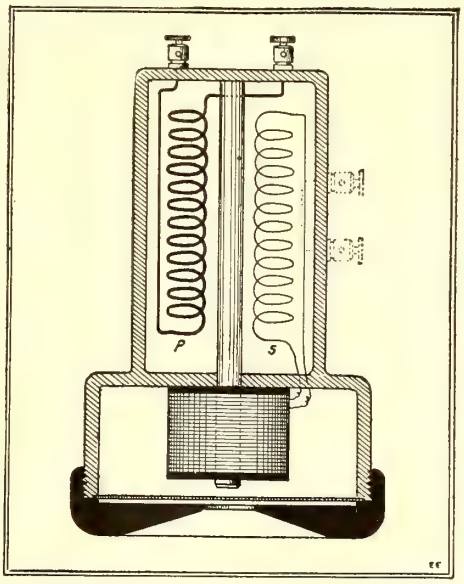
Nicotine Absorber.

(331) Philip Dubilier, New York, N. Y. submits sketch of a new device for cigarette holders which absorbs the nicotine of cigarettes. The idea in main is to have the holder in two parts to be screwed together. Between the two sections cotton can be placed which absorbs the nicotine.

A. We see nothing fundamentally new in this idea, as cotton or felt absorbers for nicotine have been made use of for many years. You might, however, obtain a constructional patent. Devices of this kind are not as a rule popular with smokers as they are very messy to handle, and the cotton gets clogged up too quickly.

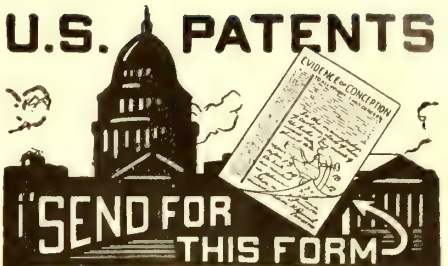
Receiver-Induction Coil.

(332) Seth Card, Winthrop, Mass., says: "My idea is to have an induction coil in the handle



Telephone Induction Coil Inside Receiver

U.S. PATENTS



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of the telephone receiver instead of having the magnet run back into the handle as it usually does. In other words, I would have a combination telephone receiver as well as induction coil. Is the idea patentable and practicable?"

A. We take pleasure in illustrating the device on account of its originality. This certainly is a clever as well as capital idea. There is no doubt that this device will work, altho we think it would be somewhat less efficient than the regular combination by having the instruments separate.

Patents and Citizenship.

(333) Samuel Guyer, New York, N. Y., writes: "I have perfected an invention, but as I am not a citizen I dislike to ask for a patent. Do you think it is safe for me to apply for a patent?"

A. You need not be a citizen of the United States to apply for a patent. Anyone can apply and take out patents, but you will have to tell your patent attorney of what country you are a subject. This must be stated in the patent application. Otherwise, you will have no trouble in obtaining a patent, providing, of course, the idea is patentable.

Astronomical Facts for All

By Isabel M. Lewis

(*Continued from page 217*)

proximate to the total number of stars in our system. They have assumed a median magnitude of twenty-two or twenty-four, far below the reach of existing telescopes, and considering that there are as many stars below as there are above this median magnitude, they find the total number of stars to be between seven hundred million and eighteen hundred million.

2. *What proof is there that no atmosphere exists on the moon?*

There are no atmospheric phenomena visible on the moon, no evidence of storms, clouds or erosions of the rocky surface, no twilight effects, no haziness of the cusps, no signs whatever of the refraction of light by an atmosphere. When a star passes behind the moon, *or is occulted,* it disappears and reappears with startling suddenness. There is no gradual fading away of the star or change in its color such as would be noticed if its light had to travel thru atmospheric strata increasing in density toward the moon's surface. All shadows on the moon are sharp and black. There is no blurring or haziness of the outlines.

At time of solar eclipse there is no distortion of the sun's limb as the edge of the moon passes over it such as would arise if the sun's light past thru a lunar atmosphere and was refracted thereby.

Also, according to the kinetic theory of gases, the ability of a body to hold an atmosphere depends on its mass and density. Molecules of the gases are continually flying off in all directions. If their velocity exceeds a certain critical amount they may escape altogether from the gravitational control of the body in question.

For the moon this "velocity of escape" as it is called, is less than two miles per second. As the molecular velocity of all the gases of the earth's atmosphere, oxygen, nitrogen, etc., exceed this amount, it is evident that the moon could not hold these gases by its gravitational attraction.

3. *What can one expect to see with a three-inch telescope?*

The rings and three or four satellites of Saturn, the belts and four satellites of Jupiter, the snow caps and most prominent markings of Mars and, according to Prof. W. H. Pickering, a number of the canals of Mars if the condition of the atmosphere, or "seeing," is particularly good; also the craters and other markings on the moon in great detail, the sun-spots, faculae and, with spectroscopic attachment, prominences on the sun, the Great Nebula in Orion and many beautiful double and multiple stars.

If the telescope is equatorially mounted and provided with graduated circles for finding and identifying stars and nebulae, a most wonderful and valuable storehouse of knowledge is opened.

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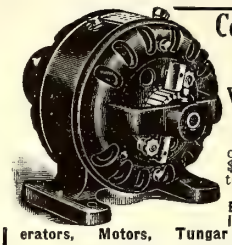
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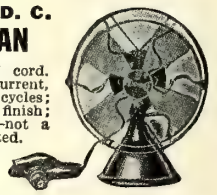
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Electrical Oscillators

By Nikola Tesla

(Continued from page 229)

Broadly, the instruments can be divided into two classes: one in which the circuit controller comprises solid contacts, and the other in which the make and break is effected by mercury. Figures 1 to 8, inclusive, belong to the first, and the remaining ones to the second class. The former are capable of an appreciably higher efficiency on account of the fact that the losses involved in the make and break are reduced to the minimum and the resistance component of the damping factor is very small. The latter are preferable for purposes requiring larger output and a great number of breaks per second. The operation of the motor and circuit controller of course consumes a certain amount of energy which, however, is the less significant the larger the capacity of the machine.

In Fig. 1 is shown one of the earliest forms of oscillator constructed for experimental purposes. The condenser is contained in a square box of mahogany upon which is mounted the self-induction or charging coil wound, as will be noted, in two sections connected in multiple or series according to whether the tension of the supply circuit is 110 or 220 volts. From the box protrude four brass columns carrying a plate with the spring contacts and adjusting screws as well as two massive terminals for the reception of the primary of the transformer. Two of the columns serve as condenser connections while the other pair is employed to join the binding posts of the switch in front to the self-inductance and condenser. The primary coil consists of a few turns of copper ribbon to the ends of which are soldered short rods fitting into the terminals referred to. The secondary is made in two parts, wound in a manner to reduce as much as possible the distributed capacity and at the same time enable the coil to withstand a very high pressure between its terminals at the center, which are connected to binding posts on two rubber columns projecting from the primary. The circuit connections may be slightly varied but ordinarily they are as diagrammatically illustrated in the ELECTRICAL EXPERIMENTER for May on page 89, relating to my oscillation transformer photograph of which appeared on page 16 of the same number. The operation is as follows: When the switch is thrown on, the current from the supply circuit rushes thru the self-induction coil, magnetizing the iron core within and separating the contacts of the controller. The high tension induced current then charges the condenser and upon closure of the contacts the accumulated energy is released thru the primary, giving rise to a long series of oscillations which excite the tuned secondary circuit.

This device has proved highly serviceable in carrying on laboratory experiments of all kinds. For instance, in studying phenomena of impedance, the transformer was removed and a bent copper bar inserted in the terminals. The latter was often replaced by a large circular loop to exhibit inductive effects at a distance or to excite resonant circuits used in various investigations and measurements. A transformer suitable for any desired performance could be readily improvised and attached to the terminals and in this way much time and labor was saved. Contrary to what might be naturally expected, little trouble was experienced with the contacts, altho the currents thru them were heavy, namely, proper conditions of resonance existing, the great flow occurs only when the circuit is closed and no destructive arcs can develop. Origi-

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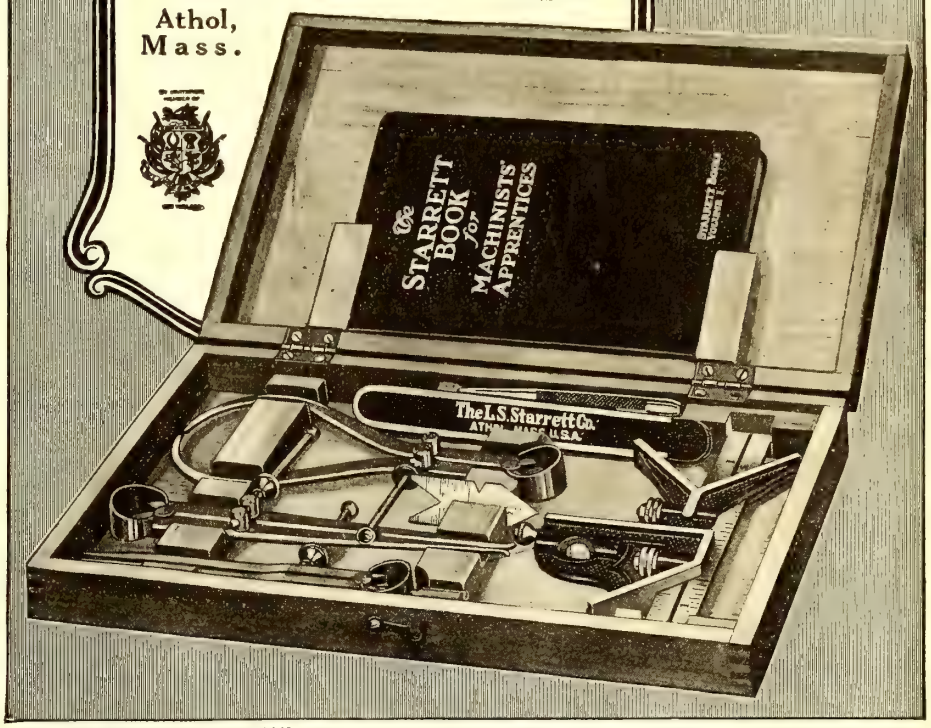
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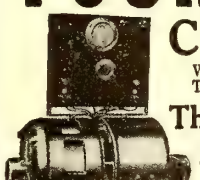


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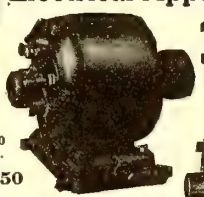
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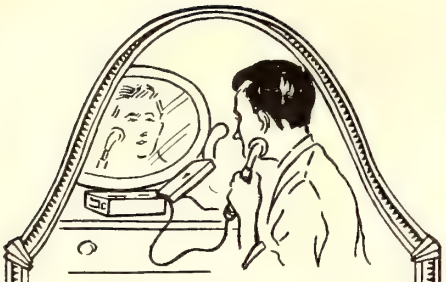
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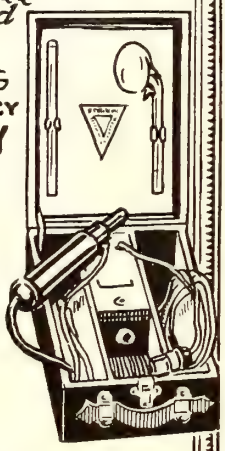
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nally I employed platinum and iridium tips but later replaced them by some of meteorite and finally of tungsten. The last have given the best satisfaction, permitting working for hours and days without interruption.

Fig. 2 illustrates a small oscillator designed for certain specific uses. The underlying idea was to attain great activities during minute intervals of time each succeeded by a comparatively long period of inaction. With this object a large self-induction and a quick-acting break were employed owing to which arrangement the condenser was charged to a very high potential. Sudden secondary currents and sparks of great volume were thus obtained, eminently suitable for welding thin wires, flashing lamp filaments, igniting explosive mixtures and kindred applications. The instrument was also adapted for battery use and in this form was a very effective igniter for gas engines on which a patent bearing number 609,250 was granted to me August 16, 1898.

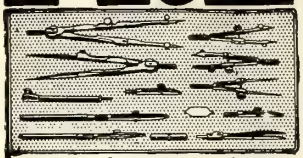
Fig. 3 represents a large oscillator of the first class intended for wireless experiments, production of Röntgen rays and scientific research in general. It comprises a box containing two condensers of the same capacity on which are supported the charging coil and transformer. The automatic circuit controller, hand switch and connecting posts are mounted on the front plate of the inductance spool as is also one of the contact springs. The condenser box is equipt with three terminals, the two external ones serving merely for connection while the middle one carries a contact bar with a screw for regulating the interval during which the circuit is closed. The vibrating spring itself, the sole function of which is to cause periodic interruptions, can be adjusted in its strength as well as distance from the iron core in the center of the charging coil by four screws visible on the top plate so that any desired conditions of mechanical control might be secured. The primary coil of the transformer is of copper sheet and taps are made at suitable points for the purpose of varying, at will, the number of turns. As in Fig. 1 the inductance coil is wound in two sections to adapt the instrument both to 110 and 220 volt circuits and several secondaries were provided to suit the various wave lengths of the primary. The output was approximately 500 watt with damped waves of about 50,000 cycles per second. For short periods of time undamped oscillations were produced in screwing the vibrating spring tight against the iron core and separating the contacts by the adjusting screw *which also performed the function of a key.* With this oscillator I made a number of important observations and it was one of the machines exhibited at a lecture before the New York Academy of Sciences in 1897.

Fig. 4 is a photograph of a type of transformer in every respect similar to the one illustrated in the May, 1919, issue of the ELECTRICAL EXPERIMENTER to which reference has already been made. It contains the identical essential parts, disposed in like manner, but was specially designed for use on supply circuits of higher tension, from 220 to 500 volts or more. The usual adjustments are made in setting the contact spring and shifting the iron core within the inductance coil up and down by means of two screws. In order to prevent injury thru a short-circuit, fuses are inserted in the lines. The instrument was photographed in action, generating undamped oscillations from a 220 volt lighting circuit.

Fig. 5 shows a later form of transformer principally intended to replace Rhumkorf coils. In this instance a primary is employed, having a much greater number of turns and the secondary is closely linked with the same. The currents developed in the latter, having a tension of from 10,000 to 30,000 volts, are used to charge con-

(*Continued on page 276*)

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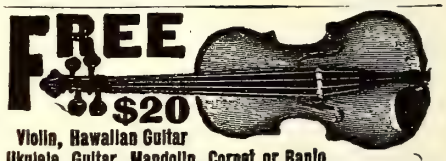
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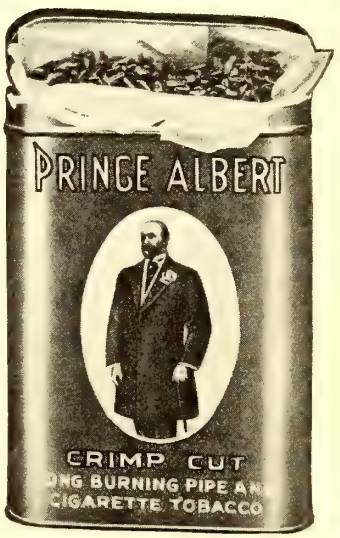
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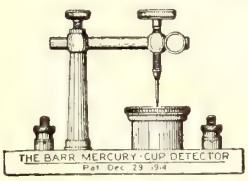
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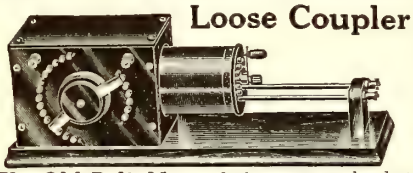
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"Hello Europe" --Via Radio

By Charles M. Ripley

(Continued from page 210)

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From the mechanical and electrical standpoint—as well as from the laymen's viewpoint—the large high frequency alternator is the big outstanding feature of the station.

An alternator is a dynamo that makes alternating current electricity. A "high frequency alternator" is a dynamo generating an electric current that alternates, or reverses itself very frequently. Alternating current for light and power has a "frequency" of 25 to 60 cycles per second, but the alternating current used in this wireless station has a frequency of 22,000 cycles per second.

A high or rapid frequency is used for wireless work, because electromagnetic waves are thrown off from wires in which such electricity flows.

That was sufficient for us to take new interest in the big machine that was throbbing with such weird energy. Evidently, this was the last word in wireless power; for was not this the mightiest station on our hemisphere? Moreover, high frequency electricity is the *sine qua non* for wireless, and here working under our very noses was the first big and really successful high frequency alternator ever built in America. In this room, then, is where a new trail was blazed toward the supernatural; here Jules Verne himself would stand agape, and, perforce, confess that his fiction has been outdone.

"The present state of the Art!" With what force that expression strikes one today. What romantic stories will some day be written of the struggles of American wireless engineers to outdo the Germans. Energy from this monster alternator was a powerful factor in bringing peace to a frantic world.

And it is a wonder of mechanical simplicity as well as a new electrical departure. *The only thing that moves is a solid steel wheel without wires, and containing no copper whatsoever. This "rotor," as it is*

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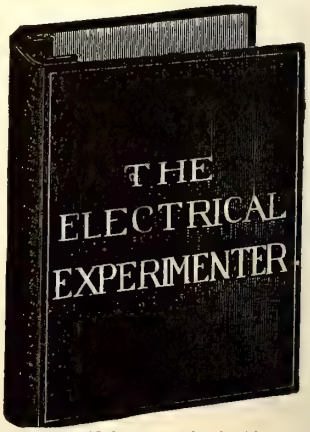
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called, weighs nearly 3 tons, with its shaft, and rotates at 2,100 revolutions per minute. This is not considered a high speed in the electrical profession, and yet if this rotating element were to roll along upon the ground at its present speed it would run from Schenectady, N. Y., where it was built, to New Brunswick, N. J., *in less than thirty minutes!*

Wonderful Regulation of 200 K.W. Alternator.

The speed of this rotating element is regulated to within 1/10 of one per cent., regardless of the amount of electrical load thrown on and off the circuit in the sending of messages.

The alternator is rated at 200 kilowatts, and weighs about 12 tons without its base. The floor space occupied by the machine, including its base, and the driving motor, is only 8 ft. wide by 20 ft. long. This 160 sq. ft. is less than 2 per cent. of the total floor area in the radio station, which is 10,800 sq. ft.

The advantages of the high frequency alternator were explained by its designer, Mr. E. F. W. Alexanderson, consulting engineer, inventor and radio specialist of the General Electric Company:—

1. As heard by the operators at receiving stations, the tone of New Brunswick's signals is a clear "whistle" of a flute-like quality.

2. The continuous wave it sends out is clear cut, *with no "harmonics."* "Harmonics" have various frequencies and different wave lengths, and interfere with other stations. Harmonics are useless wave lengths which "fringe" the message. There is no fringe or "penumbra" to the waves emanating from the new H. F. Generator.

3. It is steady in its operation, and has run for WEEKS without interruptions to service. In February it was operating 97¾ per cent. of the time.

4. It is cool, clean and quiet in operation as a motor.

5. It is of massive construction, and resembles other electrical machines in a general way—not a freakish machine.

6. It has a low power consumption. The record of one month's work, 94 per cent. time in operation, shows a power consumption averaging less than 200 K.W. drawn from the power system, including all auxiliary power demand for station and living quarters. This renders the most continuous and reliable transatlantic radio transmission. On a "freak test" a message sent by *only ½ K.W. in the antenna, reported received at a Pacific coast station 2,400 miles distant.*

The Magnetic Amplifier.

When a soldier pulls the trigger of his rifle and releases the energy stored in the powder, the motion of his finger is amplified; i.e., a small cause produces large effects. In the electrical world for many years we have had telegraphic "relays." These are devices which permit a small flow of electricity from one source to set in motion a large flow of electricity from another source. Here again a small cause produces a large effect; so relays are practically amplifiers.

Now in the case of both the trigger and the relay we have mechanical motion—i.e., moving parts. These moving parts introduce mechanical and electrical difficulties when it comes to handling large currents of electricity. These moving parts thus constitute the limitations of electrical amplifiers which depend upon mechanical motions. They are "the neck in the bottle."

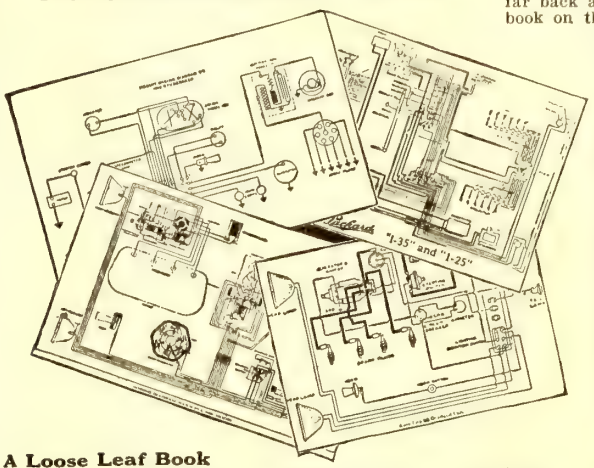
But the magnetic amplifier has no moving parts, hence it has correspondingly less limitations. Its principle depends upon the invisible and *motionless action* of magnetism within the iron.

To return to the "trigger analogy." When

(*Continued on page 268*)

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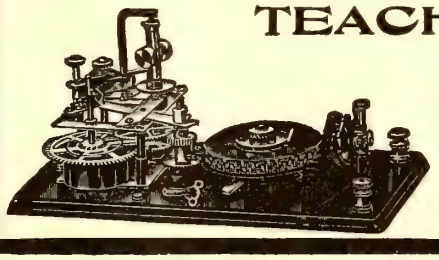
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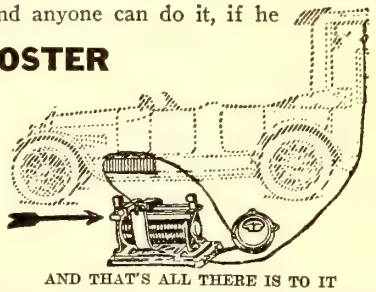
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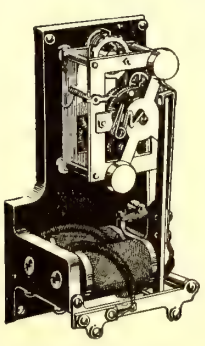
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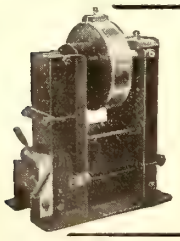
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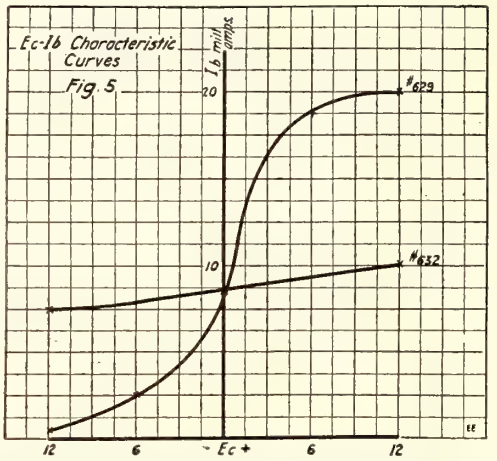
DODGE' INSTITUTE, 22nd St., Valparaiso, Ind.

The Design, Pumping and Testing of Audion Tubes

By C. Murray

(Continued from page 235)

The writer plotted curves on two Fleming valves; one with a cylinder ⅜ inch in diameter and the other ½ inch diameter. The results are shown at Fig. 4. During the test Eb was kept at 200 volts and Ia was varied until a saturation point was found. The grid, as aforementioned, is the principal element, and it is upon this that the main action of the Audion tube is based. The size or surface area depends entirely on what it is to be used for.



Graphs Showing Actual Tests and Space Currents for Two Different Audions. Grid in Tube No. 629 Had Twice as Many Turns as Grid in Tube No. 632.

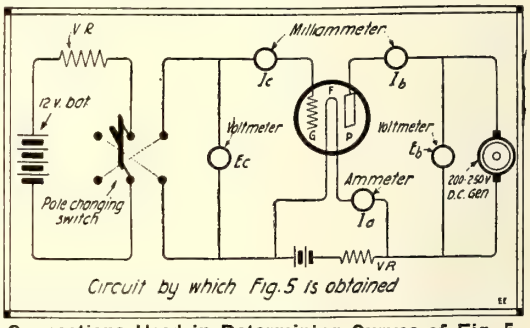
For instance, if we desire to use a tube for an *amplifier*, then we design it so that a small charge on the grid will produce a large effect on the plate current. If we wish to use it as an *oscillator* or power tube, it is not necessary or essential to have a large grid, but it must be constructed much heavier to prevent sagging during the pumping and while it is in operation as an oscillator.

The writer constructed two tubes with the grids as follows: The grid in tube No. 629 was made of .020-inch nickel wire, wound in the form of a spiral, ¼ inch in diameter, making a total of 26 turns. The grid in No. 632 tube was also the same diameter, but it only had 14 turns. The same plate spacing in both tubes was used. The results are used in graph Fig. 5. We can readily see that both tubes will give us 8 milliamperes of space current, when the grid is free, and by giving the grids a small negative charge one will drop almost to zero space current while the other only dropt to 7.5 milliamperes. We also find when we change the charge to positive that it will increase the Ib on No. 629 a great deal more than on the tube with the small grid.

By referring to the drawing of the vacuum pump, Fig. 1, the reader will see that it is constructed entirely of glass, with the exception of the mechanical pump or "backer." The *backing pump* used by the writer is of the rotary type and immersed in oil to prevent any leakage of air. With it a vacuum of from 8 to 15 mm. of mercury is readily obtained.

The *Aspirator* plays the principal part of the system and is indicated by 3, 4, 5, 6, and it is with this apparatus that we obtain the highest vacuum known to-day, which is very necessary in practically all vacuum tube work.

The mercury in the aspirator is used to absorb the gases which are generated by the bombarding or heating of the metal in the tube being pumped. The mercury must be heated to the boiling point before it starts its work of absorption. It has been estimated that a vacuum of 1 millionth of a mm. of mercury is obtained by the use of the aspirator.

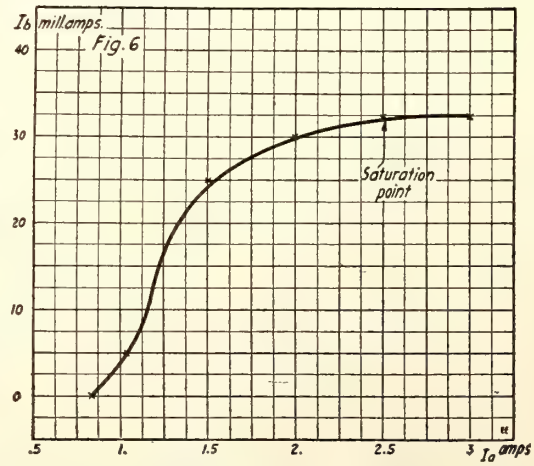


Connections Used in Determining Curves of Fig. 5. For the Rest of the Curves the Grid Circuit is Omitted.

Liquid air is also used in the pumping process, to prevent or freeze any mercury vapor which has not been condensed on the walls of the aspirator from passing into the lamp while it is being pumped; for if we should allow a very small amount of the mercury vapor to get into the tube it would cause it to show a blue haze, thus greatly reducing its sensitiveness and it would heat up considerably.

We will here describe the pumping of tube No. 632 in detail: First the tube was sealed on the pump and an electric oven was placed around the tube. The mechanical pump was started, the current turned on in the oven and also the aspirator heater—the liquid air was placed in a "Thermos" bottle and the bottle was then placed outside the air trap. When the heat in the oven reached 150° C. the filament was connected up to a 15-volt transformer thru a variable resistance and glowed at 9 volts. Next the grid lead was connected to a 250-volt D. C. generator thru a variable resistance; the current was then turned on—the tube immediately filled with a bright blue haze—in a few minutes the grid began to get

(Continued on page 266)



By Using Too Small a Plate or Too Short a Filament in the Audion We Will be Limited in the Amount of Plate Current We Can Pass, as by Referring to Fig. 6 We Will Find a Point of Saturation; That is, if We Raise the Filament Temperature Still Higher the Value Ib Will Remain at a Certain Point.

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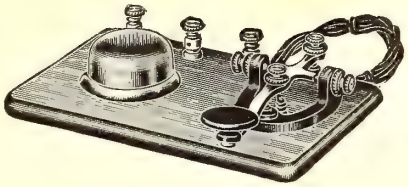
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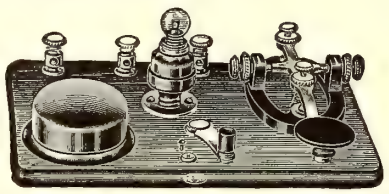
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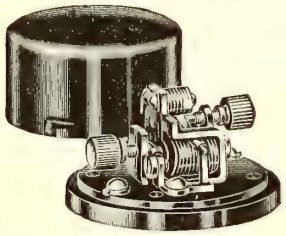
This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.



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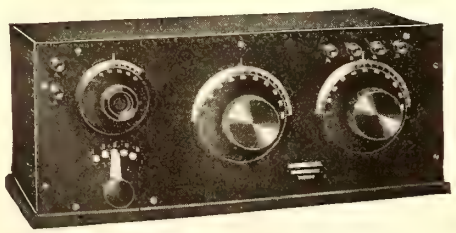
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The Design, Pumping and Testing of Audion Tubes

By C. Murray

(*Continued from page* 264)

red hot, and soon the haze could only be seen close to the grid. Then I changed over on the plate lead and worked it a while the same way as the grid, until it became red hot. Then I went back to the grid and finished it up. I shifted to the plate again, which had a slight haze on it, so I left it on till it was "clear." Then I connected the plate and grid together and heated them with the 250-volt generator for five minutes.

I turned off the oven and removed it and allowed the tube to cool. After it was cold I glowed the filament at 7.5 volts and connected the D. C. generator to the plate lead—it became red hot and was clear, so I sealed it off the pump with a blow torch. This completes the pumping of the Audion or three-element detector.

The pumping of the Audion in this way is very necessary, especially one on which we are going to use a "B" battery of 100 volts or more—for instance, the power tube, which requires at least 200 volts before it will give much of an output.

Next we have the glowing or aging of the filament, which stabilizes the action of the filament. It allows the coating of the platinum filament to firmly fix itself to the platinum and also burns away any of the remaining gases which might be in the tube. I trust the readers can understand how their vacuum tubes are constructed after reading the foregoing.

Operate Your Audions on A. C.

By Elliott A. White

(*Continued from page* 234)

for alternating current operation is the rheostat or potentiometer R2, and the large capacity condenser C4. The rheostat has a resistance of 8—10 ohms, or other value so long as it is not too high, nor so low as to draw too much current; connections are made to the two ends, with a movable contact covering all points. The condenser C4 is made of 6 or 8 discarded telephone condensers (1 or 2 mfds. each, thoroly tested for short circuits and leaks) with a total capacity of 8—12 mfds., the higher the better, around that figure. R3 is the usual filament rheostat if one is necessary, altho it is best to design any set with as few and as "fool proof" adjustments as possible. A fixt condenser of .015 mfd., or less may be bridged across the 'phones, tho it is not indispensable. A rheostat R4 may be added for the rectifier filaments, and numerous other modifications and improvements will suggest themselves. It is theoretically possible to have only one rectifier tube, but it might be noisy, and I should want to try it before recommending it.

The operation is simplicity itself. The stept-down A. C. heats the filaments in the usual way and has been employed for this purpose before. Cheap bell-ringing transformers can be used here just as well as winding a special transformer. The *new stunt,* however, lies in using the *rectified A. C.* for the "plate." This method has already been used for *transmitter* oscillators where the noise was not prohibitive, and even then a high frequency of 2,000 was provided. But it works very well on receiving tubes, even on the usual 60-cycle house-lighting circuits, if proper precautions are taken. (It is only a natural step from the receiving set here described to an

undamped wave radiotelegraph or radiotelephone *transmitter,* operated from the handiest lamp receptacle.) It will be seen that the rectifier tubes will pass current in only one direction, that is from plate to filament, so that during each half-cycle the current from one-half of the winding T3 T4, charges the condenser C4; the side of the condenser towards the high voltage winding being always negative, and that towards the low voltage winding always positive, as indicated in the figure. It is on account of the polarity of the condenser, that separate windings T2 and T5 T6 must be provided for the filaments of detector and rectifiers. The charge accumulates on the condenser C4 as available D. C. (voltage equal to half that of winding T3 T4) and will make a hot snappy spark if the condenser is short-circuited. The need of the large capacity for C4 is to keep up the potential when current is drawn off for the detector circuits, and to reduce the pulsations from the 60-cycle A. C. The only adjustment necessary is to locate the lever H of rheostat R2 at a point on the resistance, placed across the filament, where the hum is balanced out, an adjustment which has to be made only once. It is obvious that the whole apparatus is extremely simple, as the opening or closing of main switch S (with fuses FF to protect the transformer) controls all circuits. In the hook-up indicated in the figure, the only adjustments in tuning are of the inductances, coupling and condensers in the antenna and secondary, that is, L1 (C1) L2 C2 and coupling between L1 L2, which is delicate. Amplifiers may be added and operated from the same windings. My set oscillates "like a bird" on any setting.

With *low vacuum* tubes it might be necessary to provide for adjustment of the plate voltage as these tubes are sensitive but critical in adjustment, and this can be done either by winding T3 T4 to a higher voltage than ordinarily needed and cutting it down to the proper point by means of a variable high resistance in series with the 'phones (a potentiometer across C4 would discharge the condenser); or by means of variable taps on the transformer. In case bell-ringing transformers are used for T2 and T5 T6, the latter having no tap in the middle, a rheostat may be bridged across the whole winding and the lever adjusted as in the case of R2 H.

My experience has been that the adjustment of the rheostat or potentiometer R2 H, will cut out almost all the hum of the phones in receiving, but in case local conditions produce "cross talk" in some other experimenter's outfit, he will find that by proper insulating or grounding or balancing of transformer core, case, and windings, or by reversing the supply leads where the house wiring is grounded on one side, he can get rid of any objectional noise.

In making my transformer out of an old burnt-out 1 KW pole transformer core, I found that putting the whole transformer core and windings back in the iron case was advantageous in keeping induction from the core away from the rest of the set. The entire rectifier and associated apparatus should be kept *several feet away from the receiving set,* and all leads kept short, straight and separate, as in any other shipshape and efficient outfit. Bell-ringing transformers, if used, should have metal containing cases. The most important thing in using alternating current in this way, however, is care in the tuning adjustments, as there are certain critical adjustments which will make the set "howl" on account of audible beats between local audio-frequency beats and the 60-cycle alternations, besides other causes. For example, I find that in my set, keeping within "regions of silence" from interference depends largely on exact coupling, and that I have to keep L2 above a minimum amount, and to keep C2 at a small capacity—under .00025 mfd.,

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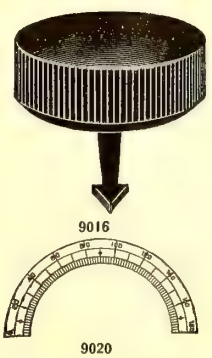
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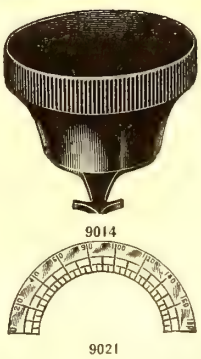
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or in the lower half of the scale on my small standard variable condenser. But I have not found the slightest difficulty in getting any desired adjustment of tuning or selectivity without starting "cross talk." A little practise is all that is necessary to make the set seem as silent as with *direct current*. Even if a faint hum still remains, it is never noticeable when fair signals are coming in, especially inasmuch as the A. C. hum is so low pitched compared with the signals, and quickly forgotten, like the scratch of a good phonograph. If anyone is unable to duplicate these results, it is his own fault. Of course a storage battery may be used for the filament, with rectified A. C. for the plate; or dry cells for the plate and a toy transformer for the filament.

This use of A. C. avoids all the bother and expense of storage batteries that cost much and require constant care and recharging; and of innumerable "plate" cells that cost a fortune now and last but a short time. The complete outfit can be constructed for the price of one "plate" battery renewal. I believe it to be the simplest and cheapest "stunt" yet.

"Hello Europe" --Via Radio

By Charles M. Ripley

(*Continued from page* 263)

the naval radio operator in Washington presses the key of his telegraphic instruments he PULLS THE TRIGGER. An instant later the effect is noted on the instruments and apparatus at the New Brunswick station 180 miles distant.

The tiny electrical impulse from Washington is used to strengthen the magnetism inside the wonderful new magnetic amplifier; and this, within the very same instant, releases the strange energy waiting inside the throbbing breast of the H. F. Alternator; and then, out on the high spun antennae flashes the AMPLIFIED dots and dashes which express the will of the American people to a listening world. So the magnetic amplifier receives minute impulses and permits terrific electric surges to enter the ether.

No device has ever equalled it for clear enunciation. There is a sharp staccato note to its messages. One way of expressing its achievement is, "New Brunswick does not slur its words."

Multiple Tuned Antennae.

A radio station without tuned antennae would be as short range an instrument as a violin without its "box" or a piano minus its sounding board. The volume of sound in each of these instruments is considerably augmented by their resonant wooden attachments, and so they can be heard at greater distances.

Just so the tuning of wireless antennae makes them "electrically resonant" with the vibrations, and augments the stations' powers of transmission.

But tuning does more than augment—it also refines the vibrations. The best comparison perhaps is that of an organ pipe.

Analogy of the Organ Pipe.

One refinement possest by the organ over practically every other musical instrument is that EACH TONE is provided with its own individual resonating pipe—separate and distinct. Since the *length* of the pipe is just ¼ the *wave-length* of its tone, it resonates only the pure tone desired. This refines the quality of the tone, as well as

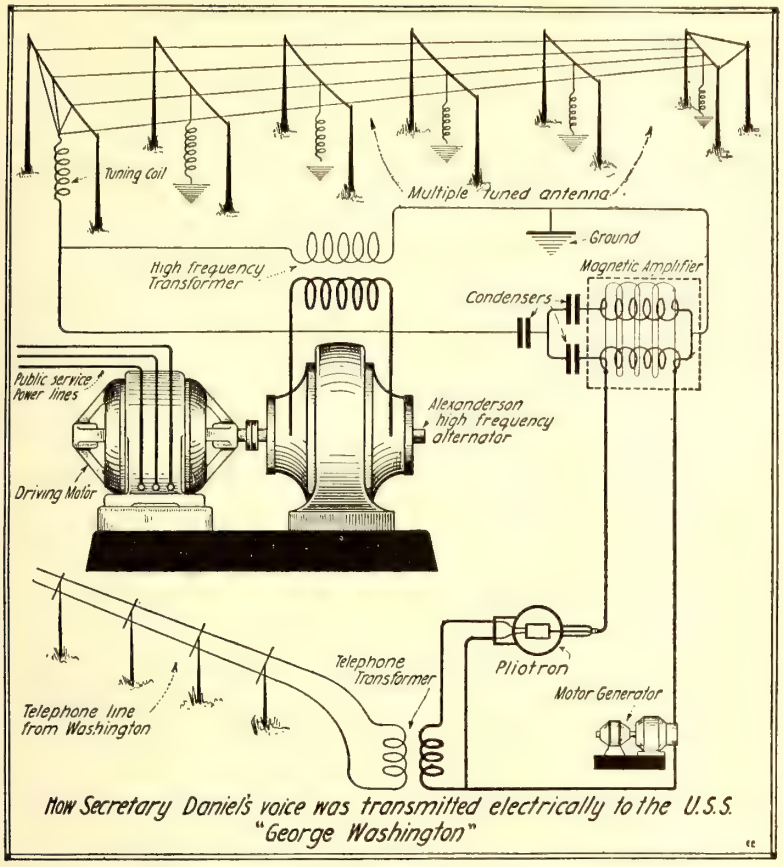


Chart-Diagram Showing the Radio Circuits at the New Brunswick Station, from Which Radio-Telegraphic and Telephonic Communication with Europe is Carried On.

amplifies its volume very markedly.

And just so the tuned antennae of a wireless station both purify as well as amplify the particular tone or vibratory frequency of the station's generator. Or putting it another way, the wires of the antennae are given electrical characteristics so that they "tingle" or "vibrate" electrically, in tune only with the particular vibrations set up by the one high frequency alternator in the station, and with no other.

Mr. E. F. W. Alexanderson explained the achievements of multiple tuned antennae as follows:

"Speaking in the simile of the organ pipe the action of the multiple-tuned antennae may be explained as follows:

"Whereas, in all previous systems the antennae may be likened to a single organ pipe, the multiple tuned antennae is six organ pipes tuned to the same pitch and sounded simultaneously in such a way that the combined sound is six times as strong as the sound emitted by each pipe. While it takes six times as much power to blow the six pipes as one pipe, the greatly increased efficiency of the new system is realized by the fact that it would require 36 times as much power to blow one pipe so strongly that it would emit a sound equally strong as the combination of the six pipes."

The six fanciful organ pipes are large "tuning coils," and as a happy by-product of their action they also serve as lightning arresters. In the accompanying illustrations these antenna tuning coils are clearly shown, as well as their relation to the antenna. One end of each tuning coil is connected to earth.

Our Heels Spark.

It was dark when we left the station, but there were two more surprises in store for me. As we walked toward the automobile under the antennae, we in the rear were astonished to *see brilliant sparks leap from the heels of those in front.* The experts explained that the electricity from the air was caught up by our bodies and discharged from our shoe nails into the ground. As an experiment one of us stooped over to touch the ground and received even a stronger shock than formerly when he stept out of the automobile that morning!

As we sped cityward, we looked back and marveled in mental perspective:

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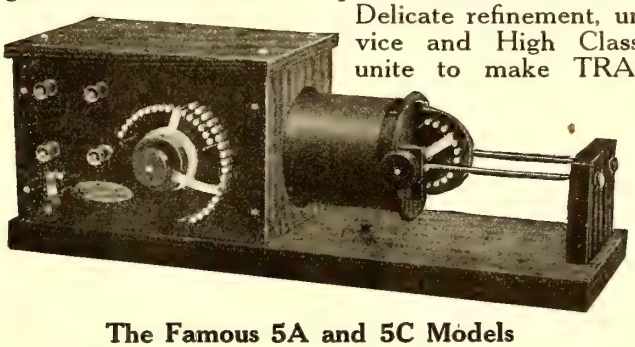
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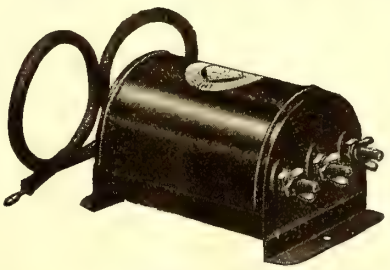
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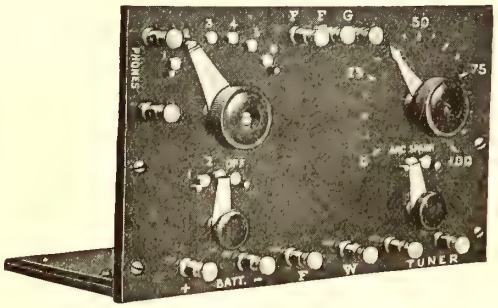
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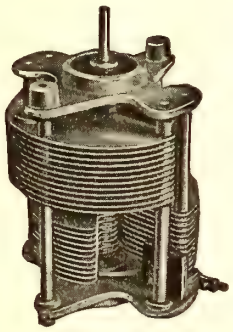
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pulses or immense power; yet small interference with other sending stations; sending 20 words per minute regularly and 90 words in test! Surely it is a privilege to live in the 20th century and to learn about these things while in the making—for many things are more interesting in their development than when fully grown to a lusty manhood.

That night the discussion of the day's visit opened up a great vision to us. A message cabled from New York to Queenstown goes to Queenstown only; but when the wireless flashes a message from New Brunswick it goes to every point of the globe simultaneously! And when we heard that it only costs $30,000 per year for power to send words to a *thousand* wireless receiving stations—then the possibilities of wireless in the future seemed to expand without limit. Here is the point: One word from New Brunswick to all the world costs—well—ask Uncle Sam! One word from New York to Queenstown only, costs 25 cents by cable.

As a whole, it may be said that the possibilities for extension of radio as a system of world communication have barely been touched upon, but the radio technique has now reached the point where it needs only capital and business initiative to duplicate and exceed in speed, accuracy and economy the trans-oceanic cable traffic; and for each sender to extend the service to all parts of

THE CALL OF W DOUBLE I

(Mr. Webster is a wireless operator at the U. S. Naval Radio Station, New Brunswick, N. J., the most powerful radio station in the United States.)

THE winter sun has settled,
Darkness is creeping near;
The moon slips behind a cold black cloud,
Denying the world of his cheer.
A sentry stands faithful to duty,
As out through the limitless sky
Crashes the call from Loyal America,
The call of W double I.
It speaks and the whole world listens,
And in the far-off city of Rome
A happy American sailor
Hears the call of his Home, Sweet Home.
It comes to the listening German,
As the Eagle's own warning cry,
And he shudders as he hears that warning,
The call of W double I.
The Frenchman hears and is comforted,
For he knows that it speaks with power;
He knows that aid is coming,
Though he knows not the day nor hour.
The load on his heart is lighter
As he settles back with a sigh;
It comes to his ear as music,
The call of W double I.
Out on the wind-swept ocean
The sailor hears the call;
He knows it comes from America,
The grandest land of all.
He grasps its high-pitched music
As it crashes through the sky,
'Tis to him as the song of the angels,
The call of W double I.
In distant cold Alaska
A soldier's eyes grow bright
As he murmurs, "Yep, that's him calling,
And he's coming good to-night."
And he sits and listens closely,
With that stern look in his eye,
For he knows 'tis the voice of Old Glory,
The call of W double I.
The moon comes out from his hiding,
And smiles his praising cheer,
On the land of Free America,
Whose call he, too, must hear.
The clouds roll away to the southward,
The stars peep down from the sky,
And the whole world stops to listen
To the call of W double I.

—H. R. Webster, U. S. N.

the globe requires merely receiving stations.

New sending stations equalling New Brunswick in power would require about a half million dollars to construct and equip.

Receiving sets of a very high grade type can be purchased for less than $100 and can be installed on a table, indoors. Messages can be sent from 20 to 90 words per minute; and with a station operating over 90 per cent. of the time, SOMEONE is going to make a fortune. Or, not thinking along mercenary lines alone, why couldn't great news gathering syndicates have their own wireless systems; or other corporations with world-wide interests might have their own private plants. Perhaps the idea of John Wanamaker with his private wireless stations may be the forerunner of a series of "jitney" wireless systems by the thousands. Who can tell in these early days along what lines the development will take place?

President Wilson's Ship Fitted With Radiophone

When the *George Washington* cleared for Brest she had installed in her wireless room a telephone transmitter which permitted the President to hold wireless conversation with the Navy radio station at New Brunswick, N. J., and with Washington direct. This was made possible by the use of the General Electric Company's apparatus designed by Ernest F. W. Alexanderson.

Wireless telephone messages were sent by this apparatus to the President thruout his last voyage to France, but the steamship was not fitted with the same apparatus and he could not reply in kind. Recent experimental work, however, perfected the answering facilities, and thus made it possible for the President to "talk back" to his Washington governmental associates.

Talking Thru the Trees

By Major General George O. Squier

(*Continued from page 204*)

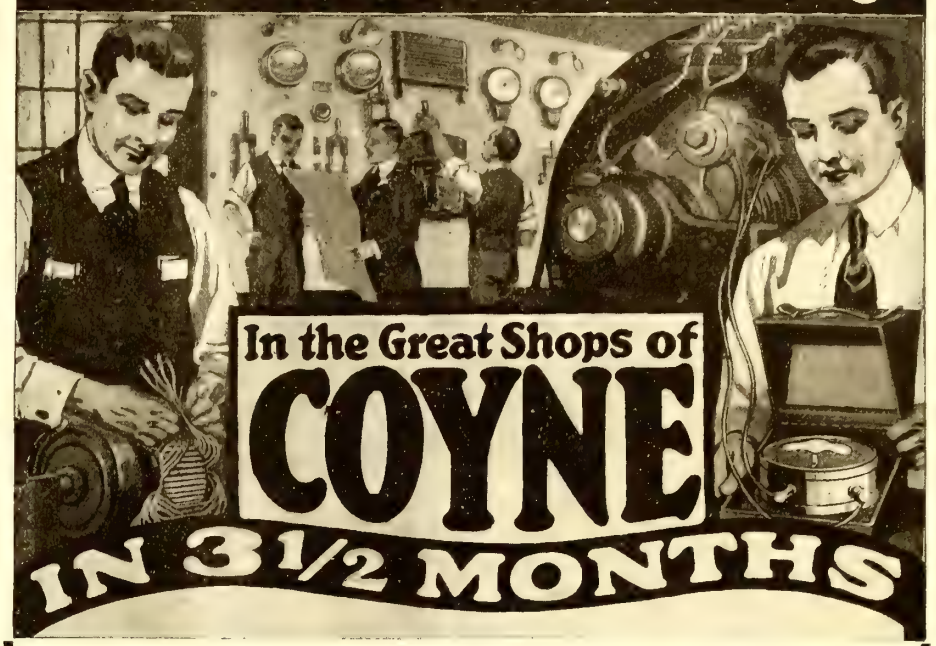
another tree-antenna, and automatically returned to the sender on a wire system, thus making the complete circuit. Illustrated at Fig. 6.

Long distance reception on any wave length from all the larger European stations and from our ships at sea was easily accomplished and traffic copied on a twenty-four hour schedule by the regular enlisted operators of the Signal Corps. A small portable house serving as a field laboratory was erected in the midst of the forest area on Grant Road, Washington, D. C., between the Bureau of Standards and Chevy Chase, Maryland (see accompanying illustration), and here was assembled a collection of the most efficient vacuum tube amplifiers developed to date by the Signal Corps of the Army, the Navy, the British and the French, and of commercial radio firms in the United States. With these unusual facilities it was a matter of a few days to test out, at least in a superficial manner, a large number of proposed arrangements *using trees as the antennae.*

Fig. 7 shows how a number of trees can be connected up to give the effect of one large antenna.

In France officers of the Signal Corps, by the simple device of driving a spike into a tree-trunk to which to connect the audion set which wireless operators use to magnify the dot and dash little sounds which make up wireless messages, found it was possible to "listen in" on communications between German airplanes and the German lines. Messages were thus intercepted in spots into which it would have been impossible to transport a field wireless apparatus. See Fig. 8.

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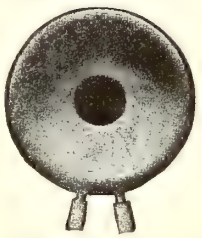
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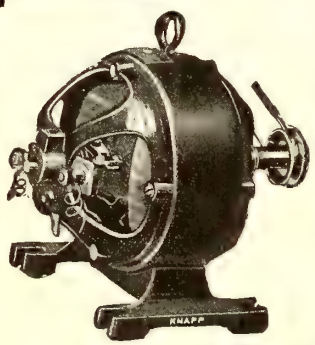
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The Physics of "Tree Wireless."

We may regard the metallic electrode rigidly driven into the living organism of a tree, as described above, as a *potential earth-terminal* for the study of the potential distribution on the surface of the earth itself. It has been shown in these experiments that this metallic terminal intimately connected to the earth itself and a part thereof is subject to changes of potential representing the innumerable frequencies required by modern radio-telephony and telegraphy, as well as any other electrical disturbances which may occur on the surface of the earth or the atmosphere above the earth.

It has been also shown, as expected, *that we can select from this composite, one or more of the different frequencies by tuned electrical loop circuits suitably connected to this electrode and study each in turn,* at will, just as color screens can select a particular component of white light. We may, indeed, by means of a highly insulated conductor bring this terminal directly to the laboratory and connect it immediately to the modern thermionic tube and amplify almost at will the particular effects we are studying. This tube (Audion) is a powerful and new instrument of research for the modern physical laboratory. Has not the physicist therefore in this electrode a means of studying in detail atmospheric and earth electrical disturbances of absorbing interest and far-reaching importance?

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For four years, under the stimulus of the World War, the efforts of engineers have been expended in producing instrumentalities for the generation and reception of radio signals and there has been little time to coordinate and assimilate the information gained into a better understanding of the ether mechanism for the transmission of electromagnetic waves thru space, over the surface, or thru the earth itself.

However, from the moment an acorn is planted in fertile soil, it becomes a "detector" and a "receiver" of electromagnetic waves and the marvelous properties of this receiver, thru agencies at present entirely hidden from us are such as to vitalize the acorn and to produce in time the giant oak. In the power of multiplying plant cells, it may, indeed, be called an incomparable "amplifier."

From this angle of view, we may consider that trees have been pieces of electrical apparatus from their beginning and with their manifold chains of living cells are absorbers, conductors and radiators of the long electromagnetic waves as used in the radio Art.

For our present purpose we may consider, *therefore, a growing tree as a highly organized piece of living earth,* to be used in the same manner as we now use the earth as a universal conductor for telephony and telegraphy and other electrical purposes.

My Early "Tree Radio" Researches.

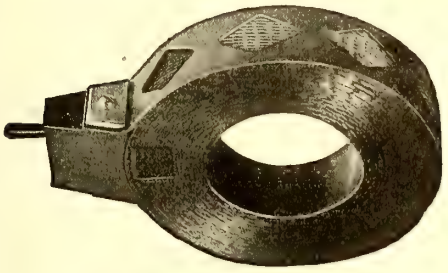
From the account of my early "Tree Wireless" experiments I quote the following selected paragraphs:*

*Reference. "On the Absorption of Electromagnetic Waves by Living Vegetable Organism." By George O. Squier, Ph.D., Major, Signal Corps, U. S. A. Official Report to the War Department on the Military Maneuvers in the Pacific Division, 1904.

(*Continued on page* 274)

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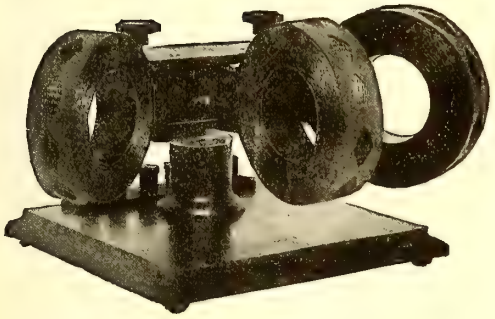
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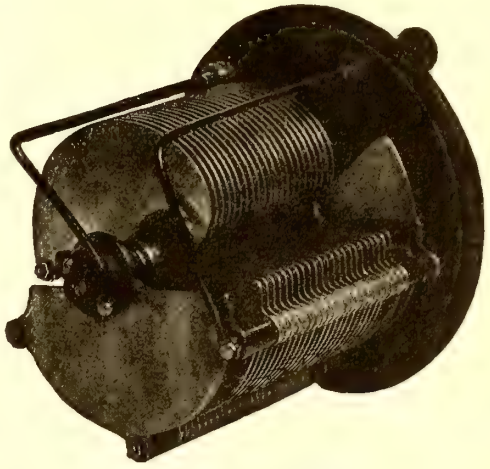
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Talking Thru the Trees

By Major General George O. Squier

(*Continued from page 272*)

"It would seem that living vegetation may play a more important part in electrical phenomena than has been generally supposed. We have seen that living vegetable organisms absorb and conduct electromagnetic oscillations over a wide range of the electromagnetic spectrum, beginning with sunlight, whose electrical action in the plant cell is at present little understood, and extending to waves of identical character, but of immensely greater lengths, such as Hertzian radiation, telephonic waves, and oscillations of the ordinary low frequencies used in commercial electric transmission lines. Disruptive discharges between vegetable electrodes, and electrostatic effects between vegetable surfaces are easily produced."

"In view of what has been accomplished in space telegraphy within the last seven or eight years, it is difficult to predict to what extent this means of communication may be ultimately developed. If, as indicated above in these experiments, the earth's surface is already generously provided with efficient antennae, which we have but to utilize for such communication, even over short distances, it is a fascinating thought to dwell upon in connection with the future development of the transmission of intelligence."

"Since a transmitting station is a central point for electromagnetic waves sent out in all directions over the surface of the earth, a large class of information, such as meteorological reports, crop reports, and general news items of interest to all, may in time be sent from central points, to be received at many places within the radius of influence of the signal station, and this, too, by the simplest forms of apparatus."

"It is seen that a growing tree, covered with foliage, is influenced inductively by electrical disturbances outside of itself, and in fact becomes generally responsive to induced electrical oscillations. It should offer, therefore, a promising means of studying meteorological effects of an electrical character, particularly those of lightning discharges, and electricity of the air. One of the first practical rules for the preservation of life against lightning is to avoid the vicinity of a tree."

"Our great forest areas may exercise an influence in maintaining a general equilibrium between the electrical charges of the upper atmosphere and the earth, which has not been fully realized. On this point, comparisons between observations from the interior of great desert areas devoid of any vegetation, with those from other portions of the earth's surface well covered with forests, would be instructive."

"From this viewpoint, the general surface of the earth may be considered as supplied by nature with innumerable meteorological observation towers, which possibly may be employed by means of apparatus involving principles already well known to science."

"In conclusion, it is believed that vegetation should be studied more systematically, from a distinctly physical standpoint than has been done in the past. Physics has been said to be the mother of all the sciences, and more and more the physical method of studying all science is proving to be the true one, as is evidenced by the great advance in recent years, in comparatively new branches of scientific work, such as Astrophysics and Physical Chemistry. Has not the time arrived for a more systematic study of Physical Botany, in the light of the new electric theory of matter?"

*Abstract of paper recently presented to Physical Society of America.

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How Don Flashed the "S.O.S."

By Mabel M. Davis

(Continued from page 236)

flashed out: — "Come pole."

In five minutes Will Merton was dancing excitedly about on the sidewalk below "Don," yelling to his brothers to bring the extension ladder. Other neighbors were gathering and demanding of "Don" why he was up there. "Don" glanced about and saw no sign of the cat he had come to rescue. When the wire flashed the cat had acquired a little common sense and gone down the way it came up. So that embarrassing element of the situation was, thank Heaven, eliminated. At the next call, "Donald Johnson, what are you doing up there?" Don replied, "Fixing the transformer. Bring up my supper, will you?"

Donald's father took his place at the bottom of the ladder, steadying it while Will Merton's older brother climbed up, unhooked "Don," and helped him get a place on the ladder. At the bottom he was besieged with questions but evaded them all. Will picked up Don's loaded coat and the hungry, shivering "S. O. S." man was glad to slip into it. All he said was: "Let's get out of this before the company's trouble man gets here to splice that wire."

When he got home he confest rather shamefacedly to his father and mother and Will Merton, that he went up the pole to rescue "A cat!"

"But I've learned my lesson. No more 'cat rescue' work for me. Of all the ungrateful creatures, that beast is the limit."

Donald's parents had to admit that this was an occasion where a practical knowledge of electricity was of some use. Several of the neighbors grumbled at being in the dark for an hour, but as soon as the lights flashed on again they forgave Donald for the inconvenience.

A SERIES-PARALLEL BATTERY SWITCH

(Continued from page 225)

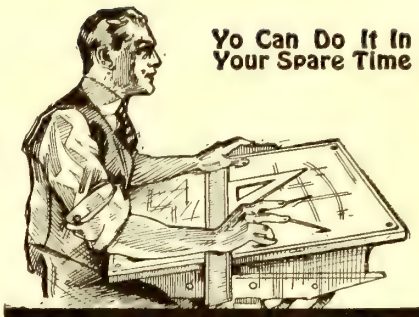
in use, all switches should be left open.

A smaller switch for taking care of a larger number of cells may be constructed by following the general proportions outlined above; each additional switch will take care of one more cell of battery. A greater number of combinations are possible the greater the number of switches used.

Contributed by ERVIN J. TROJAN.

Cells		Switch position	
Ser.	Par.	Left.	Right.
1	1	1	
2	1	4	1
3	1	2	1 4
4	1	5	1 2 4
6	1		1 2 3 4 5
1	2	1 4	
2	2	4 5	1 2
3	2	2	1 3 4 5
2	3	4 5	1 2 3
1	3	1 2 4	
1	4	1 2 4 5	
1	6	1 2 3 4 5	

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Electrical Oscillators

By Nikola Tesla

(*Continued from page* 260)

densers and operate an independent high frequency coil as customary. The controlling mechanism is of somewhat different construction but the core and contact spring are both adjustable as before.

Fig. 6 is a small instrument of this type, particularly intended for ozone production or sterilization. It is remarkably efficient for its size and can be connected either to a 110 or 220 volt circuit, direct or alternating, preferably the former.

In Fig. 7 is shown a photograph of a

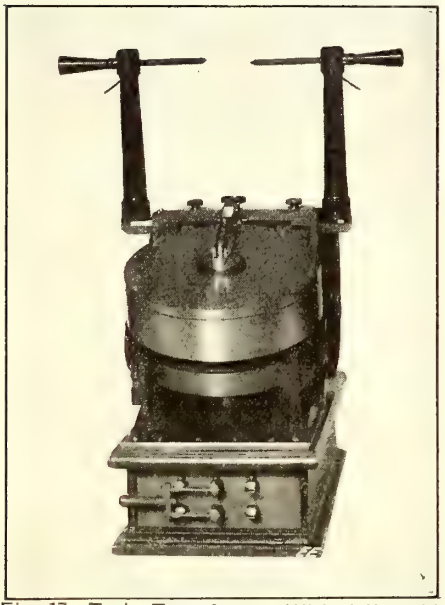


Fig. 17. Tesla Transformer With Adjustable Mercury Controller.

larger transformer of this kind. The construction and disposition of the parts is as before but there are two condensers in the box, one of which is connected in the circuit as in the previous cases, while the other is in shunt to the primary coil. In this manner currents of great volume are produced in the latter and the secondary effects are accordingly magnified. The introduction of an additional tuned circuit secures also other advantages but the adjustments are rendered more difficult and for this reason it is desirable to use such an instrument in the production of currents of a definite and unchanging frequency.

Fig. 8 illustrates a transformer with rotary break. There are two condensers of the same capacity in the box which can be connected in series or multiple. The charging inductances are in the form of two long spools upon which are supported the secondary terminals. A small direct current motor, the speed of which can be varied within wide limits, is employed to drive a specially constructed make and break. In other features the oscillator is like the one illustrated in Fig. 3 and its operation will be readily understood from the foregoing. This transformer was used in my wireless experiments and frequently also for lighting the laboratory by my vacuum tubes and was likewise exhibited at my lecture before the New York Academy of Sciences above mentioned.

Coming now to machines of the second class, Fig. 9 shows an oscillatory transformer comprising a condenser and charging inductance enclosed in a box, a transformer and a mercury circuit controller, the latter being of a construction described for the first time in my patent No. 609,251 of August 16, 1898. It consists of a motor driven hollow pulley containing a small quantity of mercury which is thrown outwardly against the walls of the vessel by centrifugal force and entrains a contact wheel which periodically closes and opens the condenser circuit. By means of adjusting screws above the pulley, the depth of immersion of the vanes and consequently, also, the duration of each contact can be varied at desire and thus the intensity of the effects and their character controlled. This form of break has given thoro satisfaction, working continuously with currents of from 20 to 25 amperes. The number of interruptions is usually from 500 to 1,000 per second but higher frequencies are practicable. The space occupied is about 10″ x 8″ x 10″ and the output approximately ½ K.W.

In the transformer just described the break is exposed to the atmosphere and a slow oxidation of the mercury takes place. This disadvantage is overcome in the instrument shown in Fig. 10, which consists of a perforated metal box containing the condenser and charging inductance and carrying on the top a motor driving the break, and a transformer. The mercury break is of a kind to be described and operates on the principle of a jet which establishes, intermittently, contact with a rotating wheel in the interior of the pulley. The stationary parts are supported in the vessel on a bar passing thru the long hollow shaft of the motor and a mercury seal is employed to effect hermetic closure of the chamber enclosing the circuit controller. The current is led into the interior of the pulley thru two sliding rings on the top which are in series with the condenser and primary. The exclusion of the oxygen is a decided improvement, the deterioration of the metal and attendant trouble being eliminated and perfect working conditions continuously maintained.

Fig. 11 is a photograph of a similar oscillator with hermetically inclosed mercury break. In this machine the stationary parts of the interrupter in the interior of the pulley were supported on a tube thru which was led an insulated wire connecting to one terminal of the break while the other was in contact with the vessel. The sliding rings were, in this manner, avoided and the construction simplified. The instrument was designed for oscillations of lower tension and frequency requiring primary currents of comparatively smaller amperage and was used to excite other resonant circuits.

Fig. 12 shows an improved form of oscillator of the kind described in Fig. 10, in which the supporting bar thru the hollow motor shaft was done away with, the device pumping the mercury being kept in position by gravity, as will be more fully explained with reference to another figure. Both the capacity of the condenser and primary turns were made variable with the view of producing oscillations of several frequencies.

Fig. 13 is a photographic view of another form of oscillatory transformer with hermetically sealed mercury interrupter, and Fig. 14 diagrams showing the circuit connections and arrangement of parts reproduced from my patent, No. 609,245, of August 16, 1898, describing this particular device. The condenser, inductance, transformer and circuit controller are disposed as before, but the latter is of different construction, which will be clear from an inspection of Fig. 14. The hollow pulley *a* is secured to a shaft *c* which is mounted in a vertical bearing passing thru the stationary field magnet *d* of the motor. In the interior of the vessel is supported, on frictionless bearings, a body *h* of magnetic material which is surrounded by a dome *b* in the center of a laminated iron ring, with pole pieces *oo* wound with energizing coils *p*. The ring is supported on four columns and, when magnetized, keeps the body *h* in position while the pulley is rotated. The latter is of steel, but the dome is preferably made of German silver burnt black by acid or nickeled. The body *h* carries a short tube *k* bent, as indicated, to catch the fluid as it is whirled around, and project it against the teeth of a wheel fastened to the pulley. This wheel is insulated and contact from it to the external circuit is established thru a mercury cup. As the pulley is rapidly rotated a jet of the fluid is thrown against the wheel, *thus making and breaking contact about* 1,000 *times per second.* The instrument works silently and, owing to the absence of all deteriorating agents, keeps continually clean and in perfect condition. The number of interruptions per second may be much greater, however, so as to make the currents suitable for wireless telephony and like purposes.

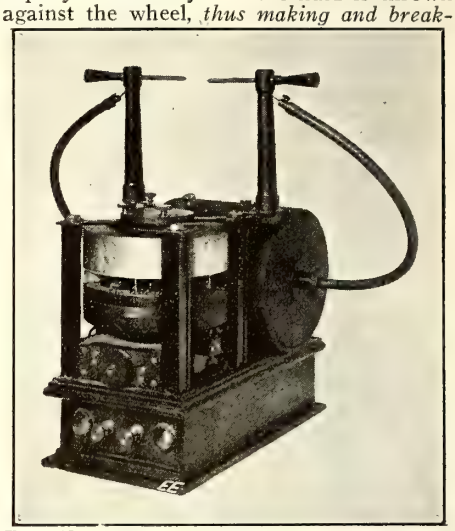


Fig. 18. Tesla Transformer With Mercury Jet Interrupter.

A modified form of oscillator is represented in Figs. 15 and 16, the former being a photographic view and the latter a diagrammatic illustration showing the arrangement of the interior parts of the controller. In this instance the shaft *b* carrying the vessel *a* is hollow and supports, in frictionless bearings, a spindle *j* to which is fastened a weight *k*. Insulated from the latter, but mechanically fixt to it, is a curved arm L upon which is supported, freely rotatable, a break-wheel with projections QQ. The wheel is in electrical connection with the external circuit thru a mercury cup and an insulated plug supported from the top of the pulley. Owing to the inclined position of the motor the weight *k* keeps the break-wheel in place by the force of gravity and as the pulley is rotated the circuit, including the condenser and primary coil of the transformer, is rapidly made and broken.

Fig. 17 shows a similar instrument in which, however, the make and break device is a jet of mercury impinging against an insulated toothed wheel carried on an insulated stud in the center of the cover of the pulley as shown. Connection to the condenser circuit is made by brushes bearing on this plug.

Fig. 18 is a photograph of another transformer with a mercury circuit controller of the wheel type, modified in some features on which it is unnecessary to dwell.

These are but a few of the oscillatory transformers I have perfected and constitute only a small part of my high frequency apparatus of which I hope to give a full description, when I shall have freed myself of pressing duties, at some future date.

The Kaiser is Canned--Can Food

By Grace T. Hadley

(*Continued from page 219*)

ples of jelly making and all the information is so clear that the work of canning and drying is no longer a mysterious problem but so simplified that school children may do it under the direction of competent teachers.

Methods of Drying.

For home drying satisfactory results are obtained by any one of three principal methods: Sun drying, drying by artificial heat and drying by air blast—using an electric fan, or other motor fan.

Sun drying has the double advantage of requiring no expense for fuel and of freedom from danger of overheating. For sun drying of vegetables and fruits, the simplest form is to spread the slices or pieces on sheets of thin paper or lengths of muslin nailed to strips of wood and expose them to the sun.

Trays should be used for large quantities. Sun drying requires bright hot days and a breeze. Once or twice a day the product should be turned or stirred and the dry pieces taken out. Care must be taken to provide protection from rain, dew and moths. During rains and just before sunset the products should be taken indoors for protection.

Drying by artificial heat is done in the oven or on top of a cookstove or range in trays suspended over the stove, or in the oven of an electric range. When drying with an artificial heat a thermometer must be used.

Air Blast—Electric Fan.

The use of an electric fan is an effective means of drying. Sliced vegetables or fruits are placed on trays and the fan placed close to one end of the box holding the trays, with the air current directed along the trays lengthwise. Insects must be kept out by the use of cheesecloth or similar material. Drying by this process may be done in 24 hours or less. As artificial heat is not used in fan drying, it is important to blanch or steam the vegetables for the full specified time. It is also necessary that all fan-dried products be heated in an oven to 180° F. for 10 or 15 minutes before storing.

Danger from Insects.

In addition to exercising great care to protect vegetables and fruits from insects during the drying process, precautions should be taken with the finished product to prevent the hatching of eggs that may have been deposited. One measure that is useful is to subject the dried material to a heat of 180° F. for from 5 to 10 minutes. By the application of this heat the eggs will be killed. Be careful not to apply heat long enough to damage the product. Store as soon as removed from oven.

Winter Use of Products.

In preparing dried vegetables and fruits for use, the first process is to restore the water which has been dried out of them. All dried foods require soaking. After soaking the dried products will have a better flavor if cooked in a *covered utensil,* at a *low temperature* for a *long time.* Dried products should be prepared and served as fresh products are prepared and served. They should be cooked in the water in which they have been soaked, as this utilizes all of the mineral salts which would otherwise be wasted.

That Wonderful Electric Action-Delayer

By Thomas Reed

(*Continued from page 223*)

ripe cantaloupe for her, but that's neither here nor there.

How about the same kind of a lock on letter-boxes? They all ought to have 'em. Put a letter in, you can, but it won't go *way* in until two minutes after you've prest a button, so you have a chance to take it back. Why, in a few years that would save more trouble than all old Bill Hoho ever made. The time you forgot to enclose the money in the mail-order. The time you just knew you'd put 'em in the wrong envelopes—and did. The sarcastic letter you wrote your wife's mother, telling her where she got off—only the place wasn't where you said, it was on your neck. Oh say, Beiler's non-mailing letter-box. Well.

Beiler himself can elaborate his invention now, all he needs is to be told what good it is. Go to it then, Al, on the biggest thing of all. Fix your machine the opposite way, so it'll *stop* something and not *let go* for those two minutes, and apply that to an electric muzzle, lip-riveter, or throat-grabber; and when you die they'll put your monument right next to Dr. Munyon's, No. 11 Benefactors' Row.

It's easy, Al, a contact just under the chin, so whenever a fellow opened his mouth to talk, he'd be muzzled, gagged, choked—or go as far as you like, rendered unconscious—for two whole minutes. Why, a guy with that apparatus on his person wouldn't have trouble enough to keep his mind occupied. Never "getting in bad," never "starting anything," always ready with those witty retorts you think of afterward, no half-baked opinions, nothing but pure wisdom. Oh hum! And if you could get your wife to wear one, think of the deep silence as you wend your way upstairs at 2 A. M., with wifie at the top struggling to get the darned thing off. Two minutes yet before she can tell you what she thinks of the poker game, and the best "thinks" of all exploding inside of her, and lost, lost!

Well, Al, I can't go on like this, I must do a little inventing myself; but you get me, don't you, and you're under full headway with your future career, yes? I'll only suggest one little handy application more, one that should be in every home, the "Safety Bargain-Shopper".

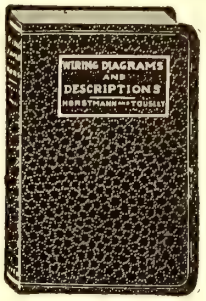
It's a common shopping-bag, containing Beiler's device, a storage battery, and a pocketbook with an electric lock. Gwendolyn sees a bargain. Instantly her hand goes into the bag for her purse, but it's locked. She presses the button of Beiler's device. Have patience, Gwendolyn, dear, in a short two minutes that filmy thing of pink batiste (is batiste right?) marked down to 79 cents, is yours. But no, Beiler is on the job, and the 79 kaplunkos are spent for one pair of fat pork chops. Does Gwendolyn change her mind? Does or rather did she have a fit of economy, prudence, far-sighted wisdom? No! Within the two minutes she is pushed away from the bargain-counter by the seething, howling mob of five thousand other bargain snappers.

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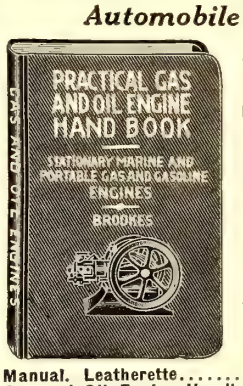


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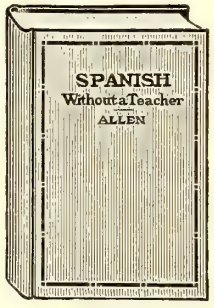
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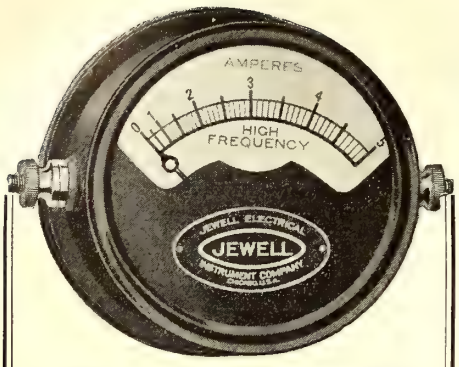
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How to Build an Astatic Galvanometer

(*Continued from page 225*)

Next make a round base for your instrument. This, too may be turned on a lathe, but may as well be made of separate disks. Make one to fit inside the other end of the chimney, and make the other about half an inch larger all around. The second disk can conveniently be beveled. Fasten the two together. Make three wooden feet for your base, and fasten them on it, letting them make an angle with each other at the center of 120 degrees. In the ends of these feet, bore holes to receive the leveling screws. The screws themselves may be the binding screws from old dry cells. If now you cut a piece of fairly hard wood (hard rubber or fiber if you have it), which will fit around the base, and be attached to two of the feet, as the diagram shows, your base is complete. This piece of wood is to hold the three binding posts.

The two coils of wire (A) need cause little trouble. Form the bobbins of heavy card-board, or, better, from thin wood, held together with glue or shellac. The size of the bobbins naturally depends on the space available inside the glass cover. Wind them with wire varying in size according to the use for which the galvanometer is intended. If you wish it to detect extremely small currents, wind it with the finest wire you have (No. 40 B & S). Fasten the coils on the base in the manner shown, taking care that, when their windings are connected in series, the magnetic field of the two will be continuous. That is, let the wire be wound in the same direction in each. Connect them in series, and bring the two leads to the two end binding posts (C). Connect the middle binding post with the connection between the two coils. This allows the instrument considerable range. If you are working with very minute currents, let them flow thru both coils. If the currents are stronger, let them flow thru only one.

The astatic element is the next consideration. Cut a light piece of wood and push thru it two steel needles, of such length, and such a distance apart, that when the whole is suspended as shown, one of the needles will swing inside the coils, and the other just above them. Before pushing the needles thru the stick that is to support them, magnetize them thoroly. Assemble them so that the *north* pole of one and the *south* pole of the other will point in the same direction. The whole element should be made as light as possible, so that it may be suspended on a silk fiber or a silk thread. Now for the actual suspension. Make a cover for the top of the test tube (see the diagram) and thru this bore a hole large enough to allow a battery binding screw to slip freely thru it. Select a binding screw with a knurled thumb nut on it, and slip it thru the hole. To its end make fast the silk thread or fiber, passing it thru a small hole in the screw itself. Let the thread be approximately the right length before assembling the instrument. By holding the binding screw firm, and turning the thumb nut, the height of the astatic element may be regulated, while if the whole screw be turned, the magnets may be brought into their proper position with reference to the coils.

Now you have a good businesslike galvanometer. You can go further and elaborate it if you like. You can experiment with different size wire, different distances between coils, and with astatic elements of different weights. You can place a circular scale on the coils if you choose, and read the values off on it with the top needle as pointer. Or you can do this stunt: Mount a small mirror on the magnet support; next take a miniature bulb and cover the glass with a coat of white paint. Let this dry, then put on one or more coats of black, or some dark color. Support the bulb and its socket on a short piece of brass tubing, as shown, or on some other support of such height that if you scratch a hole in the paint on the side of the lamp, a ray of light will be reflected by the little mirror off onto a scale which you can hold at any distance. If you do include this feature in your galvanometer, you must add two more binding posts on the base to supply current to the lamp. This stunt works fine when the instrument is to be used merely for the detection of minute currents, but remember that the magnetic field of the lamp feed wires is going to complicate matters if the galvanometer is to be used for accurate measurements. It is needless to remind the reader that with the exception of the two (needle) magnets, no iron or steel should be used in the construction of this instrument.

Musical Radio Telegraphic Sets

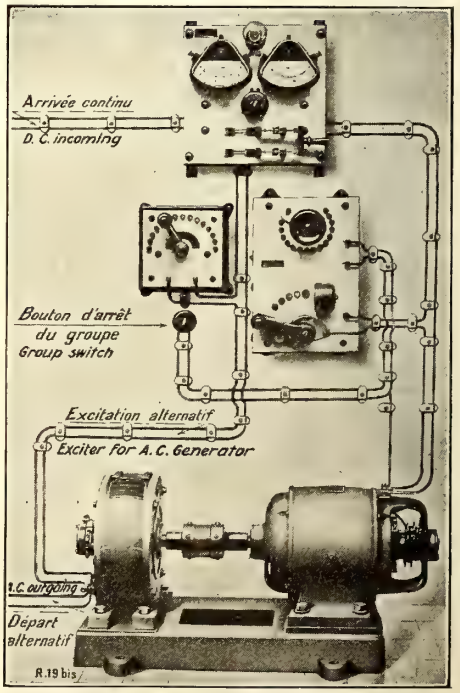
By Jacques Boyer

(*Continued from page 233*)

by means of a regulating screw.

The sending helix offers some novel points. By means of metal sliders it is possible to vary the wave lengths instantaneously. Instead of using the usual antenna switch, a special commutator is used which might be of interest to American readers.

In the sending circuit, the tuning coil has only five contacts and an air condenser. The coupling can be changed in two directions, either in series with the antenna (for short wave lengths) or in parallel with the coupler (for long wave lengths). The secondary circuit, which is a periodic, has a coil, which is regulated by means of five



Direct Current to Alternating Current Motor—Generator Used in Radio Set of French Design.

contacts for the variation of the wave length. It has the usual connections with the head receivers, and there are two detectors used, each of which can be connected into circuit by means of a switch.

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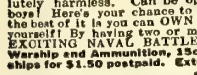
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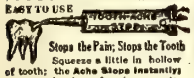
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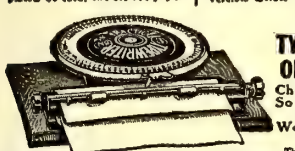
This is not a pretty object, but it is fine for people who like practical jokes. The Ghost, when displayed in a perfectly dark place, glows with a pleasant cold bluish radiance, very apt to give one a "creepy" sensation even when you know all about it, but a regular startler for those who come upon it unexpectedly. A great joke to play on your mother-in-law. **Price only 15 cents each, or three for 40 cents.**

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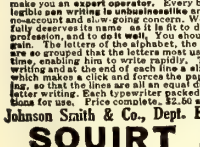


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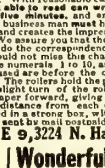
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A wonderful little instrument producing several illusions both startling and startling. With it you can see what is apparently the bones of your fingers, the lead in a lead pencil, the interior of a living in a pipe stem, and many other similar illusions. A mystery that everyone has been able to satisfactorily explain.

Price 10 cents; 3 for 25 cents; 1 dozen, 75 cents. Sent by mail, postpaid.

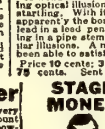
Sneezing Powder



Place a very small amount of the sneezing powder on the back of your hand and blow it into the air, and everyone in the room or car will begin to sneeze without knowing the reason why. It is most amusing to hear their remarks, as they never suspect the real source, but think they have caught it one to another. Between the laughing and sneezing you yourself will be having the time of your life. **For parties, political meetings, car rides,** or any place at all where there is a crowd, this powder is the **greatest joke out. Price 12c or 3 for 30c.**

By Express Only

STAGE MONEY



With a bunch of these bills, it is easy for each person of limited means to appear prosperous. By flashing a roll of these bills at the proper time and peeling off a genuine bill or two from the outside of the roll, the effect created will be found to be all that can be desired. **Prices, postpaid: 15 Bills 10c, 50 Bills 25c, 125 for 50c, or $3.50 thousand**

NEW BOOK ON ROPE SPLICING

USEFUL KNOTS, HITCHES, SPLICES, ETC.

How Different Knots Are Made and What They Are Used For. Knots to Use and Knots to Avoid.

A most practical handbook giving complete and simple direction for making all the most useful knots, hitches, rigging, splices, etc. Over 100 illustrations. All about wire rope attachments, lashing, blocks, tackles, etc. 37 Heraldic Knots illustrated. Of great value to mechanics, riggers, campers, boatmen. **Price 20c** p. pd.

Johnson Smith & Co., Dept. E9, CHICAGO

LUMINOUS PAINT

Make Your Watches, Clocks, Etc., Visible by Night The very latest discovery in the scientific world. Hitherto, practically unobtainable except at an exorbitant price, we have at last succeeded in producing this remarkable LUMINOUS PAINT, which, applied to the surface of any article, emits a soft, pale light, rendering it quite visible in the dark. **THE DARKER THE NIGHT, THE MORE BRILLIANT IT SHINES.** Quite simple to use. Anyone can do it. A little applied to the dial of your watch or clock will enable you to tell the time by night. On the push buttons or switch plates of your electric lights, match boxes, and innumerable other articles; make them glow. Luminous Crutches, Lemon Squeezers, etc. Bottle containing sufficient to coat several small articles. **Price 25c,** Larger sizes **50c** and **$1** postpaid. **Johnson Smith & Co., Dept. E9,**

MUSICAL KAZOO



With the **Musical Kazoo** you can, without previous practice whatsoever, play any tune right off, imitate any bird or animal, harp, snare drum, Punch and Judy, etc. No holes to finger. It is simplicity itself. Produces excellent music. You do not blow into it, but sing, speak, laugh or make any desired imitation. Used with astonishing results at society meetings, home, club or church entertainments, dances, serenades, picnics, outings, excursions. Just the thing for shows and shows, bicycle and marching clubs, etc. Excellent for vocal or instrumental accompaniments, either with or without other musical instruments. **Price 15cts. pd.**

MAGIC FLUTE



Wonderfully Sweet Toned and Musical

A marvelous musical instrument. No other instrument produces such sweet music, whether played by the novice or the skilled musician. It is the joyous delight of the quick-step or the solemn strains of a church hymn—in fact, any class of music can be played upon the Humanatone without practice, as it is almost a self-playing instrument. When played with a piano accompaniment, or any other musical instrument, the effect is charming. Full printed instructions for playing sent with each instrument.

Post Paid **15c**

All the Latest Surprising and Joke Novelties

Pharo's Serpents Eggs, box	10c	Cover the Spot Trick, a scien. nov.	10c
Miniature Water Pistol	10c	X Ray Novelty	10c
Cleopatra's Snake (very lifelike)	15c	Trick Pencil	10c
False Mustache (fool your friends)	25c	Rubber Turds (a good joke)	10c
Ford Auto Puzzle (Latest)	25c	Mesmerized Penny (defies the law of gravitation)	20c
Mysterious Ghost, shines at night	10c	Mysterious Tumbler and Vanishing Coin Trick	25c
Rubber Razor (very formidable)	20c	Magic Mirror (you see peep)	10c
Rubber Dagger (sensational)	20c	Magic Plate Lifter	20c
Window Smashers (great joke)	25c	Imitation Gold Teeth, ... a for	10c
Lookbackoscope (see behind you)	15c	Great Burglar Puzzle	10c
Great Mind Reading Mystery Cube	25c	Wire Puzzles, 10c. 22 different,	$1.95
Thurston's Mysterious Trick Cds.	10c		
Fighting Roosters, pair	10c		

JOHNSON SMITH & CO., Dept. E9, 3224, N. Halsted St. CHICAGO

Boys, you can have Movies at your own home with this latest model

MOVING PICTURE MACHINE

Uses Standard Films same as the larger machines. Very easily managed. Simply turn the handle. Good Variety of Films always obtainable

PRICE Complete ONLY **$2.50** Postpaid anywhere including Two Films

Extra Films, 15c each postpaid



THIS IS A GENUINE MOVING PICTURE MACHINE and the motion pictures are clear, sharp and distinct. The Moving Picture Machine is finely constructed, and carefully put together by skilled workmen. It is made of Russian Metal, has a beautiful finish, and is operated by a finely constructed mechanism. The projecting lenses are carefully ground and adjusted, triple polished, standard double extra reflector, throwing a ray of light for feet, and enlarging the picture on the screen up to three or four feet in area. The light is produced by a safety carbide generator, such as is used on the largest automobiles. This throws a dazzling white light on the screen.

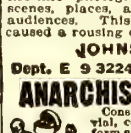
It is a solidly constructed and durable Moving Picture Machine. The mechanism is exceedingly simple and is readily operated by the most inexperienced. The pictures shown by this marvelous Moving Picture Machine are not the common, crude and lifeless Magic Lantern variety, but are life-like photographic reproductions of actual scenes, places, and people which never tire its audiences. This Moving Picture Machine has caused a rousing enthusiasm wherever it was used.



JOHNSON SMITH & CO.

Dept. E 9 3224 N. HALSTED ST., CHICAGO

ANARCHIST BOMBS



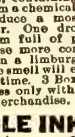
Consists of a little glass vial, containing in liquid form a chemical which will produce a most terrible odor. One dropped in a room full of people will cause more consternation than a dozen common stink bombs. The smell will entirely disappear in a short time. 3 Boxes for 25c, shipped by express only with a Dollar's worth of other merchandise.

ITCHING POWDER



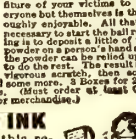
This is another good practical joke; the intense discomfiture of your victims to everyone but themselves is thoroughly enjoyable. All that is necessary to start the mad rolling is to deposit a little of the powder on a person's hand and the powder can be relied upon to do the rest. The result is a vigorous scratch, then some more scratch, and still some more. 3 Boxes for 25c, Sent only by express, (Must order at least One Dollar's worth of other merchandise.)

INVISIBLE INK



The most confidential messages can be written with this Ink. It is the writing **MAKES NO MARK.** Cannot be seen unless you know the secret. Invaluable for many reasons. Keep your pencils and other private memorandums away from prying eyes. Great fun for playing practical jokes. **Only 15c Bottle**

LOVE LETTER INK



Writing written with this remarkable ink vanishes entirely in a few weeks (sooner if desired), leaving the paper QUITE BLANK. **15c p. pd.**

LUMINOUS INK Writing can be READ ONLY IN A DARK ROOM. Writer appears like fire. Quite invisible at daytime. Very remarkable. One bottle; 3 for 40c postpaid.

JOHNSON SMITH & CO.

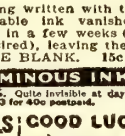
MULTIPLYING BILLIARD BALLS

The Best Feat of its Kind



This trick is so effective as it is surprising. The performer hands around three balls for examination, and immediately it is returned to him he seizes it by the tips of his thumbs and fingers and a second ball mysteriously appears. These are held in full view of the audience by the tips of the fingers of the left hand, and while being placed in position, another ballunexpectedly makes its appearance. Final y the magician apparently suffers some kind of spasm and yet another ball is the result. The feat can then be reversed, the balls disappearing one after another until none remains. It is a very interesting trick that is quite easily performed by following the directions that accompany the apparatus. **Price, 25 CENTS, POSTPAID. JOHNSON SMITH & CO.**

GOOD LUCK RING



Quaint and Original Design

A VERY striking and uncommon ring. Consists of a beautiful Skull and crossbone design, set with two brilliant flashing gems sparkling out of the eyes. A never failing object of interest. It is said by many to bring Good Luck to the wearer. Hence its name **Good Luck Ring,** and whilst we cannot positively guarantee that, it certainly a very unique ring that you will take a pride in wearing. They were made to sell at 50 cents, but as a special bargain we will supply them to customers mentioning this paper, at **HALF PRICE, 25 CENTS, POSTPAID. JOHNSON SMITH & CO.**

LOADED CIGARETTES

Just Like Ordinary Cigarettes, But Such Real Startlers.



A box containing ten apparently genuine Cigarettes. They contain a cap which explodes when about one-third smoked.

They appear as real, and afford as good a smoke (while they last) that the victim is taken entirely by surprise. A great laugh producer and entirely harmless. **Price, box of ten, 25 cents, postpaid.**

Johnson Smith & Co., Dept. E-9

THE "LITTLE GIANT" TYPEWRITER

A First Class Writing Machine For $1.25



A per set little typewriter for $1.25. There are thousands of persons who would like to use a typewriter but whose needs and business do not warrant the expense at ached to the purchase and use of a fifty or seventy-five dollar machine. To such persons we confidently recommend our Little Giant. It is strongly made, but simple in construction, so that any one can learn it, and write as rapidly as they would with pen and ink. The letters of the alphabet most frequently used being so grouped as to enable one to write rapidly, the numerals, 1 to 10, and the punctuation marks being together. With this machine you can send your best regards to your friends, ten love letters, address envelopes, bills, and do almost any kind of work not requiring a large expensive machine. With each typewriter we send a book containing full printed instructions for using the machine. Price complete **$1.25** by mail postpaid.

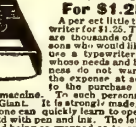
guarantee that it is certainly a very unique ring that you will take a pride in wearing. They were made to sell at 50 cents, but as a special bargain we will supply them to customers mentioning this paper, at **HALF PRICE, 25 CENTS, POSTPAID. JOHNSON SMITH & CO.**

SERPENT'S EGGS



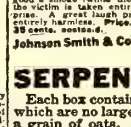
Each box contains 12 Eggs, which are no larger than a grain of oats. When lit with a match, however, each one gradually hatches itself into a Snake several feet long, which curls and twists about in a most lifelike manner. **Price per box 10c, postpaid. Johnson Smith & Co.**

MYSTIC SKELETON



A jointed figure of a skeleton 14 inches in height, will dance to music and perform various gratifying and movements while the operator may be any distance from it. The figure may be examined by the spectators. When handed back to the operator it is simply placed on a chair or table, when it will seemingly become endowed with life, and begin to move. At the command of the operator it will sit down, stand up, dance, etc. We send full direction with each Skeleton, so that any child can readily make it perform. **10c postpaid.**

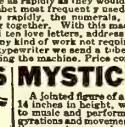
CIGARETTE ROLLER



Very neat and handy. Will hold less than a quarter of an ounce. Better cigarettes than you can buy and makes them easily and quickly. You can use just the tobacco you prefer and thus have nicer "smokes" than ready made, and more of them besides saving about half of your money. Carry case and make your cigarettes just to your own liking. **Price only 10c or 3 for 25c postpaid,** with full instructions for use.

MIDGET ILLUSTRATED BIBLE

A Great Curiosity



The Smallest Bible in the World

The Midget Bible is a perfect piece of work of art. It is about the size of a postage stamp and contains TWO HUNDRED AND FIFTY PAGES of the NEW TESTAMENT, profusely illustrated. This little Bible is a wonder. It is said to bring good luck to the owner. Must be seen to be appreciated. **Price, only 12 cents, three Bibles for 30 cents; one dozen Bibles for 90 cents; or 100 for $6.00.** Good money can be made selling these Midget Bibles amongst friends, church acquaintances, Sunday schools, bazaars, etc. Send for a few and try it.

The CONJURER'S CASKET

Apparatus and Directions for a Number of Mysterious Tricks Enough for an Entire Evening's Entertainment

ANYONE CAN DO THEM

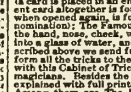


50c

It is great fun mystifying your friends. Get this Conjurer's Cabinet, and you will be the cleverest fellow in your district. It contains Directions for Performing the following Tricks, including The Disappearing Rose, that, when placed on the lapel of your coat, vanishes from sight at will; the Magic Vase and Ball Trick (a Wooden Ball is placed in the bottom of a vase, and on lifting the vase the ball is found in someone else's pocket); The Magic Nail with which you can apparently cut your finger almost in two; the Wonderful Card Trick (a card is placed in an envelope, and when opened an entirely different card altogether is found); The Disappearing Coin Box (a coin is placed in the little wooden barrel, and when opened again, is found to have vanished entirely, or can be made to change into a coin of another denomination); The Famous Mesmerized Penny that defies the law of gravitation (suspends from the palm of the hand, nose, cheek, wall, clothing, etc.); The Glass Goblet and Vanishing Coin Trick (a coin is dropped into a glass of water, and when the water is poured out the coin has vanished). With the seven tricks described above we send full printed instructions for performing each trick, so that anyone can readily perform all the tricks to the great amusement of their friends or the public. Any boy of ordinary intelligence with this Cabinet of Tricks in his possession, can give a parlor entertainment not inferior to some regular magicians. Besides the tricks contained in the Cabinet, there are twenty-five other feats and illusions fully explained with full printed instructions, for which you can easily make or procure the necessary apparatus. Among them are The House of Pack of Cards, The Drawn Card, The Hat Trick, To Knock a Tumbler Through a Table, One Cent Rubbed into Two, To Find the Number Thought of, Mysterious Wedding Ring etc. We also send the secret of performing three wonderful stage tricks, as follows: The Act of Cremating a Woman, Walking on the Ceiling of a Room, and the Disappearing Lady, together with an article of legerdemain and valuable hints to amateur conjurers, **PRICE COMPLETE ONLY 50 CENTS.**

JOHNSON SMITH & CO., Dept. E9, 3224 N. Halsted Street, CHICAGO

The Newest Novelty Aerial Balloon



Flies gracefully in or outdoors. This is the VERY LATEST SENSATION IN BALLOONS. A brightly colored balloon that measures sixteen inches long in its entirety. Blown up in the usual way, when released, the air pressure sends the balloon SOARING UPWARD, the ⅝-inch propeller SPINNING AROUND AT A LIVELY RATE. The effect is startling. It is a graceful flier that makes the youngsters WILD WITH JOY. May be used repeatedly indoors or outdoors. An immensely interesting toy. **Price 10c each, 3 for 25c ppd.**

JOHNSON SMITH & CO., Dept. E9, 3224 N. Halsted Street, CHICAGO

"The Baby" Double Action Hammerless Revolver

A HANDSOME AND MOST EFFECTIVE WEAPON

$5.50



Measures but 4¼ inches long

Takes regular .22 caliber cartridges

The new **Baby Double Action Hammerless Revolver** has been produced to meet the ever increasing demand for a revolver that would combine small size and light weight with the essential features of **Efficiency and Practicability.** It is small in size, yet is just as effective and serviceable as the most expensive weapon you can buy. Every lady should have a revolver and should know how to use it, and there is no safer or better one made than this. A great feature is its safety action that guards against accidental discharge, making it quite safe for young men and ladies. The illustration gives an idea of its appearance, but it must be seen and used to be thoroughly appreciated. The ammunition used is the standard .22-calibre short cartridge obtainable anywhere, or you may obtain the cartridges from us (cartridges can be shipped only by express). This revolver fires six shots in one loading. The operation of the charging mechanism is extremely rapid and absolutely reliable; six well aimed shots can be fired as many seconds. The revolver is very well constructed, with finest nickel plated fluted barrel of cylinder, and it weighs only 4¼ ounces. **The Price of the New Revolver is only $5.50, cash by mail postpaid to any address. JOHNSON SMITH & CO.**

THE EXPO WATCH CAMERA

The most wonderful and ingenious Camera made



It is but little larger than a watch, which it closely resembles. You can carry the Expo about in your pocket and take pictures without any one being the wiser.

One Cent a Picture

The Expo loads in daylight with 25 feet of film, ample for taking 25c, thus the picture taking part of a whole day's outing may be had for the nominal sum of 25c—One cent a picture. 10 Exposure Films also obtainable. It is simplicity itself to operate. Takes pictures through the stem, where the **Rapid Fire Lens** is located. The photos (5/6 x 7/6) may be enlarged to any size.

Price $2.50

QUICK AS A FLASH

Time and Instantaneous shutters; weight but 9 ounces; nickel plated. Endorsed by amateurs and professionals the world over. Thoroughly practical—printing and developing of films just the same as ordinary cameras—in daily use by the police, newspaper reporters, detectives, and the general public. Important deals have been secured with the Watch Camera by enterprising reporters. Produces clear, sharp negatives indoors or outdoors, equal to any camera on the market, size or price notwithstanding.

Expo Watch Camera $2.50 FILMS, 10 Exposures 15c, 25 Exposures, 25c Leather Pocket Carrying Case, 35c

Postage 10c Anywhere

Johnson Smith & Co., Dept. E 9,3224 N. Halsted St., Chicago

This Pretty WITH PAD RUBBER STAMP AND INK, 75c



E. B. BARTSCH, EUDUNDA'

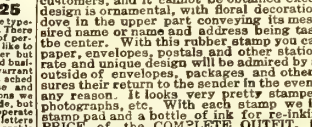
Here is the Prettiest rubber stamp you ever saw. At very great cost we have had this design specially engraved for our customers and it cannot be obtained except through us. The design is ornamental, with floral decorations, with a beautiful dove in the upper part conveying its message of love, the desired name or name and address being distinctly inked in the center. With this rubber stamp you can brand your letter paper, envelopes, postals and other stationery, and the elaborate and unique design will be admired by all. Placed upon the outside of envelopes, packages and other mail matter, it ensures their return to the sender in the event of non-delivery for any reason. It looks very pretty stamped on books, music, photographs, etc. With each stamp we include a self-inking stamp pad and a bottle of ink for inking the pad, and the PRICE of the COMPLETE OUTFIT, in box, is **ONLY 75 CENTS, POSTPAID.**



New Vamping Card

No Teacher Needed Surprisingly Simple System

Persons having neglected their Musical Education need not despair, for with the aid of our new VAMPING CARD (placing the same upright over the piano keys), you can at once Vamp away to thousands of Songs, Ballads, Waltzes, Rag Times, etc., etc., equal to a Professional Musician. No knowledge of music is required. After using it a few times, you will be able to dispense with the aid of the Vamping Card entirely. **Only 15 cts. p. pd. Johnson Smith & Co., Dept E9**



Gigantic Butter Beans

New Guinea

The New Edible Vegetable Wonder

Grows to an astonishing size, the Beans measuring from 3 to 6 feet long and weighing anything from 10 to 16 lbs. and even more. One Bean is sufficient for a family for several meals. Very palatable and rich in nutritious materials. A delicious Buttery Flavor is much appreciated. The Vines are easily grown, very prolific, and a most welcome and valuable addition to the garden. Try them; you will find them the most delicious vegetable you have ever tasted. Seed for sale by us exclusively, and we alone. Sample package of Seeds with full directions for cultivating and cooking. **25c,** postpaid.

JOHNSON SMITH & CO. DEPT E9 3224 N. HALSTED STREET CHICAGO

SHARPEN-M-ALL SAFETY RAZOR STROPPER

SHARPENS EVERY KIND OF SAFETY RAZOR BLADE

Sharpens the Gillette and Durham Duplex both edges at one time

ALSO SHARPENS THE GEM JUNIOR, EVER READY, KEEN-KUTTER, MARK CROSS, CLARK, AUTO-STROP, STAR CRU-STEEL, AND ALL OTHERS



By using the SHARPEN M ALL STROPPER you will never have to buy new SHARPENS, but will SAVE MONEY on blades, as you will be able to get from 150 to 200 shaves from one blade, and the last will be as keen as the first one. The construction is simple and will last a lifetime. There are no springs to get out of order or get out of order. Any novice can use it just as well as the most expert barber. It is operated by simply turning the lever or handle as shown in the illustration it has two spiral rollers that travel from heel to point as they are revolved, giving the CORRECT DIAGONAL STROKE. There are no screws, no adjustments, or any kind of tinkering necessary to operate the machine. The rollers are made of a special material that STROP AND HONE the blade at the same time. The rollers turn only one way, being governed by the action of the strop. The SHARPEN-M-ALL is packed in a handsome case, 4x2¼x1⅝ in., with three holders and full instructions. The weight of the complete machine is but eight ounces Price, only **$1.00,** postpaid.

JOHNSON SMITH & CO., DEPT E9 3224 N. HALSTED STREET CHICAGO

Potmend *Stops a leak in a minute*

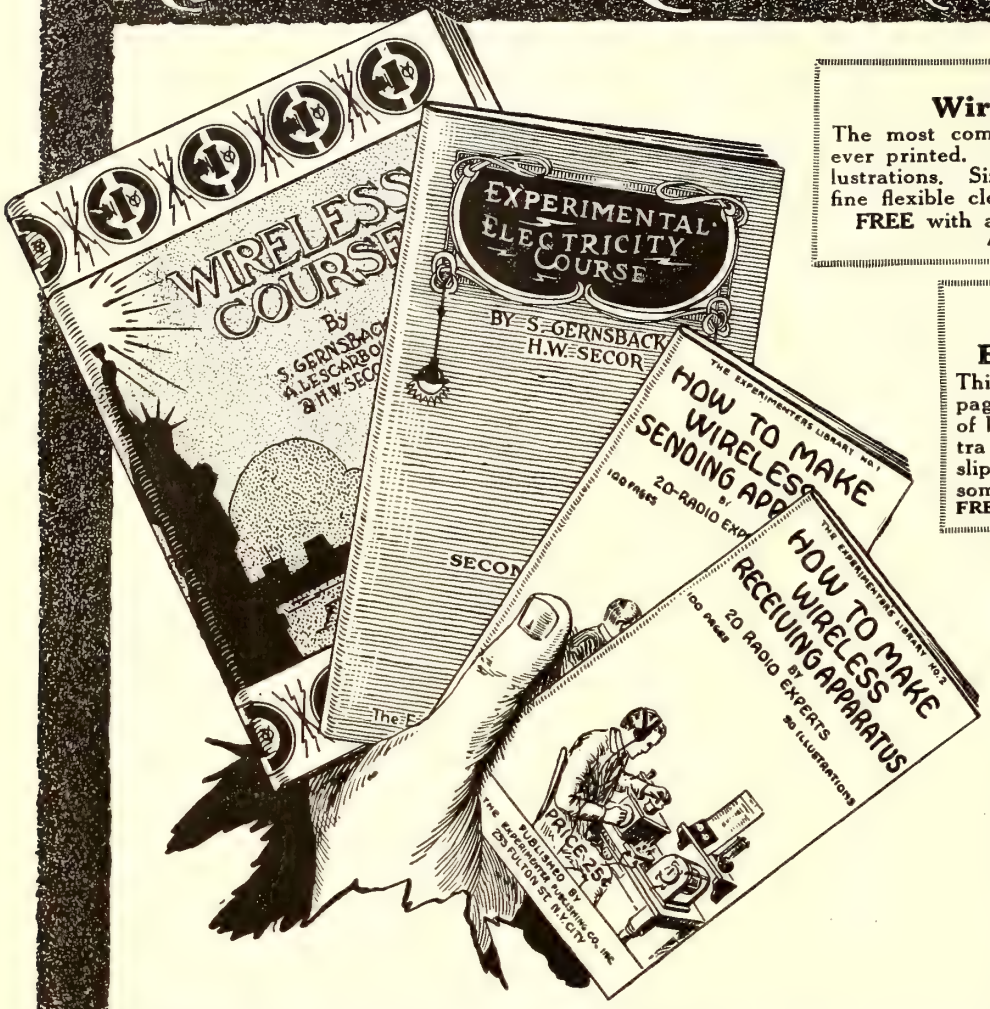


The finest repairer for Ironware, Agateware, Enamelware, etc. Good for kettles, pots, pans, boilers, and every kind of ironware. Also for tin, copper, aluminum, for loose joints, cracks in stoves, broken china, porcelain, bric-a-brac, bisque, crockery, woodenware, marble, etc. Will not chip, fry, burn, bake or boil out. THE MEND IS THE STRONGEST SPOT IN THE POT. Could not be simpler: just mix the powder with water. HARDENS LIKE IRON. Fire-proof. Water-proof. You can fill a big hole or a small crack. Mended place stronger than new. Replaces chipped enamel. Anyone can do it; FAILURE IS IMPOSSIBLE. Better and easier than solder. Three sizes, 15 cents, 25 cents and 50 cents.

Johnson Smith & Co., Dept. E9 3224 N. Halsted St., Chicago

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How to Make Wireless Sending Apparatus
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By 20 Radio Constructors

These books are by far the most successful wireless books on the market. Size of each book 5"x7", well bound on good book paper. Covers in two colors. We really cannot praise these books too highly. Each book contains 100 pages and from 88 to 90 illustrations. **BOTH** books **FREE** with a year's subscription. Add 5c for postage

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Knob, as in upper corner, 1¼ x ¾, with hole for mounting. Post paid 20c

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Talking From 'Plane to Earth

(*Continued from page 203*)

ciated distinctly to them by Lieutenant Metcalf. They craned their necks to see the 'plane soaring far above bearing the officer, whose words came down to them so distinctly thru the ether.

A few minutes later Admiral Sims, from the platform, addrest the same audience *thru the amplifier*. He praised the work of the American Army in France, saying the navy was really an auxiliary of the army. More than 100 crippled soldiers from Walter Reed Military Hospital listened attentively to Admiral Sims' address and applauded his references to the navy, every word of which was distinctly heard, thanks to the remarkable amplifying properties of the new telephonic amplifier used on this occasion.

Billie Burke, the actress, sold bonds to the audience after the address of Admiral Sims, who bought the first bond.

All of which was made possible by the use of radiotelephony on the 'plane and at the ground station, coupled to the "Magnavox," a brand new telephone amplifier thru which the crowd in front of the Treasury heard President Wilson's Victory Loan appeal. Lieutenant Metcalf of the Military Aeronautic Service, delivered the message while flying 2,600 to 3,000 feet (about one-half mile) above their heads. Altho relayed at this great height, every word of the message could be distinctly heard.

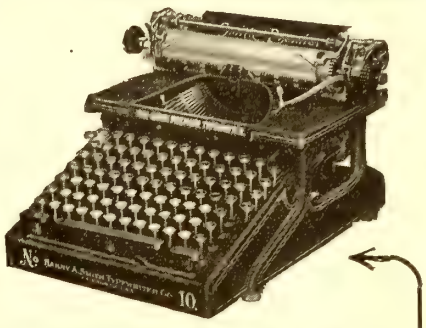
The Magnavox (i. e. magnifying voice) is the invention of Messrs. D. S. Pridham, O. B. Moorehead and P. L. Jensen of San Francisco. It was connected with the airplane by means of the wireless telephone apparatus. One of the photos shows Mr. Pridham using the anti-noise transmitter speaking to the aviator.

The first question the layman naturally asks is: "How is it done?" The effect is wonderful, to be sure, yet it seems so simple. By the aid of the accompanying illustration the successive actions taking place in transmitting the aviator's voice from airplane to earth will be understood. The uninitiated are wont to think that, by some mysterious means or other the voice itself is actually projected thru the air, and that they are actually listening to the original speech. But such is not the case. The original vocal air waves set up in close proximity to the person speaking, in this case the aviator, are imprest on a sound-sensitive instrument, known as a *microphone*.

The microphone faithfully follows every intonation of the spoken voice and modulates or varies correspondingly a weak electric current passing thru the microphone, which modulations or variations of current are caused to affect in turn an audion or "talking bottle," as it is popularly called nowadays. The modulations of current in the microphone circuit are of low or audio frequency, about 1,000 cycles per second, and when these act upon the audion the electrical condition of the circuit connected with the antenna, which is in turn connected with the audion, causes oscillations or currents of high frequency of about 50,000 to 100,000 cycles per second, or higher, which are set up and pass into the antenna. The antennæ or aërial wires from which the radio frequency energy or waves radiate on the modern airplane provides for the use of two of these antennæ, one secured at either extreme of the wings. These wires are made of the toughest phosphor bronze strands, a large number of which are cabled together to give greater strength, and at the lower end of the antennæ, which may be 100 feet or more in length, there are placed lead weights weighing about two pounds. The airplanes arise and descend to and

(*Continued on page 283*)

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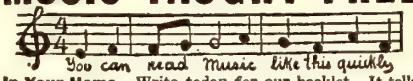
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STORAGE BATTERY TESTING

(*Continued from page 224*)

For example, a battery develops 100 amp. hours at the eight hour rate. At the five hour rate (see table) it will develop 86.5% or 86.5 amp. hours in a five hour discharge. Since amp. hours = amps. × hours, then 86.5 divided by five will = 17.3, the current in amperes that the battery will deliver for five hours.

The graphic curve, Fig. 3, showing the voltage of a pasted plate at the five hour rate will apply to any battery of pasted plates, discharged at the five hour rate.

When the battery is put on discharge readings should be taken at the following intervals: 0 hrs., ¼ hr., ½ hr., 1 hr., 2 hrs., 3 hrs., 3½ hrs., 4 hrs., 4½ hrs., 4¾ and 5 hrs. If the voltage should fall more than that shown in the curve between the 3 and 3½ hr. readings the voltage and cadmium readings should be taken at shorter intervals. When the cell voltage reaches 1.8 the pos. cadmium should read 2.00 volts and the negative about .20. Of course, these readings will vary somewhat, depending on the condition of the battery, but if the pos. cadmium falls below 1.9 volts or the negative rises above .25 it shows a lack of capacity in that group and the battery should be sent out for repairs.

A voltmeter reading on *open circuit* is of no value, since the voltage of a battery after standing a few hours is the same whether charged or discharged, approximately 2.1 volts.

Due to the fact that the *gravity* of the electrolyte changes with the temperature, the amateur very often spoils his battery in this way.

The following table will be of assistance in overcoming the above mentioned trouble. The standard temperature for all commercial testing is 70 deg. Fah.

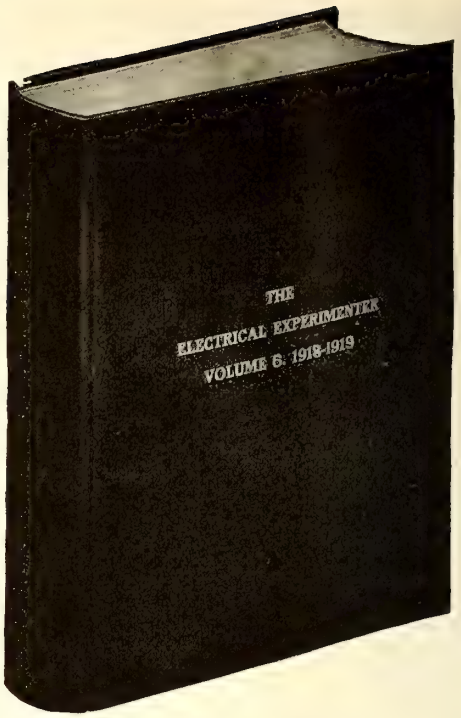
Table I

Degrees F.	Specific Gravity
100	1.275
97	1.276
94	1.277
91	1.278
88	1.279
85	1.280
82	1.281
79	1.282
76	1.283
73	1.284
70	1.285
67	1.286
64	1.287
61	1.288
58	1.289
55	1.290
52	1.291
49	1.292
46	1.293
43	1.294
40	1.295

The temperature of the battery should be kept as near 70 deg. as possible, as the capacity increases and decreases with the temperature. *A starting and lighting battery should not go above* 100 *deg. under any conditions. To do so will loosen the active material from the grids, and after a few cycles the battery will be completely ruined.* However, other batteries containing heavier plates will stand as high as 120 deg., depending on the thickness of the plates, but will be ruined if constantly operated at that temperature. It is therefore a good practise to always keep your battery below 100 deg. If it should be impossible to do this, the next best thing is to lower the specific gravity of the electrolyte.

RADIO ENGINEERS' MEETING.

The Institute of Radio Engineers held a meeting on Wednesday evening, May 7, at the Engineering Societies Building, New York City. A paper was presented on "The Detecting Efficiency of the Thermionic Detector," by Dr. H. J. van der Bijl, of the Western Electric Company. The paper presented described several different methods for measuring absolutely, or by comparison, the true detecting efficiency of vacuum tubes.



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Talking From 'Plane to Earth

(*Continued from page 281*)

from the ground with these aërial wires outstretched. They need not be reeled up as was the previous practise.

Picking up the thread of transformations taking place in the voice from the airplane and by referring to the accompanying diagram-illustration, we see that the high frequency electric currents are shot off from the airplane antenna and proceed to set up electric oscillations or waves in the ether, *not in the air*. These waves radiate spherically in the same manner as the ripples on a small mill pond when you throw a stone into it—the ever-expanding ripples finally reaching the shore, and if a little float or tippet rests on the water it will be rocked by the wave when it reaches its position. The very same thing takes place when the aviator's voice, now transformed into extremely high frequency and inaudible waves, which may pass thru our very body or thru the building in which we may be; and these rapidly traveling waves, speeding onward with the velocity of light, or 186,000 miles per second, eventually reach the receiving antennæ, located in this case on the earth. These waves also move outward from the transmitting airplane station in all directions, and other stations may pick up the message or signals when desired, even at distances of 20 miles or more.

When in an extremely small fraction of a second the radio-telephone etheric waves reach the receiving antennæ, there are at once caused to be set up in the wires comprising these antennæ, minute electric currents corresponding in frequency to the etheric waves of, let us say, 100,000 cycles per second, which are, of course, *inaudible*. This receiving antenna, in the present instance located on the Treasury Building at Washington, D. C., was connected up with a sensitive wireless telephone receiving set, in which we find some more audions, or "talking bottles." In this case the audions or vacuum tubes containing the various electrodes for controlling the stream of electrons or minute electric charges passing thru the audion, are used inversely to their action in the airplane as described above—here they have imprest upon them the *inaudible* radio-frequency oscillations or currents coming to them from the receiving antenna and set up in the manner aforementioned. Of course, these oscillatory currents are carefully tuned by means of the usual tuning coils and metal plate condensers, so that the message comes in with maximum *resonance*. The audions transform these antenna currents into *audi-frequency* currents, which may be then past into an ordinary pair of wireless telephone receivers strapt to the head, or as in the present case, they may be past into a *sound amplifying apparatus*.

An amplifier of this type and suitable for powerfully intensifying wireless telephone or telegraph messages as well as the regular telephonic speech over the usual telephone circuits from Washington to New York, etc., is shown in the accompanying photographs and is known as the *Magnavox*. This instrument comprises a diafram and electromagnet very cleverly arranged and delicately balanced, so that when a medium strength telephone or radio current passes into it, the diafram or sound reproducer of the device responds with greatly intensified effect, and in this way it proves a wonderful advance for the purpose of public speaking, amplifying radio signals under certain conditions where more than one may wish to hear them, such as in lectures, and for a hundred and one other requirements, including train announcing, theatrical purposes, ad infinitum.



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Big Money Made every day selling our automobile accessories. Every autoist a customer. Most remarkable inventions in the accessory line. Demonstration proves every claim. Particulars free. Exclusive territory if you act quick. The Embee Co., Wilkinsburg, Pa.

Install Farm Lighting and Power Plants. Our exclusive agency and special demonstrating offer insure big profits at a small investment. Get our plans at once. Acme Engineering Co., Louisville, Ky.

Beginners. Complete "Mail Order System." C, Box 1005, Atlantic City.

Agents. Big returns, fast office sellers; particulars and samples free. One Dip Pen Co., 12 Daily Record Bldg., Baltimore, Md.

$10 Daily refinishing chandeliers, brass beds, automobiles by new method, without capital or experience. Free particulars and proofs. Write today. Gunmetal Co., Ave. D, Decatur, Ill.

Signs for store and office windows. $50 a week easily made. Chicago Sign System, G 326 River St., Chicago.

Printing.

Gummed Labels! Rubber Stamps! Samples Free! Edward Harrison, "Printing," Baltimore.

100 Engraved style visiting cards, 50c.; 100 emblem cards, 70c. H. Gregory, Warwick, N. Y.

200 Bond Note Heads $1. Money back guarantee. Ferndale Printery, Cherrydale, Va.

Motors, Engines & Dynamos.

Gas Engines. Marine, stationary and cycle motors for bicycle attachment, rebuilt and guaranteed. Don't fail to get our price list before buying. Prices 50% lower than others. Write. United Motor Repair & Supply Company, 305-309 Broadway, New York.

Gasoline Engine. ¾ horse. Set of castings $8. 4 Horse $15. Send 12c. for blueprints. Speed lathe castings $1.85, blueprints 12c. M. & J. Specialty Co., 252 Parke St., Pontiac, Mich.

Small Motors and Generators from bankruptcy and receivers' sales. Motors for all phases of current. Immediate delivery. Less than one-half regular prices. See display ad on page 259. Johnston, West End, Pittsburgh, Pa.

For the Hair.

I Was Bald. Obtained hair growth by an Indian's ointment containing genuine bear oil and rare plant juices. Many others have good hair-growing results. Will send box, postpaid, with recipe, 10c. John Hart Brittain, 150 E. 32nd St., BA-300, New York.

Postcards.

Join the Largest post card exchange in the world. Members everywhere. Membership 15c. 3 months 25c. "Wide World," Box 532, E, New Glasgow, Nova Scotia, Canada.

Join a Post Card Club. Have friends everywhere. Membership 10 cents. John Miller, 1430 H Street, Sacramento, Calif.

Five Prettiest Woman Cards. Hand colored, 25c.; camera bargain list free. Chas. Durso, Dept. 41, 25 Mulberry St., New York City.

Exchange Ads.

Cheap. Selling all my photographers stuff. All new. Write for list. Earl Wright, Cole Camp, Mo.

Former Amateurs. Where are you? What doing? Write me. Let's get busy. Whatcha got, sell or trade. Radio Amateur, Marion, Ill.

Standard Type Corona and Case. Perfect condition. Want 1 KW Thordarson and rotary or other apparatus of equal value. Harry Wright, Fire Island Radio Station, Bayshore, N. Y.

Wanted. Used motorcycle engine, preferably a twin. George Weitz, Boonville, Mo.

3000 Meter Coupler, Tron Bulb. Bargain. L. B. Wilcox, 113 E. 6th, Erie, Pa.

Attention! We have something you want! See our advertisement in main columns. Tabulated Information Card Co.

Sell. Complete receiving set and 5-dial omnigraph. E. Schuessler, 2209 Wheeler St., Cincinnati, O.

Selling My Amateur Wireless. Bargains. "Wireless," Str. Huron, Marine Post Office, Detroit.

Trade. 3-inch spark coil for good phones, audion bulb or loose coupler. Roy Schilling, 2476 W. 29th St., Denver, Colo.

For Sale. ¾ kilowatt transmitter and regenerative receiver, perfect condition. Myrl Priest, St. James, Minn.

For Sale. Official Boy Scout supplies. Send for list. Carl B. Mayo, Orleans, Mass.

Regenerative Cabinet Receiver. Other wireless, electrical and chemical apparatus. Send stamp and state wants. Ray Keogh, 328 Larel Ave., Chicago.

Radio Apparatus for Sale. Receivers, condensers, sending keys, switches, storage batteries, wall telephones, high frequency apparatus, etc. Send for list. George Holmes, 164 W. 146th St., New York City.

For Sale. Wavemeter 100 to 20,000 meters, $25. List of other apparatus for stamp. Gebhard, 1127 Ellicott St., Buffalo, N. Y.

For Sale. New cyclopedia of applied electricity, $16. Claude Grace, Princeton, Ind.

Practically Giving Away wireless instruments amounting $100. List for stamped envelope. Fliegel, 4535 N. 17th St., Philadelphia, Pa.

Sell or Swap wireless apparatus and little of everything else. Send for list. All inquiries answered. Ellsworth Erickson, 3005 Cedar Ave., Minneapolis, Minn.

For Sale. Correspondence course in wireless. Earl C. Brown, Martinsburg, W. Va.

For Sale. Experimental chemical laboratory. Bert Emerson, 704 N. Haydon St., Hannibal, Mo.

Sell. New 5-record Morse omnigraph, key, sounder, $12. Wm. Ericksen, Exchange Bank, Spokane, Wash.

For Sale. Mignon R. L. C. 5 receiving cabinet. Fine condition, wave length, 9,000 meters. Price $30, or will exchange for Paragon regenerative in good condition. Enclose stamp. Harold Smith, Charleroi, Pa.

Typewriter. Oliver and Royal. First class condition. Your choice $25. Emerson Tanner, West Vine St., Canton, Ill.

For Sale. Complete transmitting set, 3 in. receiving apparatus and electrical supplies. Heiges, Wheatland, Pa.

Sacrifice $300 worth Radio and high frequency apparatus all new. Write for description. G. Dunfee, Shenandoah, Iowa.

Must Sell. Send stamp for list electrical books, chemicals, microscope, cameras, phonograph records, etc. T. H. Blacknall, Raleigh, N. C.

Exchange, Buy, Sell. Wireless, electrical goods, etc. Large list 6c. State what you have and want. Zehrbach, Box 500, Hiram, O.

Kodak No. 1-A. Like new with film. Eight dollars. Edward Wilson, Spangler, Pa.

Typewriter. Like new. For sale or exchange. John Galbreath, Rogers, O.

For Sale. Blueprints for connecting A. C. motors. See ad under "Blueprints." Charles L. Chittenden.

Wanted. Electrical or mechanical instrument that will locate buried treasure, from three to five feet underground. I. A. Blalock, 614 Parker St., Jacksonville, Fla.

Exchange Ads (Cont'd)

For Sale or Exchange. 8 H.P. kerosene engine, dynamos, motors, magnetos, switchboard meters, musical instrument and a lot of other things, for list and particulars write at once. F. J. Bretzke, Brownsville, Wis.

Sell or Trade—Toward good wireless receiving apparatus, Westinghouse A. C. ammeter 0-200 amperes and busbar. Ladies' violin, $45. Duncan Eader, Shelby, Mich.

For Sale—Apex Electric Cleaner $43. Never been used. Edw. Juselius, Safepack, Millis, Mass.

For Sale—1 gasoline engine, 4 h.p. complete with new coil plug, piping and tank $19 also 6-100 storage battery $15 and 4-40 storage battery $6.50. Write for list of electrical things. Herman Silber, 166 S. 3rd St., Brooklyn, N. Y.

For Sale—Grebe, DeForest, General Radio and other apparatus. Please enclose stamp. Natalish, 68 West 56th Street, New York City.

For Sale—Clapp-Eastman type E, 5 K. W. transformer, slightly damaged, $100.00. K. M. Briggs, 26 Albemarle St., Rochester, N. Y.

Motion Picture Plays.

Photoplays Wanted. Big prices paid. You can write them. We show you how. Free particulars. Rex Publishers, Box 175, E-3, Chicago.

Blue Prints

Blue Prints. ½ H. P. gas engine, 30c.; ¼ H. P. steam engine, 50c.; ⅛ H. P. boiler and engine, 70c.; all 3 for $1. Circulars on castings and engines for stamp. Universal Gas Motor Co., 364 Monadnock, Chicago.

Blue Prints, 236 A. C. diagrams, 2 to 12 poles, contains 54 single phase, 42 two phase, 50 three phase Star, 40 Delta, 12 Star-Delta. Appendix 38, changes of voltage, phases, speed, cycles etc. Easily understood. Price reasonable. Terms. Write for particulars, or send 25c. for 10 full size samples. Charles L. Chittenden, 811 West 18th St., Kansas City, Mo.

Salesmen Wanted.

House-to-House Salesmen, why not the line that sells and repeats every 90 days? Our Sanitary brushes, mops and dusters pay big commissions, and we protect you in good territory. Only live ones wanted. Early promotion for producers. If you know and admit that you're good, write us. North Ridge Brush Company, 114 Clark Ave., Freeport, Ill.

Stammering.

St-Stu-t-t-tering and Stammering cured at home. Instructive booklet free. Walter McDonnell, 105 Potomac Bank Bldg., Washington, D. C.

Rubber Stamps.

Rubber Stamps Made to Order. McCaddon Company, Zanesville, Ohio.

Dogs.

Airedales, the classy kind. Write your wants. Oak Crest Kennels, Liberty, Mo.

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$5 a Day gathering evergreens, roots and herbs. Ginseng, $14 lb.; Belladonna Seed, $64 lb., or grow it yourself. Book and war prices free. Bontanical-D, New Haven, Conn.

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Earn $25 Weekly, spare time, writing for newspapers, magazines. Experience unnecessary; details free. Press Syndicate, 566 St. Louis, Mo.

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Wonderful! Chemically prepared cloth—makes ice last twice as long. Cuts bills in half. Guaranteed, sanitary, odorless, easily cleaned. Prices, 30c., 60c. E. D. Romig, Pottstown, Pa. Agents Wanted.

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Tricks, Puzzles, Jokes, toys, games, novelties, doll and cane racks, plays, wigs, stage supplies, escapes and illusions. Large 1917 catalogue free. Oakes Magical Co. Dept. 549, Oshkosh, Wis.

Black Art Hindoo experiments. 1919 edition, 25c. Invisible ink. Free trick. Catalogue each order. Linhorst Magic X Shop, St. Louis.

"How-Zit-Dun"? The latest and most mystifying novelty! Only 25c. D. S. Schindler, 661 Washington Ave., Brooklyn, N. Y.

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Magic—Card Tricks. Sensational escapes, jokes, novelties. Everything in the amusement line. Large illustrated catalogue of a thousand tricks free. Write today. Largest amusement goods manufacturers in the world. Heaney Magic Co., Desk 200, Berlin, Wis.

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Business Opportunities.

Problems and Advice in radio, mathematics, electricity, chemistry, etc., answered by experts for $1 and up. Paragon Technical Bureau, 329 E. 5th St., New York City.

Many Suggestions for starting profitable home business, 60c. Central Company, 599 Ninth Ave., New York.

Make Die-castings. Sketch, Sample, Booklet and Proposition, 12c. Byrd & Blair, Box 227-E, Erie, Pa.

Victory. Mechanical Toy Soldier window attraction. 30 inches high. Salutes, turns head, points with finger, etc., as set. Well made, nicely dressed officers, privates, Uncle Sam, etc. Electrically operated. Does some stunt every half minute or oftener as set and will salute soldier and pay no attention to other if desired. Representative wanted in each city and town. Write for prices. The John M. Biggs Co., Box 324, Chattanooga, Tenn.

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Mail Order Business may be your opportunity. Can be started in spare time on small capital. "The Mail Order Man's Magazine" gives inside facts how big profits are made. Contains latest money-making schemes and plans. Valuable suggestions for beginners. Articles by experts. Illustrated. Sample copy, 10c. None free. Mail Order Man's Magazine, Dept. M, Cambridge, Mass.

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Automatic Telegraph Transmitters. Must dispose of fifteen at once. Brand new. Never used. Works like typewriter. Type used by Chicago Telegraph Institute. Real bargain. Photograph. Byron Cook, Wilson Y. M. C. A., Chicago.

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Guaranteed Directions for preserving eggs, 25c. McLardie, Box 465, Dayton, Ohio.

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Inventors. Send sketch of your invention for advice regarding patent protection. Twenty years' experience. Handbook on patents sent free. Talbert & Talbert, Patent Lawyers, 4820 Talbert Bldg., Washington, D. C.

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We Buy and Sell Old Coins. $2 to $500 each paid. Keep All Old Money; you may have valuable coins. Send 10c. for New Illustrated Coin Value Book, 4 x 6. Guaranteed prices. Get posted. Clarke Coin Co., Box 110, Le Roy, N. Y.

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Write the Words for a Song. We write music and guarantee publisher's acceptance. Submit poems on war, love or any subject. Chester Music Co., 920 So. Michigan Ave., Room 265, Chicago, Ill.

Write the Words for a Song. We revise poems, write music and guarantee to secure publication. Submit poems on any subject. Broadway Studios, 1970 Fitzgerald Bldg., New York.

Continued on page 286

Scenery for Hire.

Collapsible Scenery for All Plays. Amelia Grain, Philadelphia, Penn.

Electrical Supplies & Appliances.

Pocket Tester for Electricians, trouble-shooters and maintenance men. For use in place of lamps on 90 to 500 volt lines for locating shorts, grounds, opens and blown fuses. Sizes 2½ x 5", in neat leather case with leads for testing. $1.50 postpaid. Falls Electric Shop, Cuyahoga Falls, O.

Motor Winders. See ad under "blue prints." Charles L. Chittenden.

Battery charging and repairs are big profit makers. Get our special offer. Wolkee Co., Louisville, Ky.

Amateurs Take Notice. Just your chance. Everybody tells you it is impossible to make a practical electrical generator without an expensive layout of equipment, but send for our latest booklet entitled, "A Practical Home-Made Alternator," containing complete instructions and drawings for the construction of any size generator of any phase. No castings or machine work required. Made in the simplest way with the simplest tools. Price 50c. postpaid. Practical Science Shops, Utica, Kan.

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I can show you how to make an efficient electric furnace for less than $2. Send 20 cents for instructions. Box 1788, Los Angeles, California.

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Mark Your Tools with a steel name stamp, and stop theft. 1/10 inch and smaller. 15c. per letter. Harman Stamp Works, 264 Main St., Springfield, Mass.

Wanted. Small gasoline and steam engines, small lathes, drill presses and other light machinery. Will pay high cash prices for good material. Johnston, West End Pittsburgh, Pa.

Multiplying Simplified! For further information see our advertisement in main columns. Tabulated Information Card Co.

Traveling Stoves of Pure Aluminum. Do not rust. Cooks quickly and retains the heat for a long time. Is light in folding. Burns alcohol. Price $1. C. Stelmach, 1318 Crittenden St., Chicago, Ill.

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Get Vital Strength. Retain youthful vigor. Wonderful results. Intensely interesting booklet free. Winslow H. Chase, Washington, D. C.

Traveller. Starting soon on a round the world trip will do all kinds of errands, and is offering his services to collectors of post cards, photographs, postage stamps, etc. Pictorial post cards with views of different parts of the world, each sent by mail from the country of its origin. 10 for $1, 25 for $2.25. Original photographs (post card size) of places of interest (principal buildings, monuments, etc.) which will be taken by myself and sent by mail from the country of origin. 10 for $2, 25 for $5. With all inquiries please send a 3c. stamp to cover return postage. No postage stamps accepted for payments; kindly send a P. O. money order. Mr. P. Hoppen, 181 W. 88th St., New York City.

Rubber Air Pillows. For outdoor sleeping. Could be put in pocket when folded. Price $1.50. C. Stelmach, 1318 Crittenden St., Chicago, Ill.

Julian's Liquid Fishing Lure. Doubles your catch. Trial bottle, $1. George Julian, Albany Bldg., Boston, Mass.

The Wonderful Gas Lighter. No matches to use. Every home should have one. C. Stelmach, 1318 Crittenden St., Chicago, Ill.

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Chemicals. Special, 35 different chemicals, one ounce of each, containing mercury, acids, etc. Sent express prepaid $2.50. Jos. Simpson, 3880 Windsor Place, St. Louis, Mo.

Standard Chemicals and laboratory apparatus, cheap and reliable. June list, 5c. Frane, Eureka, Ill.

Chemicals. Amateurs and experimenters. We can supply you with any chemicals or apparatus that you need. At the lowest prices. Write for our price list. Jos. Simpson, 3880 Windsor Place, St. Louis, Mo.

100 Chemicals—Young Man $6—Complete chemical laboratory. 100 chemicals, as mercury, iodine, silver, molybdenum, together with 96 others, generous quantities, also chemical glassware, blowpipe, etc. Prepaid anywhere $6. C.O.D. terms accepted. Full list on request. Borough Chemical Co., Successors to the Swimmer Chemical Co., 1904 Park Place, Brooklyn, N. Y.

Must Sell Chemicals! Particulars 3c. Pray, 102 Heath, Somerville, Massachusetts.

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Stamps—61 All Different Free. Postage, 3c. Mention paper. Quaker Stamp Co., Toledo, O.

100 Different Stamps 12c.; 200, 27c. Michaels, 5600 Prairie, Chicago.

Fortunes in Postage Stamps. Start stamp business of your own. Send 50c. for sample stock, worth $1.50. M. Shedel, 29 Collahie St., Toronto, Canada.

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Coins, Medals, Paper Money, antiques, firearms, swords, Indian relics, historical engravings, stamp collection. Lists free. Antique Shop, 33B S. 18th St., Philadelphia, Pa.

Stamps & Coins (Cont'd)

50 Different Stamps 3c. Approvals. R. Buckey, 412-B Bowen, Dayton, O.

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Make Die-Castings. Sketch, sample, booklet and proposition, 12c. Byrd & Blair, Box 227F, Erie, Pa.

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The Pliotron Oscillator

By William C. White

(*Continued from page 232*)

maximum value of about 2.5 milli-henries. They should preferably be of the variometer type, continuously variable in the range 0.5 to 2.5, altho a variation by a dozen to fifteen steps is fairly satisfactory.

The object of having L_4 variable is for the purpose of applying the high-frequency energy from the pliotron to the resonance circuit at the correct voltage, so that the energy available is used most advantageously in the resistance of this circuit.

The inductance L_3 is made variable so as to supply to the grid just the right amount of high-frequency energy to make the system self-exciting and to excite it in the most efficient manner.

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With such values of inductance and capacity that a frequency of 100,000 cycles is obtained, a voltage of 12,000 may be produced from one pliotron tube operating from a direct-current source of 500 volts.

Pliotron tubes may be operated in parallel for the production of a voltage higher than that obtainable from a single tube.—*Photo Courtesy G. E. Co.*

BATTERIES LIGHT HOUSES IN SWEDEN.

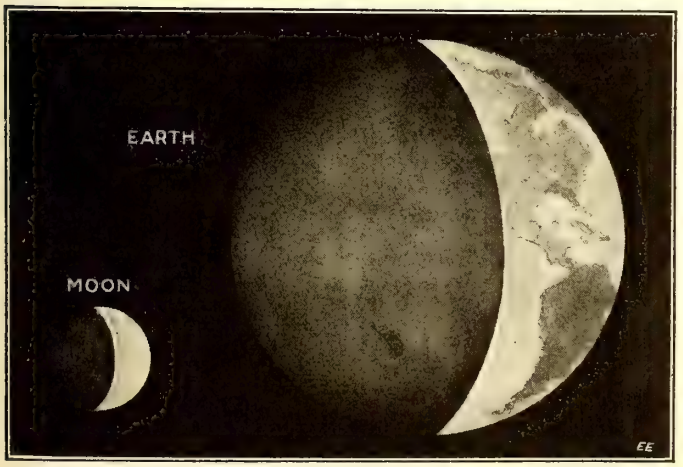
A recent fair held in Sweden brought out the shortage of oil and the many substitutes and methods of economy displayed. The efforts of the lighting industry to find a substitute for the kerosene lamp were shown at the fair in the form of carbid lamps for use in places where there is no electric current—a battery lamp called the "Mercal," and also the Jungner primary elements intended for the electric lighting of entire buildings.

This Is How We Look in Arabic

الروضة (٢٣٥)

بسهولة من سكان الزهرة بمساعدة التلسكوب الذي نستعمله نحن هنا لرصد السيارات

فمتى كان المريخ في مركز مناسب للرصد عن الارض يكون قطر الدائرة من قرصه ما بين خمسة عشر او خمسة وعشرون ثانية من القوس حسب تعديل مسافته عن الارض في اوقات الرصد وعندما تكون الارض بنقطة موافقة لرصدها من الزهرة فقطر دائرة قرصها يكون ثلاثة وستون ثانية من القوس وقطر دائرة القمر سبعة عشر ثانية من القوس وحتى ان قرص القمر الذي نراه فانه يبان للزهرة في اوقات خصوصية اكبر مما يبان قرص المريخ



Articles from the ELECTRICAL EXPERIMENTER Have Been Reprinted in Almost Any Language You Could Think of. Last Month, However, Was the First Time That We Were Quoted in an Arabian Publication. We Reprint Herewith Mrs. Lewis's Article "The Planet Earth" Taken from "Ar-Raudat" — (The Meadow), a Semi-monthly Arabian Magazine, "Ar-Raudat" Republisht the Entire Article from Our April, 1919 Issue.

(الرسم الرابع)

هذا الرسم يظهر هيئة الارض كما تبان للمريخ في وقت لمعانها وهي بهيئة هلال ولزيادة التوضيح انظر شكل ٢ و٥ فالارض لا تظهر لسكان المريخ الا كما هي ظاهرة في هذا الرسم اي هلال ومتى اضيئت بنور الشمس تختفي ولا تعود تظهر للمريخيين

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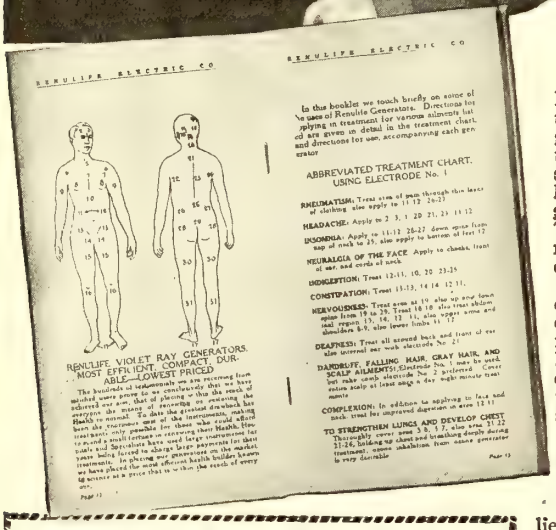
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EDITORIAL

Speeds

IF you had read twenty years ago that it was considered probable and very possible that in 1919 some one would fly across the Atlantic Ocean on canvas wings, propelled by a gas engine, at a speed of 100 miles an hour, you naturally would have turned away impatiently at such childish nonsense. Moreover, you probably would have doubted the sanity of the writer; but even Jules Verne with his most prolific and prophetic mind never prophesied the 1919 trans-Atlantic flight in a heavier-than-air machine.

This naturally brings us face to face with the future. Tho prophesying, as a rule, is bad business, there are certain scientific subjects that can be predicted safely, basing the prediction on mathematical as well as purely scientific grounds.

The question before us is: How fast is it possible for man to travel thru the air? Theoretically at least, there is no limit to the speed at which a human being can travel.

Airplanes already have covered over 200 miles an hour without discomfort to the aviator. At this point we venture to say that should the speed be increased over 300 miles per hour, the aviator will probably be very uncomfortable, due to the terrific rush of air. Even at 100 miles per hour the air lashes the face of an aviator badly. Therefore, flying above 300 miles per hour, he will have to sit in a cabin surrounded by glass, where the rush of the air cannot be felt. Suppose we increase the speed to 500 miles. What happens? Nothing. This speed is so probable that it will no doubt be reached before 1925; possibly much sooner. But we think such speeds will not be reached near the surface of the earth where the density of the air, and consequently the greater resistance to an airplane, is too high. In order to travel at 500 miles per hour, the future airplane must offer as little surface to the air as possible. It should have no struts, wires, or stays. It probably will fly at a height of 5,000 feet or more, decreasing its speed as it approaches the earth. 1,000 miles an hour? Yes, man will do it. It is not only possible, but very probable. It will be accomplished in a machine which bears but little resemblance to our present-day airplane. Moreover, it will be absolutely necessary to rise at least to 25,000 feet above the earth, as otherwise the dense air will tear the machine apart, unless it were constructed entirely of metal. But because very much less power is required at the level of 25,000 feet, future express airplanes will prefer the high altitudes.

We might mention, *en passant,* that if you were in a machine flying at a steady speed of 1,039 miles per hour, also supposing you had enough fuel to stay up 24 hours, the following historical event would take place. Starting at noon and flying due West along the equator, with the sun above your head, the sun will not set for you on that memorable day. It will be directly overhead, as long as you keep on going, *for you will now be flying at the rotational speed of the earth,* which is 1,039 miles an hour. Looking down you will see the earth make one complete revolution; you will have seen every point and every continent along the equator. But 1,000 miles per hour is very tame. The earth in its orbital motion around the sun rushes thru space at the terrific rate of 65,533 miles an hour; Venus at 77,054 and Mercury at 105,325 miles per hour. So let us be hopeful!

H. GERNSBACK.

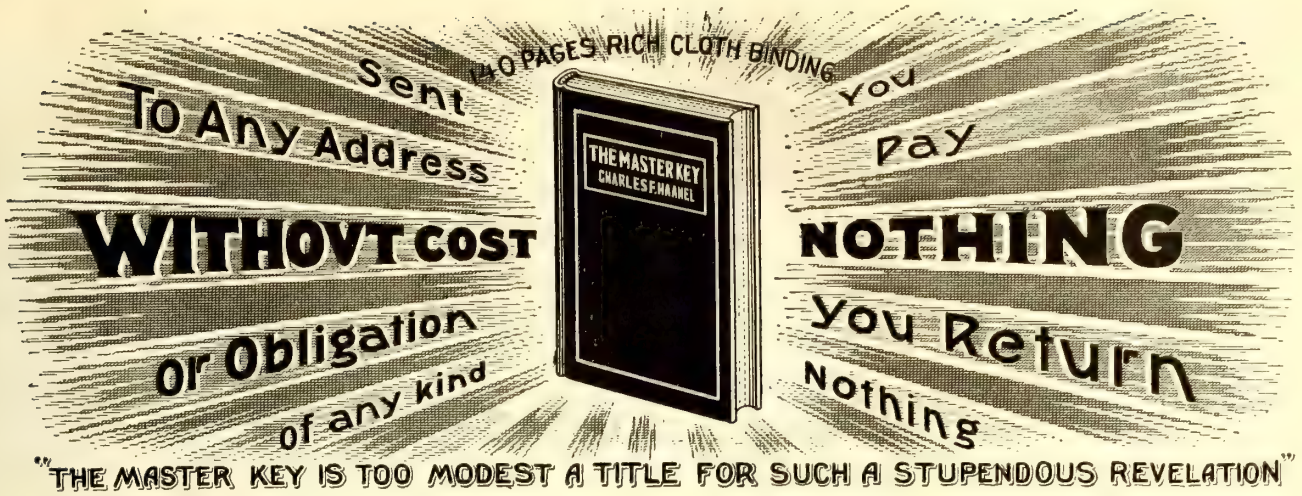
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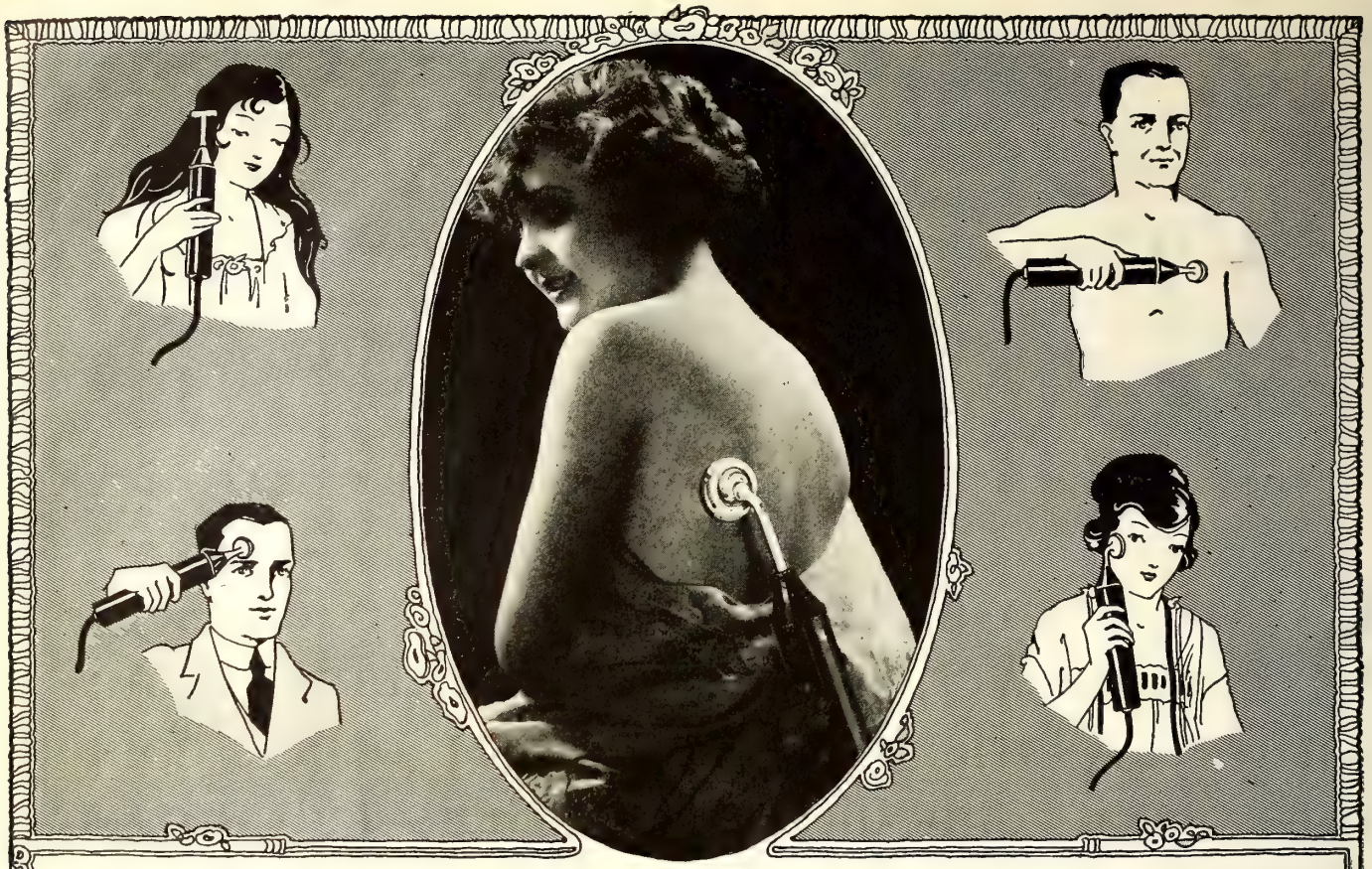
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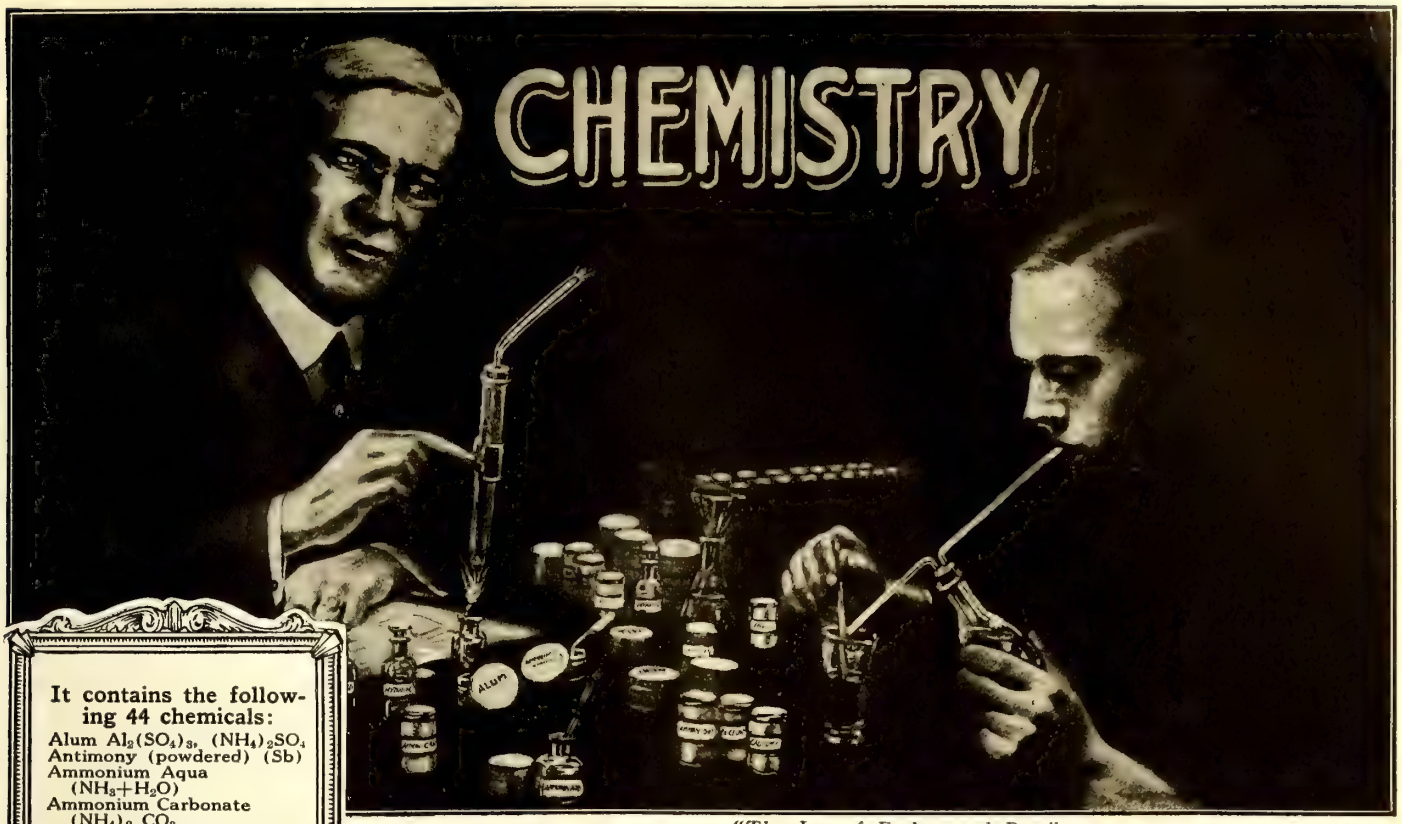
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Not a Vibrator

The Violetta is not a machine that contracts the muscles—it does not shock, it does not pound the muscles—it is absolutely painless. Violet Rays administered by the Violetta are wonderful even for infants!

This advertisement copyright 1919, by Bleadon-Dun Co.



"The Joy of Father and Boy."

It contains the following 44 chemicals:

Alum $Al_2(SO_4)_3$, $(NH_4)_2SO_4$
Antimony (powdered) (Sb)
Ammonium Aqua (NH_3+H_2O)
Ammonium Carbonate $(NH_4)_2\ CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride ($BaCl_2$)
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride ($CaCl_2$)
Calcium Oxide (CaO)
Calcium Sulphate ($CaSO_4 2H_2O$)
Charcoal (Carbon) (C)
Chloride of Zinc ($ZnCl_2$)
Copper Sulphate ($CuSO_4$)
Ferrous Sulphate ($FeSO_4$)
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride ($FeCl_2$)
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate ($MgCO_3$)
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride ($NiCl_2$)
Oxalic Acid ($H_2C_2O_4$)
Sodium Bicarbonate ($NaHCO_3$)
Sodium Borate ($NaBO_2$)
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate ($NaNO_3$)
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride ($SnCl_2$)
Sulphate of Nickel ($NiSO_4$)
Sulphate of Zinc ($ZnSO_4$)
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
Zinc Carbonate ($ZnCO_3$)

The following apparata are furnished:

One Standard Washbottle
One Alcohol Lamp
One Conical Glass Measure
One Erlenmeyer Flask
One Glass Funnel
One Delivery Tube
Six Assorted Test-Tubes
One Test-Tube Holder
Ten Sheets of Filter Paper
One Glass Dropper
One Spoon Measure
Glass Tubing
One book containing Treatise on Elementary Chemistry and 100 Chemical Experiments to be performed with this outfit.

"ELECTRO"

Chemical Laboratory

We present herewith to our friends our new **E. I. Co. Chemical Laboratory** which contains **real** chemicals and apparata to perform **real** chemical experiments. This outfit is not a toy, put up merely to amuse, but a practical laboratory set, with all the chemicals, apparata and reagents necessary to perform real work and to teach the beginner all the secrets of inorganic chemistry. With this outfit we give free a book containing a **Treatise in Elementary Chemistry, useful data and recipes, and 100 instructive and amusing experiments.**

DESCRIPTION OF THE OUTFIT:

The outfit consists of forty-four (44) Chemicals all C. P. (chemical pure) put up in appropriate wooden boxes, glass bottles, and hermetically closed jars. The acids are put up in glass bottles, with ground-in glass stoppers and there is a sufficient quantity of chemicals supplied (mostly one to two ounces) enough to make dozens of experiments with each. See list of Chemicals herewith.

The apparata furnished are all of the best obtainable make and of standard laboratory size and shape. A list of the 17 pieces of apparata furnished with this outfit is printed also herewith.

The Instruction book is a real **Chemistry Course for the Beginner.** Some of the Contents are: **Division of Matter:** This is a Treatise on Elementary Chemistry and deals with the theory of the Elements, Molecules and Atoms, etc. **Chemical Nomenclature.** This explains in simple language the derivation of the chemical names of the Elements and their compounds. There is a chapter on **Laboratory Operations; Glass Working; First Aid; Fire Extinguishers; Experimenters' Aphorisms,** etc.

A good part of the book is devoted to Weights and Measures. The Metric System, the English system and the U. S. System are fully explained.

The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

Among the **100 Experiments** are:

How to make chemical tricks; How to make invisible and magic inks; How to test flour; How to test soil; How to Make Chlorine Gas and smoke (German War Gas); How to bleach cloth and flowers. How to produce Oxygen and Hydrogen; How to make chemical colors; How to test Acids and Alkalies and hundreds of interesting hints and formulas.

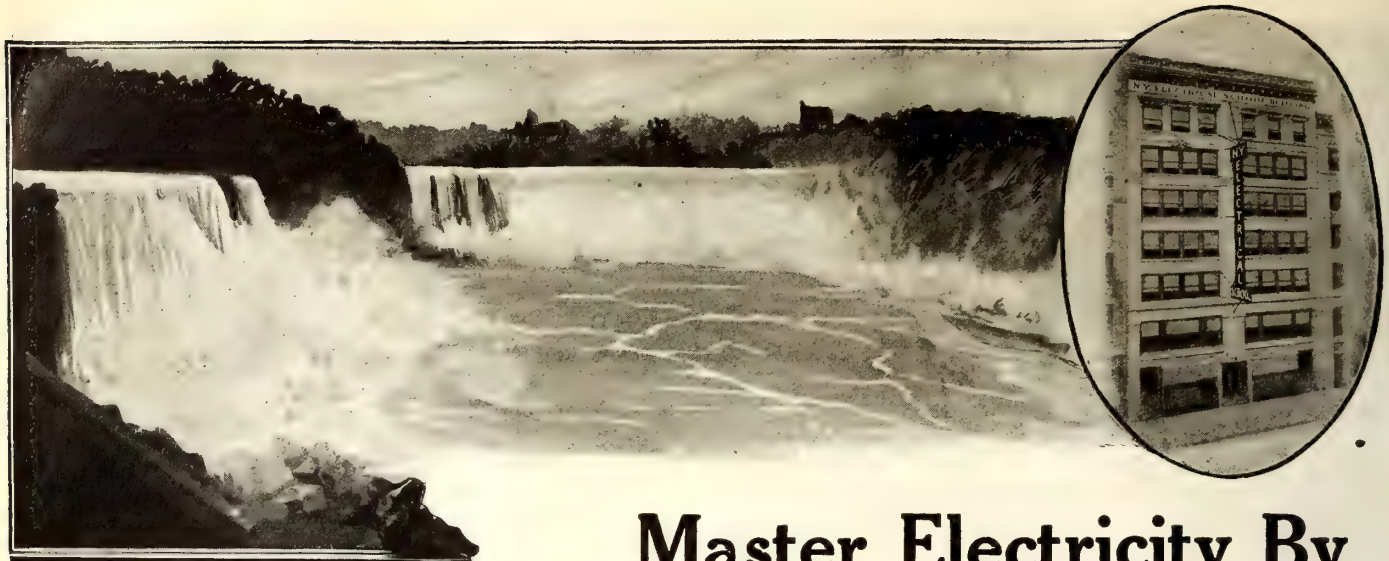
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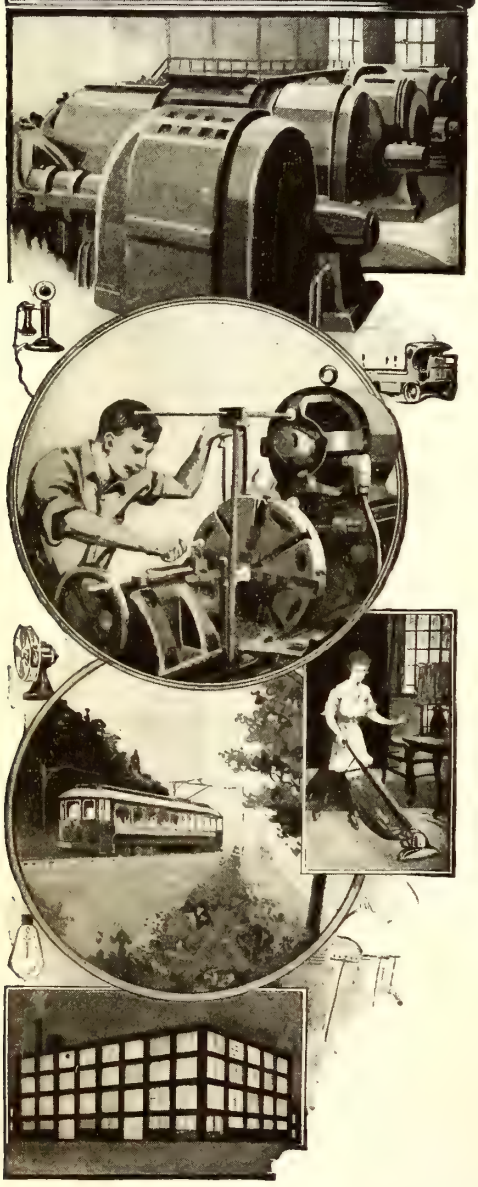
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We have just installed a special automobile ignition course for auto mechanics, garage men and owners. The course covers completely ignition, starting, lighting and other electrical equipment in connection with automobiles, motor boats, etc.

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ELECTRICAL EXPERIMENTER

H. GERNSBACK – EDITOR
H. W. SECOR – ASSOCIATE EDITOR

Vol. VII. Whole No. 76 AUGUST, 1919 No. 4

Radio-Planes Watch Forests and Ranches

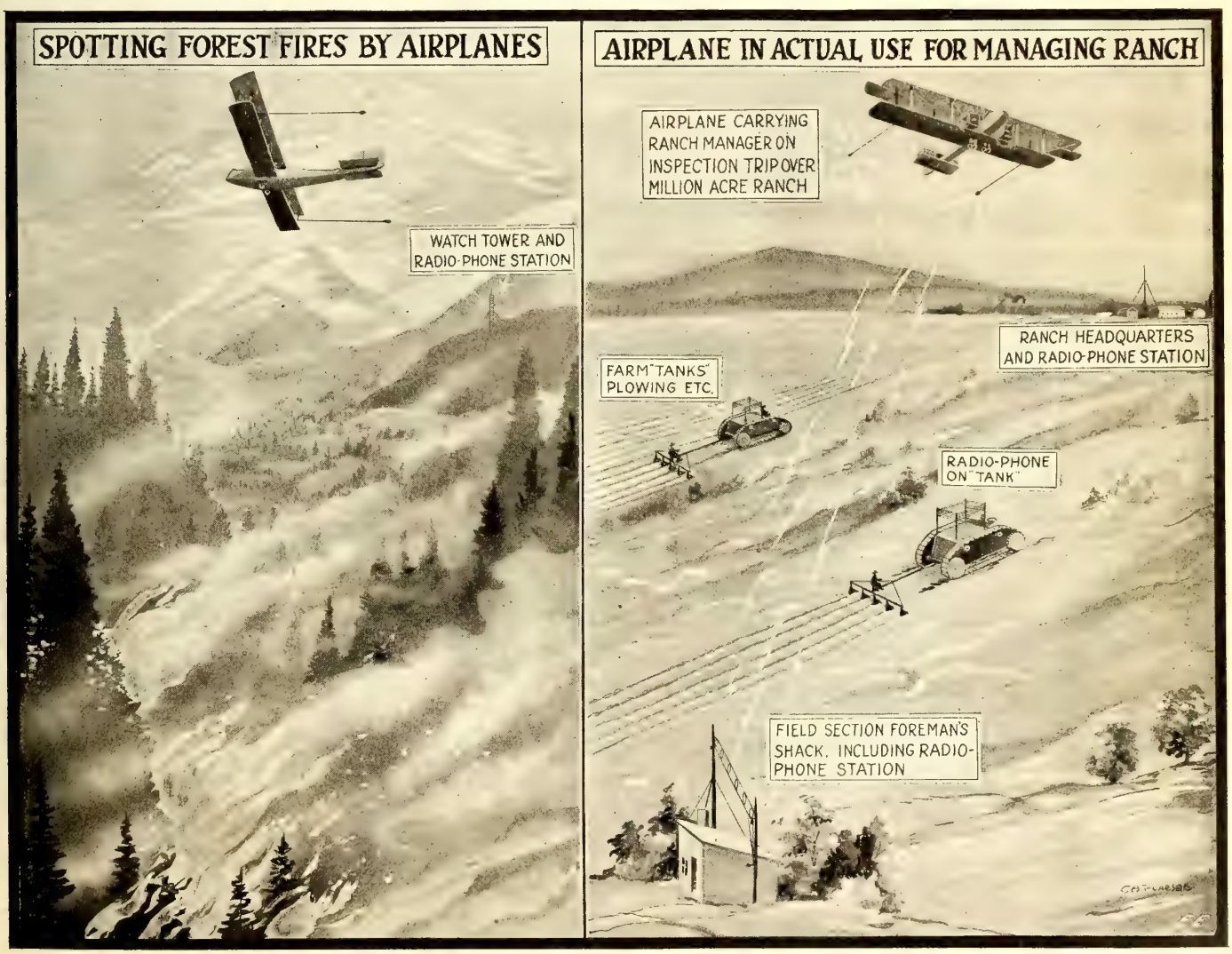
AIRPLANES, plus radio-telephone equipment, have found a brand-new peace-time utility—watching for forest fires in the vast government timber preserves, and also for supervising the operation of large ranches, such as those embracing thousands of acres and found frequently in the great Western farming regions. Some of these farms and ranches are so large that it takes a superintendent all day to make an inspection trip across the ranch, even with a high-powered automobile.

How the Airplane Plus Radio Is Used to Watch Great Forests and Ranches

The airplane as part of a farm equipment is now a reality. It makes its appearance at Hardin, Mont., on the wheat ranch owned and controlled by John Pierpont Morgan and other New York capitalists. Erhardt Schmitt, former American army aviator, has been employed to operate the machine. His duties are to carry the ranch manager from one part of the 250-mile, 100,000-acre wheat ranch to other fields. A wireless telephone in the airplane enables the manager to keep in constant communication with the ranch headquarters.

Not only can the manager or superintendent immediately report back to the ranch headquarters, by radio-telephone, but he can give local orders to gang or section foremen by means of small radio receiving

(*Continued on page* 364)



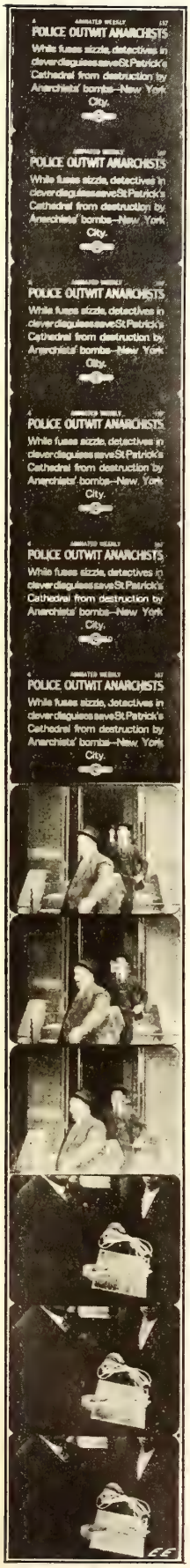
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Two New and Important Peace-time Uses for Radio-equipt Airplanes—Watching for Forest Fires and Inspecting Large Farms and Ranches.

Bomb Expert Eagan

SPECIAL INTERVIEW TO THE ELECTRICAL EXPERIMENTER

Types of Bombs and How to Handle Them



"OWEN EAGAN"! At the mention of his name, the thought of bombs, anarchistic plots and explosives flood the mind. Seated at his desk, I found a man of sixty years, of medium height and massive proportions; head covered with curly gray locks. His

Section of a Film Story of Mr. Owen Eagan's Exploits in "Bombland." For Years Inspector Eagan Has Inspected Infernal Machines by the Hundred and Still Lives to Tell the Tale.

eyes are of piercing steel gray and he has an ever-ready smiling countenance. A firm hand clasp told of a man of power, youthful in spirit, a believer in the great out-doors, a staunch American who cherishes a long and lasting friendship with that Great American, Theodore Roosevelt.

Mr. Eagan Classifies the Bombs.

We will now let Mr. Eagan tell of his bombs. Among other things. Mr. Eagan said:—

Bombs may be classified into four types, according to the explosives used: Nitro-cellulose, Nitro-glycerin, Nitro-benzol, Alkalin metallic nitrat mixtures.

These explosives permit of many combinations and varied means of igniting them. Bombs may be further classified according to the method of ignition used: Manual, Mechanical Electrical, Chemical.

The container or envelope of a bomb may be anything from a newspaper wrapt around the explosives to iron pipes, ice cream freezers, violin cases, cigar boxes, bottles filled with concrete and all imaginable kinds of wrappers.

RULES FOR HANDLING BOMBS

By INSPECTOR OWEN EAGAN,
Bureau of Combustibles,
NEW YORK FIRE DEPARTMENT.

If you should receive what you believe to be a bomb or infernal machine thru the mails or by messenger

1. **LEAVE IT ALONE.**
2. **DO NOT PLACE IT IN WATER.**
3. **CALL THE FIRE DEPARTMENT, OR IF IT IS NOT CONVENIENT, CALL THE NEAREST POLICE OFFICER, WHO WILL AT ONCE NOTIFY THE FIRE DEPARTMENT, AND HAVE THE EXPERT COME TO INSPECT THE SUSPICIOUS PACKAGE IMMEDIATELY.**

It is a common but fallacious rule among the general public, that in order to be safe with a bomb or infernal machine, it should at once be placed in a pail of water. If the bomb or infernal machine has a fuse attached to it, and the fuse may be seen burning or sputtering, then drop the bomb in water, which method usually is efficacious in making it harmless, as the lighted fuse is at once extinguished, but the best advice is to leave the house.

However, when this lighted fuse is NOT PLAINLY EVIDENT on the bomb or infernal machine, IT SHOULD NOT BE PLACED IN WATER, as many of these hellish devices are chemically or electrically operated. Another possibility likely to occur, if the suspected bomb or package is placed in water, is that some of them are made up in part of certain chemicals which will explode as soon as the water reaches them. There is an added probability that if the package or bomb is immersed in water, the reaction between the water and the chemical may give rise to a violent and persistent combustion, the flames of which will set fire to the house. In some of these contrivances there is a second compartment containing a high explosive, which can be ignited by heat, and where such a condition as outlined may occur, it is at once apparent that the heat due to the combustion of the initial chemical may generate sufficient heat to detonate the explosive, with possibly fatal results.

Every bomb presents a new problem as regards its envelope, contents and construction, and the best means of opening it without causing it to explode and send me "West." Everything is filled with uncertainty at this stage. The task requires ingenuity, nerve, precision and firmness of hand, which is essential to a surgeon in performing a very delicate operation. In both cases, a life is in the balance. These qualities cannot be gained by study, but must be secured by experience covering many years.

We now enter the second phase of the work. It is now necessary for me to classify and analyze the layout, materials, methods and plan of the bomb maker. What's in the vial? Why the wire? Where is it attached? What's this powder? Is it a mixture of several chemical substances? Why this and why that? Two, four, seven compartments, everything interlocking! Can't see the battery, detonating cap! Can't pull its "teeth"!

The scene is set in someone's home or office, sometimes it is my laboratory; every one has gone; the windows have been raised, doors opened to relieve the compression in the event of an explosion. There are two opponents, a bomb and Eagan, but Dame Experience is always with me.

The hellish combination has been broken down and then the "guests" are called and there on the table before them in various groups are explosives, timing devices, detonators, ignition mixtures, acids, vials, batteries, wires, fuses and the "bomb-maker's camouflage". Now the wheels of Justice are set in motion and the search for the bomb-maker begins.

Since the discovery and use of gunpowder, bombs of various types have been used.

The First New York Bomb Outrages.

The first series of bomb outrages in New York, from 1902 to 1910, known as the "Blackhand Bombs," occurred in the Italian section, and these were chiefly of the nitro-glycerin group, manually ignited. Dynamite was placed in olive oil cans and ignited by a time fuse which the "dynamiter" lighted and walked away to await developments.

A large number of bombs of the alkalin metallic nitrat group were made dur-

Another view of the "Animated Weekly" Film Story of Inspector Eagan's Great Work—that of Official Bomb Opener to the City of New York. His is the Only Job that Has no "Waiting List" of Future Aspirants.

ing this period. These consisted of various nitrats and chlorats and were exploded by time fuses manually ignited. Some were of the grenade type and were hurled at the victims.

Most of the bombs of this period were of a crude design and were made from articles of every day

(*Cont. on page* 341)



A Few "Samples" of Eagan's Bombs



(Exclusive Story of Mr. Eagan's Bomb Exploits on Opposite Page.)

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Peacetime Uses for War Inventions

By H. Winfield Secor

"SCIENCE moves in mysterious ways, her wonders to perform"—to paraphrase the well-known biblical passage, and never was this demonstrated more pertinently than at the present time, when we find many of the great World War's deadly inventions being converted to peacetime uses. Everybody is being benefited by the industrial application of some of the greatest inventions yet perfected by man, and many thousands more will live to reap the benefits accruing from the as yet undreamt-of applications for both business and pleasure, of airplanes, tanks, wireless devices, submarines, and a thousand and one other attainments of the world's master scientific minds.

A semi-humorous application of the Meissner *airfone*, described elsewhere in this number, is shown in Fig. 1. This device, which is very simple in construction, resembles a speaking tube in form, but incorporates several novel and distinct improvements, among others, an acoustic amplifier, making the device very efficacious for carrying on conversation between the pilot and observer in an airplane, where it is extremely difficult to hear under ordinary conditions, due to the great noise of the engine. A new application of this device is here suggested, namely, to muffle the ever-present and detestable "movie pest." Not only do we find these miserable atoms of humanity in the dark quiet of the movie theater, but also in all of the regular theaters. These brilliant insects must have seen some of the shows which we happened to frequent, about 999 times,—so replete is their knowledge of the "star" and "staress" and all the lesser satellites appearing in the play. They will tell you loudly the climax half an hour before it comes off and so on. So, thanks to the Meissner *airfone*, it should not be so very long before "us ordinary mortals" shall be able to go to the theater and enjoy a performance without having one of these human dramatic compendiums racing along two knots ahead of us, all the way thru the play and telling his sweetheart every move just before it happens. Some of you may like your entertainments served up that way—as for us, we object!

A very good use for the Boche's far-famed *Poison Gas* is shown in Fig. 2. What better application than to annihilate the rats by asphyxiation—"sauce for the goose is sauce for the gander." The Germans thought they had something brand new in strictly war inventions when they tried poison gas on the Allies, but among other recent applications of this invention to peacetime utilities and requirements was that of killing rats. Of course it goes without saying that before injecting a few dozen cubic feet of mustard or chlorin gas into a rat hole, that you had best provide yourself with a guaranteed gas mask and also buy a few dozen corks with which to plug up the other openings in the walls or floor boards. Give it a trial, ladies and gents—it's the "kaiser" of all rat killers.

Embryonic *Tanks* were already in use for agricultural and other purposes long before the World War, and in fact the first tanks used by the British Army on the battlefields of France were reconstructed agricultural tractors, built in the United States. These tractors were armed with steel plates and fitted with rapid-firing guns. The illustration, Fig. 3, shows another application besides that of the usual plowing and cultivating operations—that of hauling large logs in the lumbering districts of the great West. In these localities it is difficult to build even small railroads, and it doesn't pay to build any extensive trackage for such log railroads, as they are not apt to be used for any great length of time. Therefore, the tank tractors should prove very useful, as they can travel over practically any kind of ground, including ditches and even over logs. It will be remembered that during operations in the World War the tanks could crawl over great shell holes, trenches and brooks. This application should provide some fine chances for those of our Tanks Corps soldiers who are aching for army life and the ups and downs met with in the everyday career of a "tank rider." These tanks can haul tremendously heavy loads and resemble in their operating characteristics the work of the famous elephants of India, who pick up with their trunks giant timbers 30 to 40 feet long and measuring 8 to 10 inches square.

Airplanes—oodles of them—will soon be flying over our heads every day all over America. Many people have an idea that the airplane is a peacetime luxury, not to mention a wartime necessity. But such is not the case. If for no other reason the airplane has come to stay in its everyday application to the transportation of mail and the lighter classes of merchandise as by multiplying its everyday utilities, the practical development of aircraft is bound to result. This country, as well as every other power, is keen, of course, to develop aircraft to the highest pinnacle of practicability. The U. S. Army, as well as the Navy Department, has only recently put up a stiff fight for many millions of dollars with which to carry on much-needed airplane developments. One of the best ways to train fliers, especially in this country, where a large standing army or navy personnel is never maintained, will be without a doubt to encourage in every way possible the commercial application of flying machines of all types. Already in England a piano has been transported across the English Channel by airplane, and airplanes are at present available which can lift very heavy loads, and, morever, they are daily becoming more reliable and less liable to accident, should any part of the machinery fail while in the air. Hundreds of people of course take one look at an airplane, especially when it is ascending or descending in flight, and are satisfied to keep both feet on old *terra firma*. However, some of the latest types of airplanes are guaranteed to right themselves and land safely, even if the engine stops in mid air and the control cables become tied or ruptured. See Fig. 4.

Liquid Fire, as shown in Fig. 5, should prove efficacious for several industrial uses, such as burning off paint from iron and steel structures, vessels, etc., and, according to H. Gernsback, also for blazing a path or hole thru ice jams, which frequently prove extremely dangerous during the American winters, when they clog rivers and streams, as well as dams. Under certain conditions it might also be used to blaze paths thru jungle brush.

The *Geophone* is a remarkable physical instrument greatly improved and perfected during the war by the engineers connected with the Allied technical staffs, and used with great success for the purpose of locating enemy artillery and other military operations. Now it has found a distinct peacetime use. See Fig. 6. The saving of many miners' lives has been made possible, thanks to the Geophone, which can detect sound vibrations thru the earth at surprisingly long distances. It has been used successfully in some Government mine tests to pick up the sound of a pick-axe at a distance of about one-quarter mile. There is nothing electrical about the Geophone. It is purely mechanical and acoustic in its function. It operates on the principle that the inertia of a small lead weight within the instrument, and which is secured to a set of diaframs, will tend to hold its initial position whenever an earth-borne sound vibration, for instance, happens to affect it. The other part of the instrument moves and the lead weight tends to remain stationary in the same manner as your body sways forward due to its inertia when a car suddenly stops. The relative movement of the diafram to which the weight is attached with respect to the movement of the casing sets up an air wave, and this is transmitted to the ears thru a rubber tube, in the same way as a physician's stethoscope works. By means of this wonderful instrument, therefore, it is now possible to actually locate entombed miners at considerable distances. Communication with them is also possible by this means. Knowing the location of the entrapt men, it becomes much more expeditious to carry on rescuing and excavating operations in order to save them.

(*Continued on page* 365)

September Number of the Electrical Experimenter

Sir William Crookes' Psychical Researches, by Hereward Carrington, Ph.D., Scientific Proof of the Existence of Psychic Force, as investigated by one of the world's foremost scientists.

Paris Letter—the Latest Electrical and Scientific News from French Scientific Laboratories. by Jacques Boyer.

Practical Experiments in Chemistry, by Albert W. Wilsdon—An everyday plain English talk on the cleansing of clothes.

Thermo-Electricity, by Thomas W. Benson.

The Mystery of Atmospheric Electricity, by Rogers D. Rusk, M.A.

How to Make a Machine for Telegraphing Pictures, written especially for our young readers by America's greatest tele-photographic expert, Leroy J. Leishman.

Experiments in Physics—Illusions, by John J. Furia, M.A.

New American Salvage Device for Raising Sunken Ships—A most timely and important article, by Joseph H. Kraus.

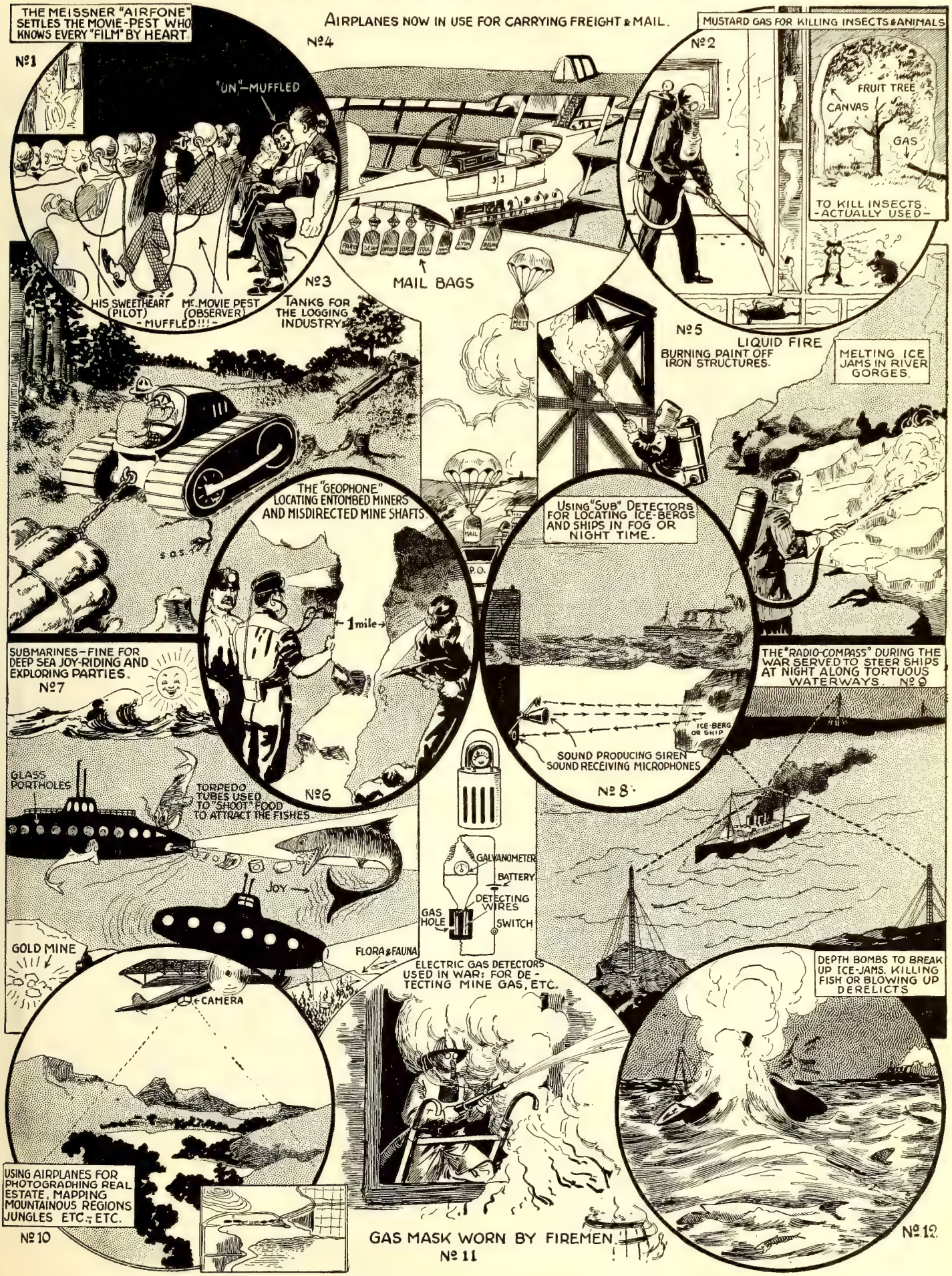
Latest Amateur Radio Receiving Apparatus, by Charles W. Noller.

Light Houses—How They Signal, by A. H. Whedon.

Electrical Detective to Register Your Chauffeur's Joy Rides, by Thomas Reed.

Latest Developments in Flying.

Peacetime Uses for War Inventions



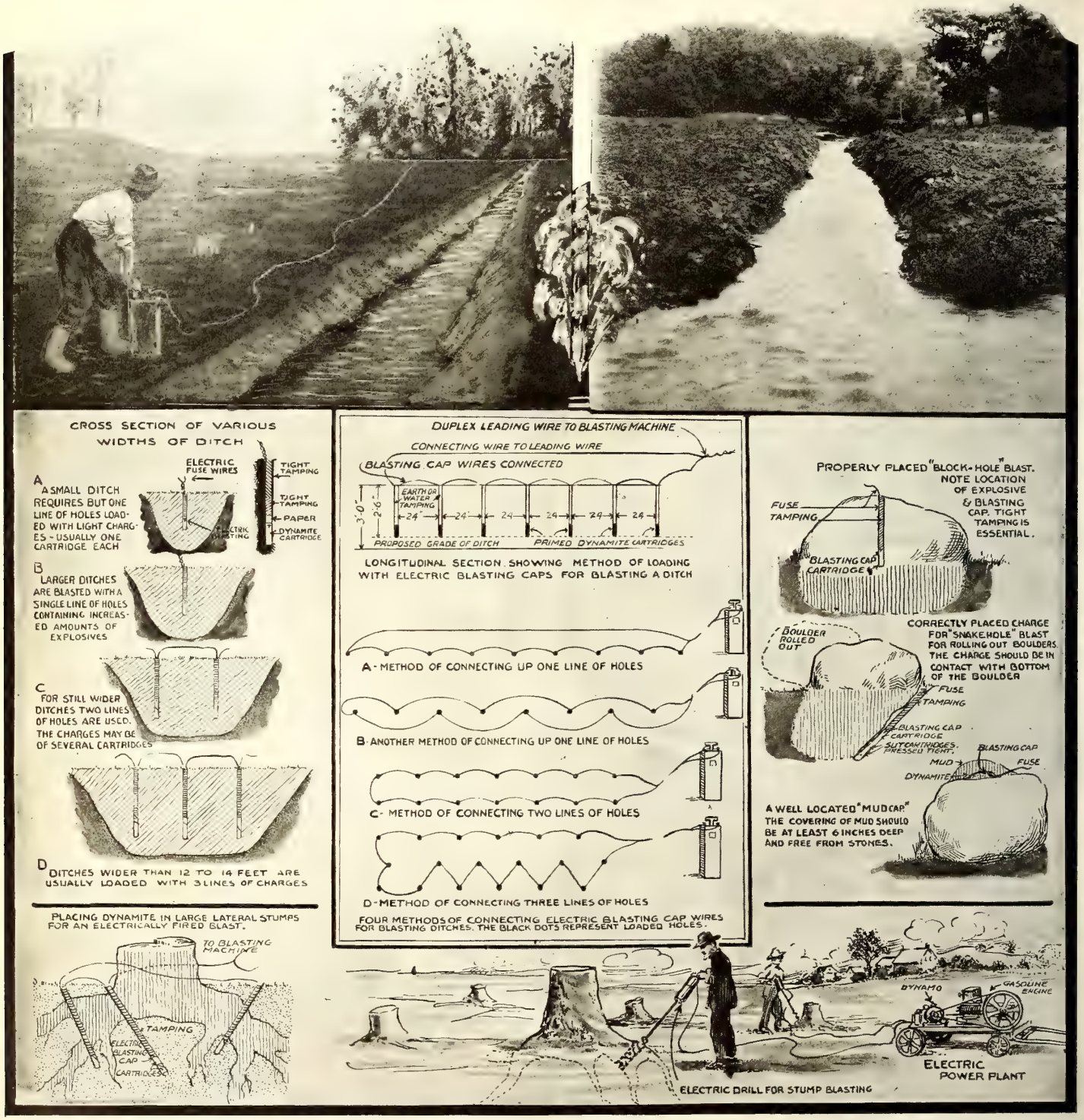
Full description on opposite page.

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Changing Nature's Face

How Electricity Plus Dynamite Makes Brooks, Removes Stumps and Breaks Up Rock

THE World War has, if nothing else, brought to light the great flexibility and usefulness of explosives such as *dynamite,* not for the purpose of annihilating men and cities, but for the more human, utilitarian purpose of leveling uneven and rocky ground, blasting out stumps from previously wooded ground,



Illustrating a Few of the Wonders Which Dynamite Plus Electricity Accomplish Every Day All Over America. Stumps Are Cleared Out—Boulders Shattered—Ditches Constructed and Even the Courses of Rivers and Streams Altered. Verily the Face of Nature is Changed By Man.

and breaking up rock. Again, brooks and irrigating streams are rapidly "dug" in a single day by the use of *dynamite plus electricity,* under the highly developed methods now available for applying explosives, and even the course of a river has been changed in the twinkling of an eye.

What we are interested in, in the present discussion, is the practical application of explosives to the everyday requirements of the tiller of the soil and those who are interested in improving wooded or rock strewn property.

The Electrical Detonator.

In "blasting by electricity," use is made of a slight electric current usually generated by a hand-operated dynamo of the magneto type. The dynamo is placed in a substantial cabinet to stand hard usage such as is encountered in blasting work, with a handle protruding from the top of the box containing it. This handle is attached to a gear rack and pinion, the pinion being secured to the shaft of the dynamo, so that when the handle is drawn up and then quickly deprest, the armature of the dynamo will be spun rapidly, thus generating a current of fairly high potential.

The *electric detonator* used in blasting, comprises a small copper shell, in which an explosive charge is placed. Two insulated

(*Continued on page* 351)

Man's Greatest Curse--Infected Teeth

The Work of HENRY A. COTTON, M. D.

MEDICAL DIRECTOR NEW JERSEY STATE HOSPITAL, TRENTON, N. J.

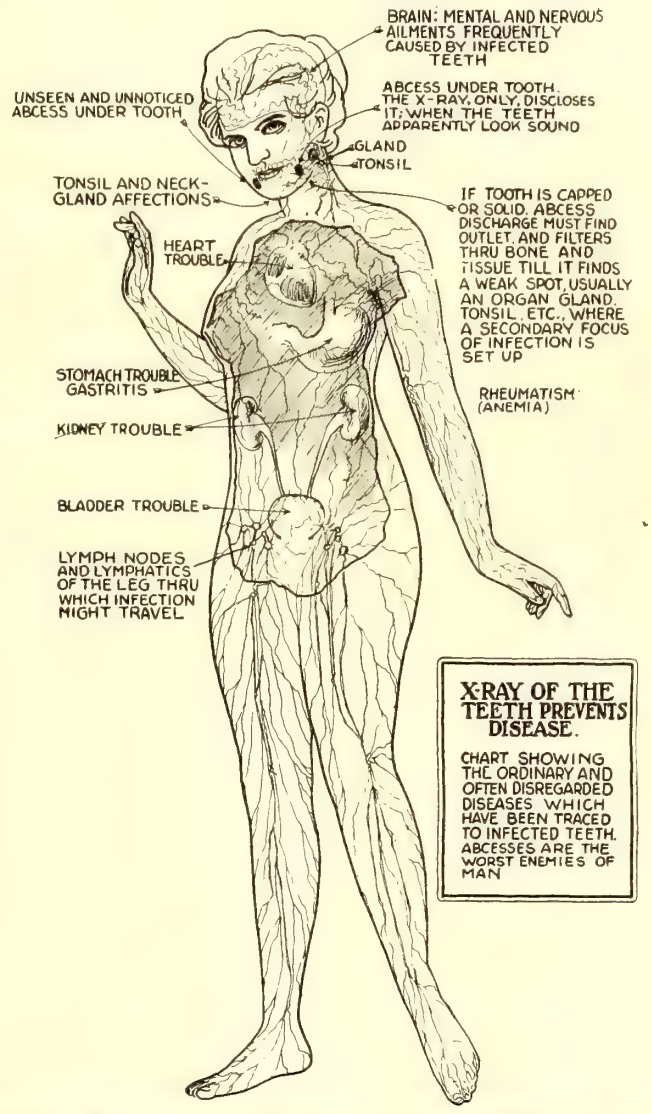
How X-Rays of Teeth May Prevent Disease and Insanity

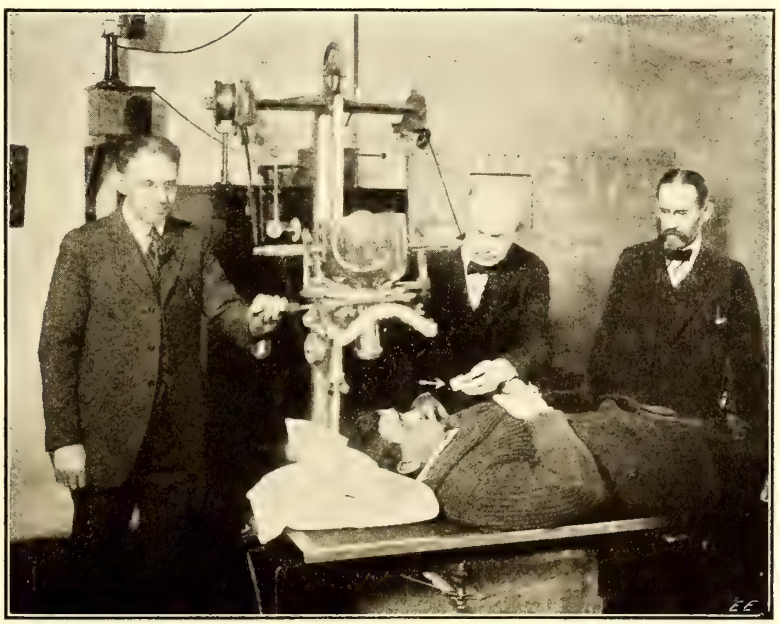
INVESTIGATIONS in the last few years, by both dentists and physicians, have shown conclusively that the greatest menace to the health of the human race today is to be found in the bad condition of the teeth of a large majority of the populace. The instinct of the individual is directed toward saving the teeth, and, unfortunately, a large proportion of the dentists foster this instinct, and in consequence, teeth are capt and otherwise repaired by expensive *bridgework* in order to save the teeth, when from the standpoint of the patient's subsequent ill-health, these teeth should be extracted. Happily,

MAN'S greatest danger, the biggest curse of humanity today, are infected teeth. Millions of people are dying of all sorts of diseases, caused directly by infected teeth. Inflammatory rheumatism, insanity, chronic stomach diseases, Bright's disease, nervous diseases, all these are now attributed to infected teeth. The work of Henry A. Cotton, Medical Director of the State Hospital of Trenton, N. J., is of such epoch-making and tremendous importance that every human being ought to know of it.

the best dentists have realized for some years that serious results frequently follow such procedures and have warned the profession against this danger. This subject has received special attention by Dr. Henry A. Cotton, Medical Director New Jersey State Hospital, Trenton, N. J., who in a recent statement on the importance of X-raying the teeth, has the following to say:

"Unfortunately for the patient, infected teeth may not and often do not cause any symptoms which would lead one to believe that anything is wrong with his teeth. This type of infection is what is known as *chronic* in contradistinction to an *acute* infection, and does not cause pain, pus or swelling, and frequently no rise in temperature. Hence, there are no symptoms which direct the patient's attention to this condition, and often they are amazed when they are told that they have infected teeth and that they must have a certain number extracted if they wish to recover from their particular illness. The question is often asked, 'How are we to know that teeth which give no evidence to the patient of serious and often dangerous infection, and externally give no evidence to the dentist of such condition, are infected'? The answer to this is the *X-ray*, and a more general use of this very simple and harmless procedure will reveal to the dentist as well as to the patient the existence of infected roots, *when to casual inspection the teeth may seem to be healthy and worthy of saving!* Naturally, these should immediately be extracted.





Taking X-Ray Photos of the Teeth at New Jersey State Hospital Laboratory. Arrow Indicates the Small Plate Holder About to Be Placed in the Mouth.

"Each individual should know whether or not he is harboring dangerous infection, which may not only undermine his general health but may endanger his life if it be not eradicated. With this knowledge of the danger of infected teeth, all persons should insist upon a thoro examination of their teeth by means of the X-ray and not take the word of a dentist who merely inspects the teeth and pronounces them all right. The failure of the dentist to recognize the existence of root infection and the practise of putting in pivots, gold crowns and bridge work, without first taking *radiographs* of these teeth to be sure that there are no infected roots, has sounded the death knell of many people, for when the infection has invaded other organs it is often too late for extraction of the teeth to be of any benefit. No matter if the teeth give no trouble or if one feels perfectly healthy at the present time, if he has had any dental work done at any time, *he should insist upon his dentist radiographing his teeth* so that he will not be the victim of a false security and finally succumb to a fatal disease, which might have been prevented if he had taken the precaution mentioned.

Dr. Cotton proves to us that it is wrong to cap or crown devitalized teeth as they will positively make serious trouble sooner or later. Such teeth should all be extracted immediately; they are the seat of nine-tenths of all our modern diseases.

This article is one of the most important we have publisht for a very long time, and we urge every reader not only to carefully read it, but to spread its gospel among friends. It will save thousands upon thousands of lives.

—EDITOR.

The Cause of Infected Teeth

"The public naturally inquires: 'Why do we have such bad teeth today when our parents and grandparents did not have these conditions, or, at least, did not have these fatal diseases?' There are several reasons for this. In the first place, our forefathers did not bother with dentists except to have an offending tooth extracted. In the second place, modern dentistry had not developed to the point of expensive repair and preservation of the teeth as we know it today. It has been estimated that 80 per cent. of the people who have had repair work done, even in the most expensive and latest manner, *have infected teeth which may become a menace to their health at any time.*

(*Continued on page* 345)

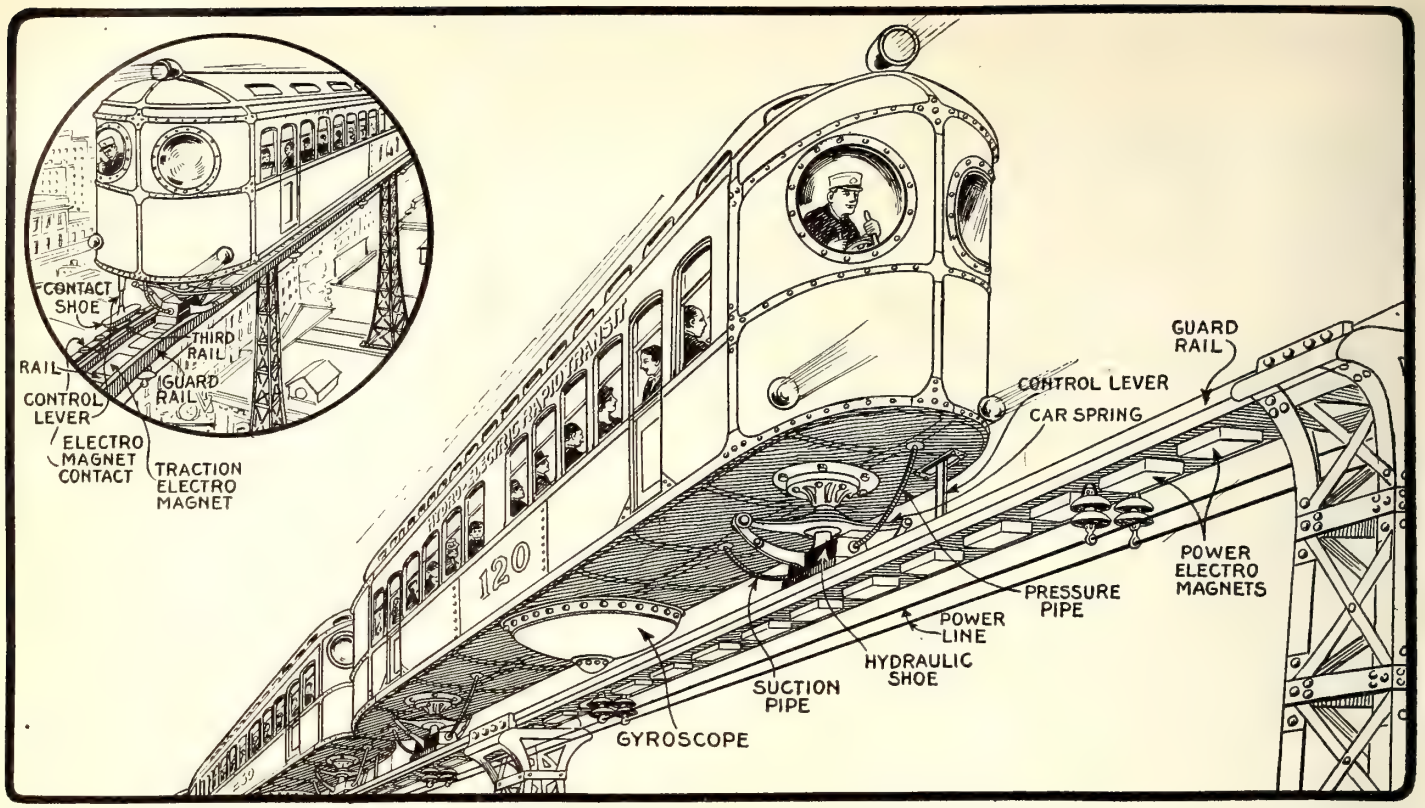


Fig. 5. This illustrates the Propulsion of the Wheelless Gliding Train. The Two Hydraulic Shoes Glide On a Film of Comprest Water Squirting from Underneath the Shoes. The water is Recovered by Suction from the Same Shoe So None is Lost. (See Fig. 3.) The Train Itself is Kept Upright On a Single Track by Means of a Gyroscope, While the Cars Are Propelled by Powerful Electro-magnets, the Contacts of Which Are Closed Automatically by the Train as It Moves Along. These Gliding Railroads, Having No Friction, Work So Easily that a Child Can Push Along a Car With Its Passengers.

Solving the Transportation Problem

By H. GERNSBACK

A Railway Which Actually Existed In France

THIS is the story of a most extraordinary railway which at one time existed in France. Its inventor was killed by the invading Germans in 1870. A railroad that is practical and which has demonstrated its successful operation. It is practically frictionless and can move SAFELY with a speed of one hundred miles an hour. It will be in use thruout the world.

SINCE the advent of the steam locomotive in the early 50's of the last Century, no progress whatsoever has been made as far as speed of our railways is concerned. We are today not riding faster either in our electric or steam railways than our grandfathers did 60 years ago. It is true that we have greatly improved everything else as far as comfort, safety, etc. is concerned, but the speed has not been increased whatsoever. Sixty miles an hour was an everyday occurrence sixty years ago, and was attained by many trains. Today, the average speed of the steam or electrical railways does not approach more than 50 miles.

Present Disgraceful Conditions.

What are we to do? In our big cities we are running street-cars on the surface, trains on elevated railroads and down in the subways. The more roads we build, the more acute becomes the shortage of transportation as far as passengers are concerned, and in any big city transportation facilities are always woefully behind the actual demand. In the morning everyone goes to business about the same time and in the evening everyone must ride home—our so-called rush-hours. The density of travel thus become enormous, particularly in cities like New York or Chicago, where conditions, as is well known, are intolerable, and in many cities, disgraceful. If it were possible to operate our railroads with safety only two or three times as fast as they are running now, it stands to reason that everybody would have a seat, an impossible condition now.

We cannot run our trains faster than they run now without encouraging accidents such as collisions, derailments, etc. As far as the present day railroad is concerned, it is not possible to increase its speed at all. There is, however, one solution, an invention which dates back to 1852. we refer to the *Gliding Railroad* which actually had been tried in France, and had been perfected in a small way. At that time, however, many technical obstacles made the project impossible, but all of these objections have now been overcome by new inventions and methods which we will discuss more fully.

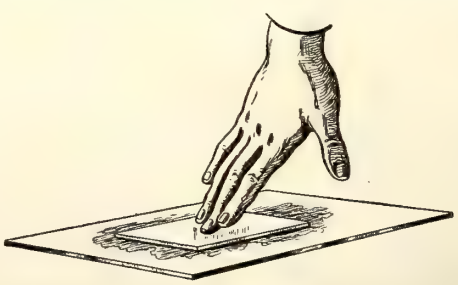


Fig. 1. The Principle of the Gliding Railway. Two Glass Plates Are Dipt Into Water. The Upper Plate Will Glide With Astonishing Ease. The Two Plates Do Not Touch. A Thin Water Film Separates Them.

Principle of Gliding Railroads.

Let us turn to Fig. 1 which gives us the principle of the gliding railroad. Take two smooth pieces of glass, such as are used for photographic plates. Boil them in water, until the gelatin comes off and clean thoroly. Use one large plate and one small plate as shown in illustration. Dip the two plates into water, and place the small plate on top of the larger. It will be seen that the small plate will *glide* with remarkable ease over the large plate. The important thing to note is that *the two plates do not touch.* They are supported by a thin film of water, *hence the top plate glides on an exceedingly thin water film.* As we move the plates back and forth we squeeze out the water little by little, and as soon as the plates touch, the free movement will stop. Were we to drill a hole in the top plate and attach a small tube to it containing water under pressure, we could then for a long time move the plate back and forward with very considerable ease; we would then always maintain a good water film on which our top plate could glide.

Exactly this is the principle of the gliding railroads, first invented by L. D. Girard, a great French engineer. Already in 1852 M. Girard proposed to replace the ordinary railways by means of hydraulic propulsion. He was quite successful with

his first models and in 1854 he conceived the idea to replace the wheels by means of *hydraulic skates* gliding over flat rails. By means of this method, he did away entirely with all friction for the reason that *he interposed between the skate and the track a film of water under pressure.* At first M. Girard was using comprest air, but he found that it was necessary to use water under pressure because air did not give satisfactory results.

Railroad was Actually in Use.

He actually constructed on his property de la Jonchère, near Paris, such a wheelless railroad which had no locomotive, the cars of the train gliding on a film of water. The propulsion of the train itself was affected by a sort of turbine arrangement whereby a stationary water jet was hurled against stationary vanes mounted under the cars. In other words, the train acted as the stationary part of a turbine, while water jets placed alongside the road, and operating automatically, pushed the train along. This railroad worked very well and actually transported passengers in a limited degree. In 1869 M. Girard obtained a concession from the French Government to run a wheelless railroad line from Paris to Argenteuil. Unfortunately, the Franco-Prussian War in 1870 then broke out and his experimental railroad at de la Jonchère was ruined by the Germans and Girard himself was killed. Nevertheless, the principle had been proven sound by actual practise. There is no reason why with modern methods and improvements it cannot be made a huge success.

In our Fig. 2 is shown one of Girard's hydraulic skates or shoes and its operation. M. Girard's train had two *flat* rails, and each car had four hydraulic skates or shoes which replaced the usual wheels. Fig. 2 shows three views of the shoe. It will be noted that water pressure is supplied to the shoe which fills the interior fully. As soon as the pressure becomes high enough, it is obvious that the water must escape by raising the shoe clear from the rail, providing enough pressure is used. While the water escapes, it will be readily understood that the shoe itself can nowhere touch the rail proper. In other words, *the shoe floats on a thin film of water.* If no other means were provided, it can be seen that an enormous quantity of water would be needed to supply the hydraulic shoes, while the train was moving, or even standing still. The water would squirt out incessantly.

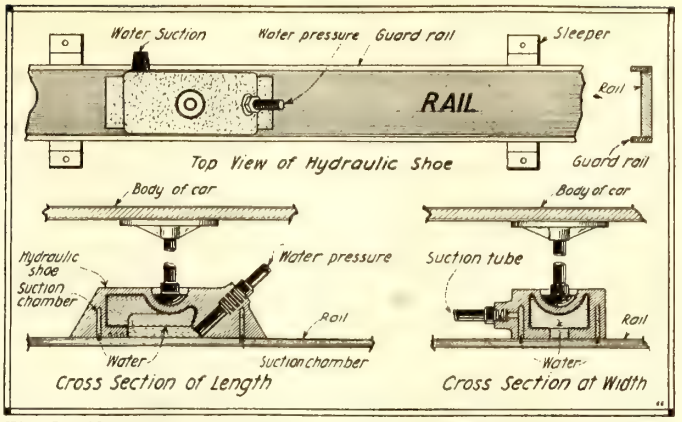


Fig. 2. Showing the Construction of the Hydraulic Shoe in Several Views. The Water Is Pumped Into the Shoe Under High Pressure. As the Water Leaves the Shoe, It Is Sucked Back Thru the Suction Chambers. The Hydraulic Shoe Cannot Leave the Track On Account of the Guard Rails. (See Upper Right Hand Detail Sketch.)

No Water Is Lost.

However, another French engineer, M. Barre had the happy idea to recover nearly all the water, and this arrangement is also shown in Fig. 2. Running near the edge of the hydraulic shoe will be found an annular suction chamber which is connected to a suction tube. It will be realized that as quickly as the water is prest out from under the shoe, it must pass the suction chamber, *and here it is sucked back to the water reservoir* of the train to be used all over again. With this ingenious arrangement, it will be readily seen that practically no water is lost except a minute quantity used in wetting the rail, and this loss per train amounts to only a gallon or two per mile, even for a heavy train.

A very important, and as a matter of fact, the most important part of this railway is, that as the cars glide on water they *can be made to run with marvelous ease.*

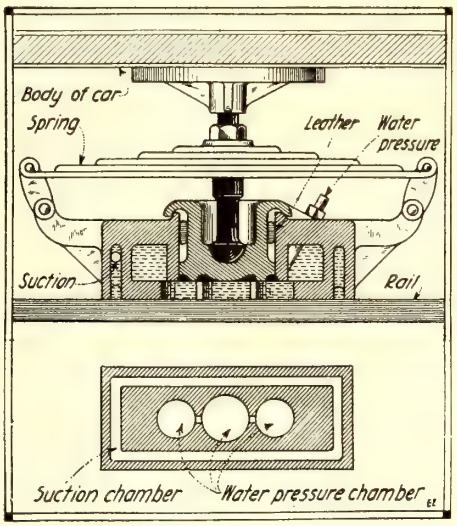


Fig. 3. A Modified Form of the Hydraulic Shoe. It Works Similarly to the One In Fig. 2. Note the Piston Arrangement Which Gives the Train a Feathering, Cushion Effect.

Child Can Pull Train.

M. Girard already demonstrated that *a six year old child could move a standard railway car* rapidly over a track, so easily does such a railway operate. The reason is of course that no metal of the train touches the track, therefore nearly all friction is suppressed. By actual experiments it has been shown that M. Girard's cars could be moved with a weight *one half of one thousandth of the weight of the car.* In other words, a railroad car weighing several tons can be pushed along rapidly with an expenditure of a few pounds of energy. The water film itself is of course exceedingly thin, measuring only from one-half to three-quarters of a millimeter. In other words, not much thicker than six sheets of paper on which this story is printed. Nor was the water pressure as high as one might think at first:—10 lbs. per square centimeter.

M. Girard found his greatest trouble in two points. First, he had trouble with his rails at the point where the latter connected. It is of course necessary that a railway of this kind should have an exceedingly smooth metal rail which must not have any uneveness whatsoever. Also where the rails join, it was found necessary to interpose pieces of leather or soft rubber, otherwise the water would squirt out between the rails. Of course, we would not have this difficulty today because we would simply weld the rails together, making them a uniform piece of metal. This source of trouble, and it was M. Girard's greatest one, would be unknown today. The other great difficulty was to propel the train.

How to Propel Wheelless Trains.

There was used in Paris at one time an arrangement as shown in Fig. 4. Inasmuch as no wheels are used, and because the hydraulic shoes have no tractive effect themselves, entirely new means must be provided to move the train. The old French idea is shown in this illustration where a rail rack was run all along between the (*Cont. on page* 336)

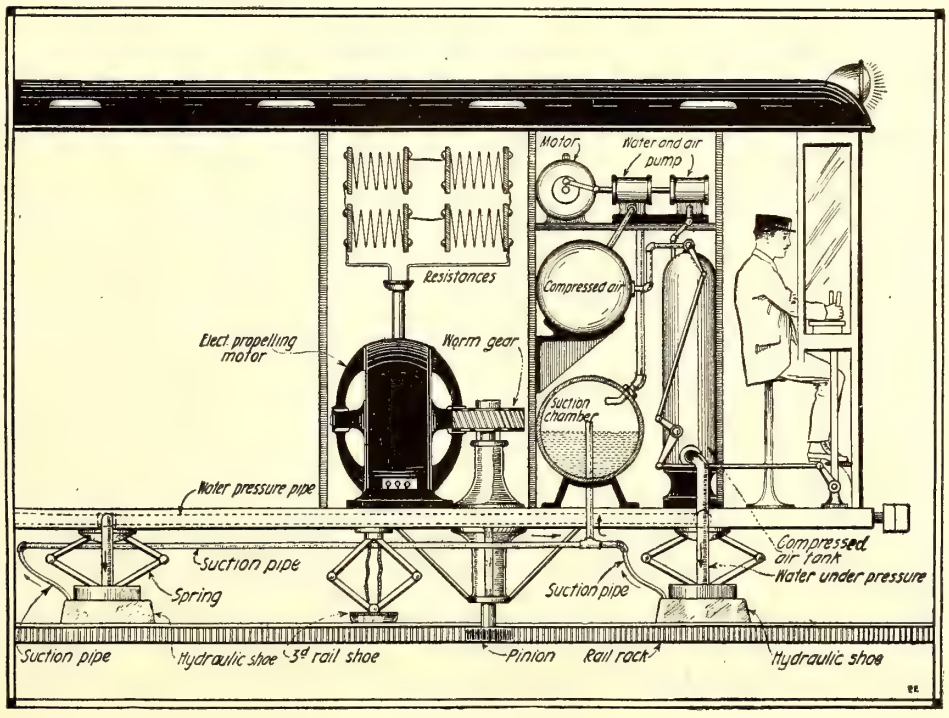
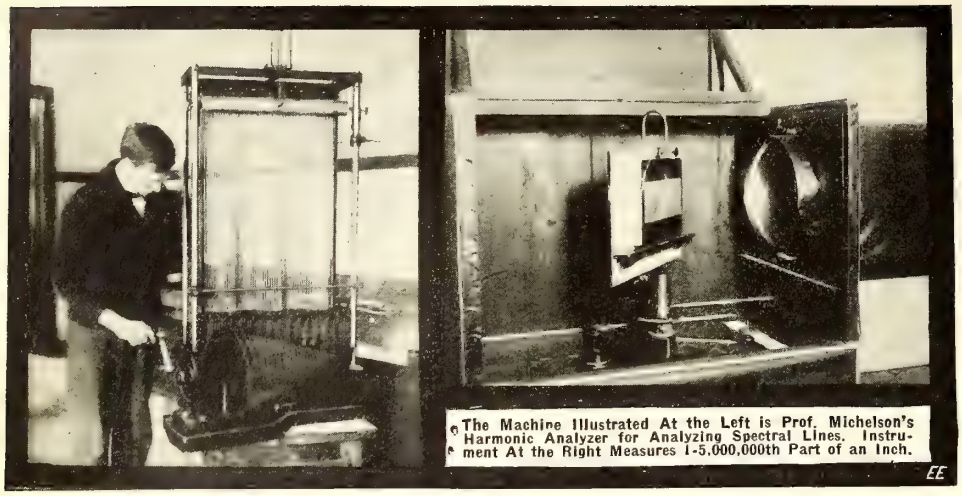


Fig. 4. Showing the Propulsion Used in the early French Gliding Wheelless Trains. A revolving Pinion Engages with a Rail Rack, Thus Pushing the Train Along. Illustration Also Shows the Method of Hydraulic Shoe with Comprest Water, and How the Lost Water Is Sucked Back.

Measuring 1-5,000,000 of An Inch



The Machine Illustrated At the Left is Prof. Michelson's Harmonic Analyzer for Analyzing Spectral Lines. Instrument At the Right Measures 1-5,000,000th Part of an Inch.

The wonderfully precise measuring machine here illustrated measures down to 1-5,000,000 of an inch. It was invented by Prof. G. Michelson. Prof. Michelson's grating (on the stand to the left) contains 50,000 parallel, equally spaced lines to the inch.

Precision to the 1/1,000,000th part of an inch has until recently seemed only to be within the realm of ultra-science, as we might say. However, during the war, mechanical precision instruments were improved so markedly that it was quite common, especially in Government ordnance specifications and requirements which called for an accuracy of 1/1,000,000th of an inch.

The photo at left shows Prof. Michelson's Harmonic Analyzer, for analyzing spectral lines into their constituent parts. By means of this device an assistant can do in a few minutes what would require many weeks for a skilled computer.

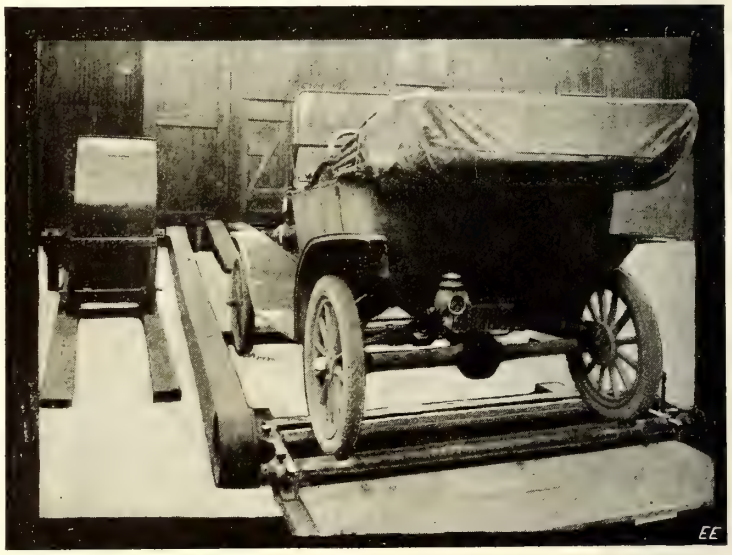
Farmers Drive Machinery from Automobile

Herewith is illustrated the latest in automobile power transmitters for driving farm or other machinery. A recent invention of the proprietor of a Colorado machine shop promises to become very popular with farmers who own autos. The invention is an apparatus for transmitting power from an automobile to run the machinery of the farm, but unlike most contrivances of its kind, nothing is removed from the auto, and the auto can be driven off within a minute of the time it is used on this new invention.

The device consists of two four-inch rollers set parallel to each other in a frame and long enough to run the automobile onto them. These rollers are connected by a chain belt, and on one of them is a pulley to run a belt to the machinery. The rollers are locked against turning while placing the auto on the machine, by putting an iron pin thru the links of the drive chain. When the rear wheels of the auto are resting squarely on the rollers, pin is removed and the engine started. This turns the rollers as the wheels revolve, and the belt runs the machinery, the same as any other power would do.

The inventor claims to develop half the rated horsepower of any automobile engine on the belt of the machine, which is very good indeed, considering that the power is transmitted by friction only, with a consequent loss by slippage. The device should find wide favor among farmers everywhere.

Here's How to Put Your Henry Ford to Work and Make It Drive Farm or Other Machinery—even Down to Cutting Up Fire Wood. The Inventor of the Automobile Power Transmission Scheme Here Illustrated, Claims to Develop Half the Rated Horsepower of an Automobile Engine on the Belt of the Machine, Which is a Very Good Efficiency Indeed, Considering That the Power Is Transmitted by Friction With a Consequent Considerable Loss, Due to Slippage. The Device Comprises Two Four-Inch Diameter Rollers, Set Parallel to Each Other, in a Frame Long Enough to Permit the Rear Wheels of the Automobile to Rotate in Contact With Them.



"Movie" Sign Works by Colored Lights



This Picture is not Quite so "Infantile" as it Might Seem At First Glance, Altho the Subject Illustrated Happens to Be. By Painting Two Objects Such as a Hobby-Horse as Here Shown, in Two Different Colors, Say Red and Green, a San Antonio, Texas, Inventor, Richard M. Craig, Has Found That When a Set of Red Lights Are Flashed on the Sign by a Special Electric Flasher Switch, the Red Image Stands Out Plainly; and When the Green Lights Are Lighted and the Red Extinguished, the Green Image Stands Out. By Rapidly Switching the Lights On and Off a "Movie" Effect Is Obtained.

One of the lastest and cleverest advertising devices is that covered in a patent recently granted to Richard M. Craig of San Antonio, Texas. The inventor arranges two figure positions on the sign, one position of the figure for illumination by red lights and the other by green lights. Next he arranges red and green lights for illuminating the display with a device for alternately switching the current from one set of lamps to the other, the switching device being motor-driven. In the present illustration, we at once perceive that the subject is painted twice in two extreme positions, each position being painted in a different color, such as *red* for the extreme position and *green* for the second extreme position. These two positions in red and green under ordinary daylight conditions show plainly, but when they are lighted alternately with red and green lights, then the sign becomes alive and animated, giving a very near approach to a moving object.



Two Views in Paris, Showing the Famous "Camelots" or Street Fakirs, Who Have Here Elected to Tell the Good French People Their "Past, Present and Future" by Wireless. Only it Isn't Wireless!

Paris Letter

By JACQUES BOYER

THE Parisian "camelot" is more than a street peddler, he is a business man and an actor, sometimes even an acrobat, but always he is a marvelous talker and a humorous entertainer.

A good "camelot" will sell anything on the asphalt of the good town of Paris, be it an old sponge, a pocket-book, a collar button, or ice-cream. We have no intention to give in the following, a history of this so interesting specimen of human being, but we will show, with the help of the photographs herewith, that the renown of the "camelots" is by no means exaggerated and that they keep abreast with the developments of science and are not at all indifferent to the particular trend of public attractions. These peculiar peddlers, instead of meddling with ordinary merchandise have put the fairy Electricity at work to attract their clients.

Here for instance, one of them detects your thoughts by means of the *"Teleradio"*; the other one uses the *"Radiograph"* to discover the past, present and future.

Of course we don't need to tell you that the instruments which they exhibit have only a very vague resemblance to the ones attributed to Tesla, Marconi or Branly.

Most of the time these apparatus consist solely of a bell connected to a few dry batteries and other formidable appearing scientific apparatus. The answer to the question concerning the past, etc., of the victim, is printed in advance, of course, and glides out of a box by means of a clockwork.

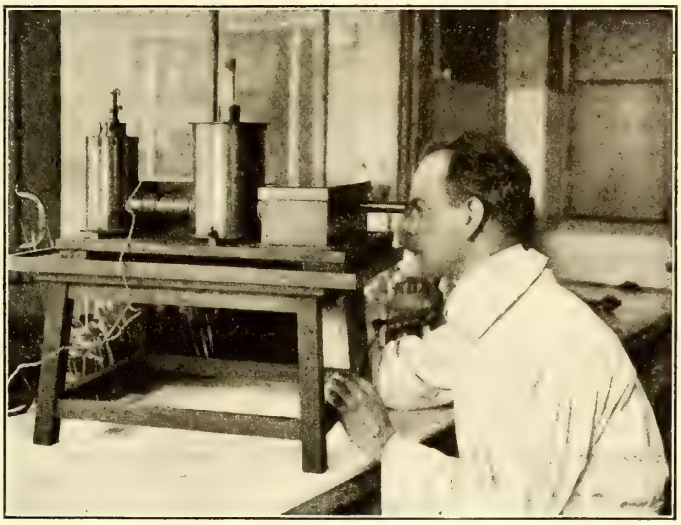
The rest is *camouflage. Scientific camouflage.* But some one always falls for the fakes. P. T. Barnum was right. The public wants to be fooled—and gladly pays for it.

New Electrical Apparatus to Count the Microbes.

The Opacimeter.

This new instrument invented by Messrs. Lambert, Vles, and de Watteville, who have given it the name of *Opacimeter,* makes it easy to count rapidly the microbes in an emulsion prepared for vaccination purposes.

It is composed principally of a photometer made up of two parallel light circuits, coming from one source, the one traversing the phial containing the emulsion, the other subject to a system of dimmers, capable of modifying the intensity of light, after a determined law. The two circuits produce, in the field of an eye piece, two light-spots opposite each other and the other realizes their equal value by adjusting the dimmer system.



New French Instrument for Rapidly Counting the Microbes in an Emulsion. It is Called an "Opacimeter."

A very ingenious system of gauges, lenses and microscopes, the detailed description of which it is not possible to give in this limited space permits the observer to establish with the aid of Spectrophoto-Metric Measures the actual number of microbes contained in the emulsion. The laboratories of the French Army are using the Opacimeter to determinate rapidly and accurately the dose of bacteria to be contained in a vaccinating emulsion.

SHELL LOCATER FOR FRENCH FARMERS.

The shell locating apparatus here illustrated was invented by M. Gutton, Professor of Physics at Nancy, and is akin to one used by surgeons for locating bullets in the body. It consists of two wooden rings each fitted with a pair of electric coils, one traversed by a variable current and the other connected with a telephone. If there is a metal object under the soil in fairly close proximity to the apparatus, the telephone signals the fact; if not, it remains silent. Unexploded hand-grenades are more dangerous than shells, as they are nearer the surface, and liable to burst at the least touch. This apparatus operates on the principle of the Hughes Induction Balance.

The Hughes induction balance is composed of four coils, two in the primary and two in the secondary circuit. When the relative positions of the coils are adjusted correctly, the inductances neutralize each other and no current flows in the secondary circuit. If, however, the slightest change is made in any of the coils, such as by the insertion of any metal object, the mutual induction is unbalanced and a sound is made in the telephone receiver. A detailed description of this device appeared in the February, 1918, issue of this Journal, where a diagram is given of the coil connections. The secondary coils may be connected in series with a galvanometer or 'phones. An experimenter who has no galvanometer can purchase an inexpensive Weston ammeter. When the shunt has been removed, this will serve as an excellent galvanometer. Some form of interrupted primary circuit is necessary to induce currents in the secondary. An interrupter, mounted on the armature of a buzzer, serves the purpose.



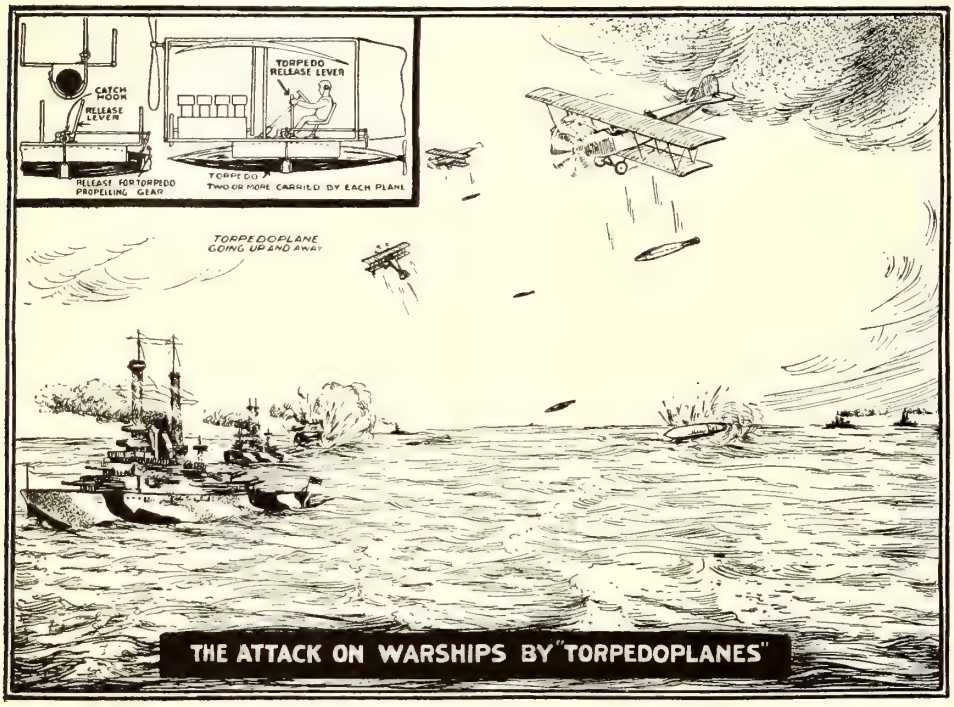
The Fields of France Are Strewn with "Dud" Shells. To locate them Before Plowing, the Electrical Instrument Here Illustrated Has Been Perfected to Detect Their Presence, Even When Buried Several Feet.

The "Torpedoplane" and "Sub" Spotter

By GEORGE HOLMES

TWO important and novel war inventions are here illustrated and described—the torpedo-carrying seaplane or dirigible, and the microphonic submarine locater, both of these naval warfare improvements being the inventions of an American naval officer, Rear Admiral Bradley A. Fiske.

Two Revolutionizing Naval Inventions of Rear Admiral Fiske



The Naval Engagement of the Future as Rear Admiral Fiske, U. S. N., Sees It. His Powerful "Torpedoplanes" Will Provide New Ways to Repulse Landing Parties and Attack Warships That Are Worrying Naval Experts of Foreign Powers.

The torpedo-airplane or "torpedoplane" as it is called, is a development of the torpedo-carriers, which were first successfully employed in action by the R. N. A. S. at the Dardanelles in 1915, and were subsequently used against us by the Germans in 1917, when they were thus enabled to sink three of our merchant ships off the Southeast Coast. The torpedo carried by the torpedoplanes is of a small size as modern torpedoes go, and weighs about half a ton.

The Mystery Plane or "Torpedoplane"

The "mystery airplane" was designed to perform from the air more effectively and more swiftly the work formerly allotted to our torpedo-boats. The enemy had devised such successful protection of harbors and ships against our torpedo-boats and submarines that it was only with the gravest risk that we could approach within 30 miles of Kiel and other German fortified ports. But for the newest peril, the torpedoplane, the enemy had no reply.

The news of our discovery of a means of attack that was immune from mine dangers and too swift in its operation to be held off by gunfire reached the ears of the enemy, and is believed, in one quarter at least, to have hastened the Germans in their decision to accept the surrender terms.

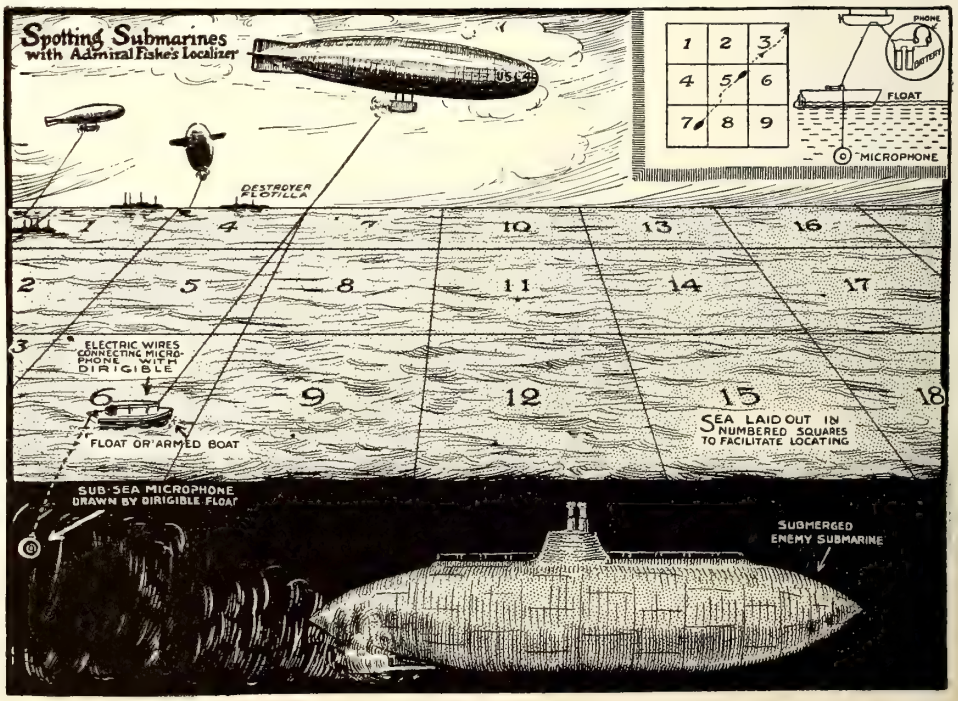
Had not hostilities ceased so suddenly these machines would have operated effectively against Kiel harbor and the German warships in their very lair. The efficacy of the weapons will be realized when their operation is explained. One of these mystery airplanes, espying its target, makes a sudden dive from the clouds, at a speed of 150 to 200 miles an hour, levels out at 50 feet above the surface, discharges a torpedo directly at the enemy ship at the right moment, after which the pilot pulls back his control stick and disappears into the clouds as suddenly as he appeared. The operation is so swift that the enemy has little if any chance of training a gun on the assailant. The "smoke cloud" produced by modern war planes is excellent for this purpose. In one of these attacks a British airman torpedoed and sank a Turkish troopship containing 3,000 troops.

When the idea was first conceived of having an airplane to carry an ordinary torpedo such as is used on the submarine, technical difficulties almost defeated the project, until an American designing firm got hard at work in conjunction with the Air Ministry. The difficulty was not so much of lifting a torpedo as of ensuring that the action of discharging the torpedo be carried out with accuracy of aim and with safety to the pilot. Experiments were carried out in the face of great difficulties and perils.

On the occasion when the initial experiment of discharging a torpedo from an airplane was made, the lightening of the airplane had such a serious effect on the latter that the wings collapsed and the pilot was hurled to sudden death. In another case when the torpedo had been discharged, it hit the water at an awkward angle, and ricocheting over the surface, rose and demolished the airplane, which had not risen out of the way. This discharging of a torpedo was no light risk when the torpedo was of full size, weighing anything up to a ton—three times the weight of the machine in which Blériot first crost the English Channel.

These wonderful planes can ascend from land or from the deck of a ship, and can descend on the sea and float until help is brought by wireless. When the German fleet surrendered, a seaplane "mothership" with 20 of these machines in its bosom met the Germans 50 miles out at sea, and had any tricks been tried, it would have been simple work for a score of "mystery airplanes" to have leapt into the air and torpedoed the major part of the enemy fleet. This mystery or "cuckoo" airplane—so

(*Continued on page* 348)



The "Fiske" Submarine Spotter. The "Sub," Once It Is Picked Up by Sound Waves Impinging on a Microphone, Is Trailed Along From Square to Square. The Aircraft Can Attack It With Depth Charges or Signal Instructions to Destroyers.

Thunderstorm Electricity

By ROGERS D. RUSK, M. A.

Late of the Meteorological Section, U. S. Army Signal Corps.

ONE hundred and fifty years ago the famous Voltaire said: "There are some great lords whom we should always approach with extreme precaution, and lightning is one of them." This is perhaps one reason why we know so little about lightning at the present time, for it certainly is not a very safe subject for close laboratory investigation. For a long time after the electrical nature of lightning was demonstrated by Benjamin Franklin, very little more of any scientific importance was discovered about it, and only today are we learning how the great charges of atmospheric electricity are generated in a thunder-storm. It is a significant fact when we think that a thunder-cloud is the most stupendous and powerful generator of electricity of which we know. A single lightning flash may carry *twenty thousand or more amperes at a pressure of millions of volts.* Moreover it is Nature's own method, the simplicity of which makes it the more wonderful, for it involves no intricate and complicated machinery. It is not too much to think that the future will sometime see Man harnessing and making use of this tremendous source of energy and bidding it do his will instead of holding it in awe, as he so long has done in the past.

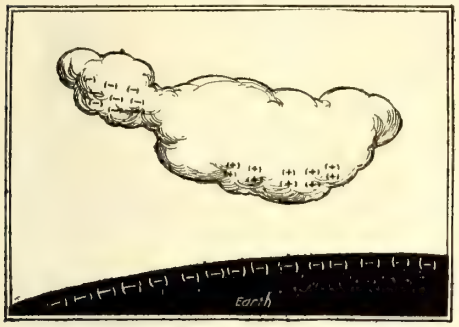


Fig. 1. Showing How a Cloud Is Charged by Electro-Static Induction. The Negative Charge on the Earth Induces an Opposite Charge in the Cloud.

During the war lightning and thunderstorms proved a serious menace to balloonists and aviators, and on this account they were made the subject of special study by the *Meteorological Section of the Signal Corps.* Their results, in connection with the latest discoveries of scientists in general, are now beginning to throw light on the long hidden mysteries of thunder-storm electricity.

In recent years many theories have been advanced to explain the cause and nature of lightning, but all of them have been more or less vague and indefinite and for the most part they have been unsatisfactory one way or another. Electricity is now recognized as being one of the important factors in the determination of weather conditions, and conversely, weather conditions are very definitely known to determine the electrical state of the atmosphere at any particular time. *Sometimes rain produces electricity, and sometimes electrical phenomena cause rain.* The place where the two, rain and electricity, are most closely related is in the thunder-storm. Here the rain drops condense primarily about small electrically charged particles called *ions,* and then again the motions of these particles cause the growth of the lightning charges in a manner to be explained more in detail.

The Physics of Thunder and Lightning Simply Explained

How Thunder-Clouds Form.

In a thunder-cloud the almost inconceivably large charges of electricity are often generated in a very short space of time, and sometimes a complete reversal of sign from *positive* to *negative,* or vice versa, may occur in a *thousandth of a second or less.* It is usually thought that lightning discharges occur from one cloud to another or from a cloud to the earth, but this is not necessarily the case. Quite frequently discharges *as long as a mile in length* will take place in the interior of a single cloud itself. For these reasons it must be explained just what a thunder-cloud is, and how it differs from other clouds which seldom carry charges of electricity of any great magnitude, or act in the capacity of electric generators.

WHAT TO DO IN A THUNDER-STORM

If you are out of doors in a very severe electrical storm, it is well to observe the following rules for your own protection:

1. Keep away from wire fences. They may carry a dangerous electrical charge long distances. Cattle in pastures are frequently killed thru the neglect of farmers to ground the wire of the fence.

2. Keep away from hedges, ponds and streams.

3. Keep away from isolated trees. Oak trees are frequently struck; beech are seldom struck. It is safe in a dense forest.

4. Keep away from herds of cattle and crowds of people.

5. Do not hold an umbrella over you.

6. It is safer to sit or lie down in an open field than to stand.

7. Drivers should dismount and not stay close to their horses.

8. Do not work with any large metal tool or implement.

If you are indoors:—

1. Keep away from the stove and chimney. The hot gases from the chimney may conduct the lightning to and down the chimney.

2. Do not take a position between two bodies of metal, as the stove and waterpipe, for example. An exception to being near metals is the case of an iron bed. One of the safest places is on a mattress in an iron bed, provided you do NOT touch the metal. The metal surrounding you makes a safe cage, which will prevent the lightning from reaching a person inside.

3. Do not stand on a wet floor nor draw water from the well or faucet.

4. Do not stand directly under a chandelier, near a radiator, nor on a register.

5. Do not use the telephone in suburban districts. In cities there is practically no danger, as the wires are placed underground.

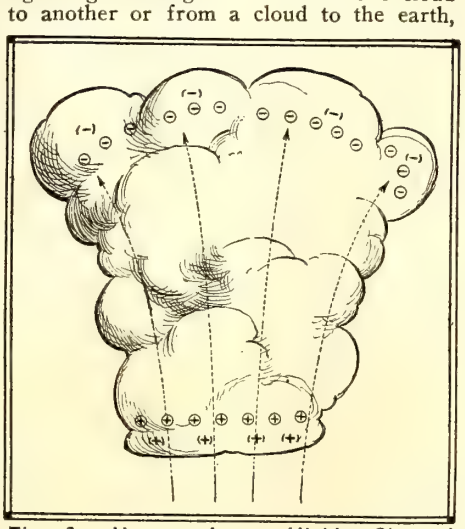


Fig. 3. How a Large Highly Charged Thunder-Cloud Forms by a Continual Shifting of the Oppositely Charged Particles Composing It. The Negative Charges Tend to Move Toward the Top, and the Positive Charges Toward the Bottom of the Cloud.

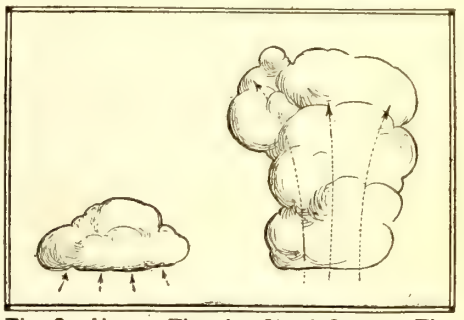


Fig. 2. How a Thunder-Cloud Grows. The Larger Cloud Is the Result of Intense Local Heating and a Strong Up-Rushing Current of Air. Its Height May Be a Mile or More from Base to Top. The Smaller Cloud May Measure Only a Few Hundred Feet in Height.

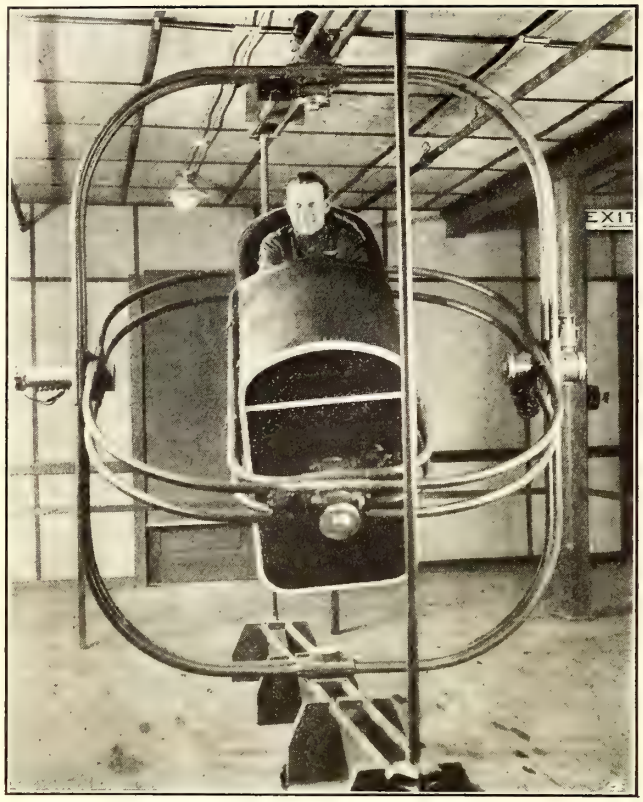
Everyone is familiar with the huge rolling, billowy clouds (cumulis) so common on a warm day, but not everyone knows how they are formed. In reality each cloud represents a column of heated air which has risen by convection from the earth's surface, due to the heating effect of the sun, and has carried moisture up with it. When the top of this column has risen to such a height that it begins to cool, and the moisture to condense, the cloud is formed. This may seem unimportant but in reality it is the beginning from which a thunder-storm may develop, if conditions are just right. As moisture in the air does not condense in the form of drops unless there are dust particles or electrically charged particles (ions) in the air to act as centers of condensation, the cloud may already have received a charge from these ions, providing there was a majority of ions of one sign present.

How Clouds Receive Charge.

A cloud may also become charged by *induction.* If a cloud which has approached the earth as shown in Fig. 1, is of a form which may divide into two parts, the charge of the opposite sign which has been attracted to that portion nearest the earth may be carried away by it at the time of division, and the other portion of the cloud may carry away a charge of the same sign as the earth. Neither of these two ways in which a cloud may become charged, explains however the production of the enormous charges which are present in a thunder-cloud. These are produced in another way, due to the forces at work when a thunder-cloud is formed.

If the heating is intense and there is much moisture present, when the billowy clouds mentioned above are formed, the result is a thunder-cloud. The process is shown in Fig. 2, where the smaller cloud is the common type visible on most any warm summer day. The larger cloud is the result of intense local heating and a strong up-rushing current of air, and its height may be a *mile or more from base to top,* while the smaller type may be *only a few hundred feet in height.* The bulging tops of the larger clouds are the common-

(*Continued on page* 376)





Above:—The Meissner "Airfone" for Talking Between Pilot and Observer. It Amplifies as Well as Localizes the Speech Waves. At Left:—The Ruggles "Orientator". It Is Electrically Operated and Gives All the Thrills of Real Flying.

"Ground Flying" for Aviators

This machine is used to familiarize the student aviator with the various loops, turns, cuts and dives that every flier must know. One can loop the loop, take a nose dive, make a tail spin and execute the "falling leaf" by simply operating the various electric controls. The invention is now being used with greatest success by the young army officers learning the elements of the flying art at the Army's flying school at Washington, D. C. The Orientator may be controlled by a switch-board at the side but on the floor, so that when desired the instructor may put the student thru various flying maneuvers at unexpected moments.

How Pilot and Observer Talk

The airfone is a form of speaking tube designed especially for service as inter-communication device between pilot and observer, instructor and student, or any airplane occupants, during full power flight. It consists essentially of a flexible speaking tube provided with a mouthpiece and a neck band, and of a helmet to which two earpieces are attached, suitable connections between the speaking tube and the earpieces being provided. For two-way conversation, two such head gears and tubes are used. Its present design is based on a very close and detailed study of aircraft noise conditions and in the application of acoustics.

Electric Brush Contains Dynamo

We are all more or less familiar with the various faradic electric appliances such as massage rollers, brushes, et cetera, which can be used in connection with medical coils and the like, but one of the most interesting and withal extremely efficient electric devices recently brought out is the Electro-dynamo Brush shown in the accompanying illustrations. It is claimed for this brush that it will rejuvenate the hair, and the makers cite the testimony of experts that it will in many instances help the scalp and also aid in the treatment of a great many ailments. In treating other parts of the body than the scalp, use is made of a flexible conductor and various electrodes which can be quickly attached to the brush. No batteries are required and a powerful current is generated as soon as the projecting finger lever is gently prest. This brush was tested by one of the leading New York electrical testing laboratories, and their report states that it develops an average potential of about 50 volts, and a peak value of from 100 to 200 volts. It is therefore impossible to receive an injurious shock from this unique device.



Young Lady Using the Newest Electric Hair Brush. On the Back of This Brush Is Mounted a Tiny Dynamo Operated by Pushing the Trigger.

A New York physician, Dr. H. J. Lowbringer, expresses his opinion on the electric brush as follows: "This little dynamo is therefore more than a scientific curiosity, because it generates currents of very high voltage with an amperage of infinitesimally low strength; consequently the results of application are similar to one of high frequency current, and thoroly superior to the ordinary faradic battery or the galvanic current, in instances where either diathermic or catalytic results are intended." With this electric brush and the attachments furnished with it, it is possible to give an excellent face massage, the current passing thru the hand of the massager. Also electric foot baths may be taken, or the current, in fact, past thru any part of the body, such as in the treatment of rheumatism, nerve disorders, etc. There is nothing in the device to wear out. The strength of the current may be varied by a regulator on the back of the brush, and it is also controlled by the rapidity with which the finger lever is prest and released. The device is well built.

Application to the Scalp With This Electric Hair Brush Is Said to Revitalize the Hair Roots and Tone up the System.

Inside of a U-Boat

Details of Machinery Found in the Surrendered U-Boats

OWING to the extent and the manner in which it was used by the Germans to attack commerce, the submarine emerged from the war a rather discredited weapon. This is not to say that it was discounted as a legitimate fighting instrument, and the question is being discust in Allied naval circles as to whether, and to what degree, the type will be included in the plans of naval constructors for the fleets of the future.

An answer to the question has its importance because of the possibility of the peace conference being asked to consider the desirability of abolishing submarines altogether. Even if the conference did not touch the matter, it was expected to be one of the first plans for the general reduction of armaments which, in accordance with schedule 111 of the League of Nations covenant, the council would suggest to the member states concerned.

Professional opinion, in all the nations engaged in the war on the side of the Allies, so far as it is confined to the men concerned in the actual fighting, inclines to the view that the submarine was beaten. There have been clear expressions on this point in Britain, America, France, Italy and Japan. Admiral Sims, for instance, declares that 205 U-boats were sunk by the Allies during the war. Altho this was not known until information had been obtained from German sources after the surrender. He also says that the grand fleet, when cruising in the North Sea, was surrounded by a screen of destroyers so intimately placed that it would have been suicidal for any submarine to attempt to penetrate it.

When such a screen was out, a submarine had to go down and stay down on penalty of being "depth-charged."

Altho the German high command to the end profest faith in the submarine war on merchantmen, Captain Persius has declared since the armistice that this faith was built up on "lies" spread about by the naval chiefs, as to the powers of the U-boats.

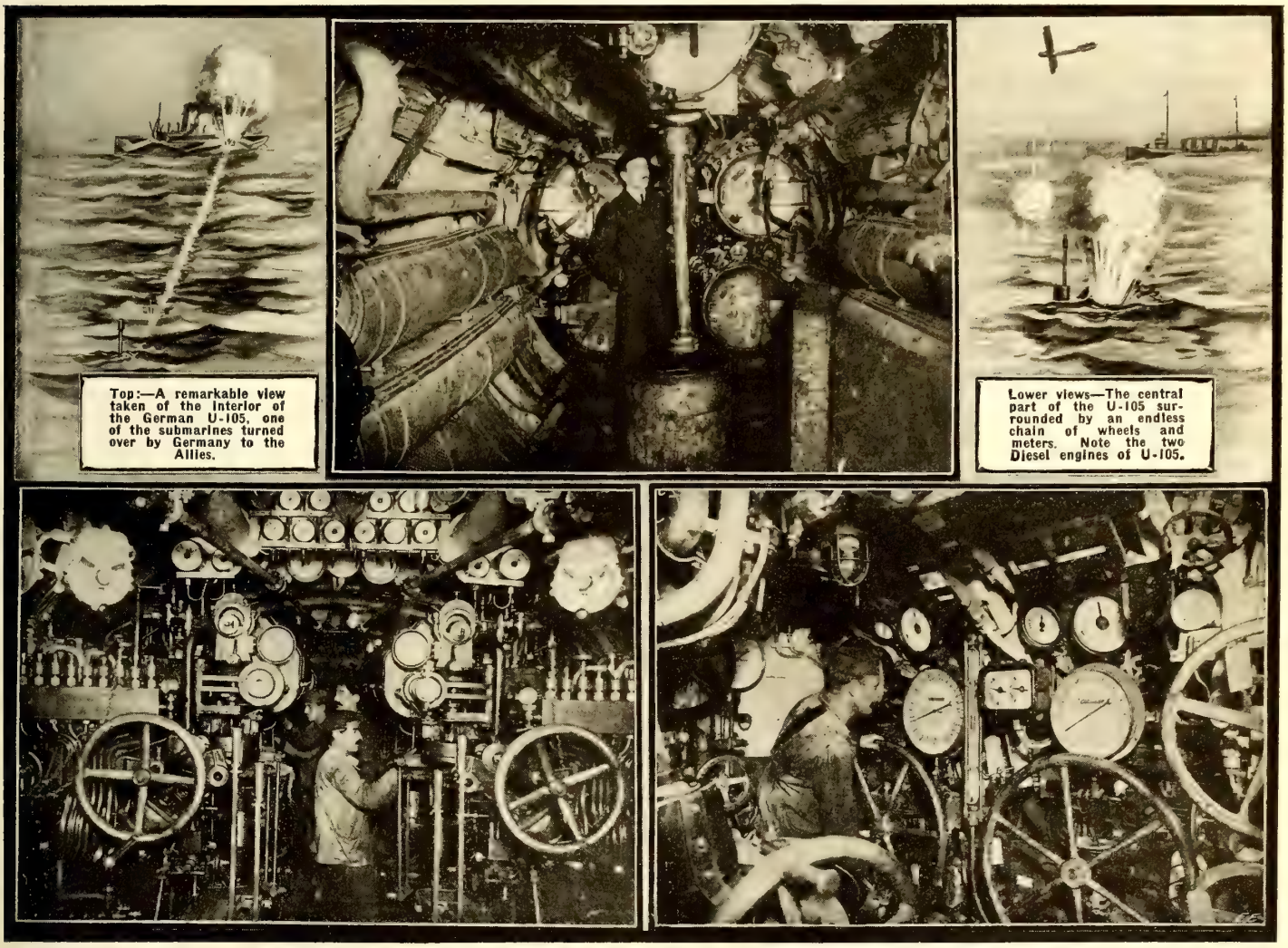
Submarines Have Advantages, Say Naval Experts.

On the other hand a significant indication of the utility of submarines for scouting duty has been afforded by Lord Jellicoe's recent book. He shows therein that not until June, 1916, was it possible to maintain a regular submarine patrol off the Horn reef (Denmark), by two or three submarines. By that time, the range of wireless equipment in the British submarines had been increased from 50 miles to 300-400 miles. "It was a vital matter," says the commander-in-chief, "to install efficient wireless apparatus in the only class of vessel that could carry out a watching patrol in the vicinity of German bases."

While, therefore, there are many strong reasons for desiring the abandonment of submarines as they were used by the Germans, yet equally strong is the professional opinion that under-water craft have not been rendered entirely useless by the inventions directed against them in the war, and that in any case they form a necessary adjunct to any complete naval organization of the future.

What the inside of a German U-boat looked like was a complete mystery to the layman until quite recently when several of the Ex-Kaiser's *unterseeboote* "visited" this country under the guidance of American crews. These sub-sea craft were piloted 3,000 miles across the Atlantic to aid in putting over the Fifth Liberty Loan. The first captured U-boat to reach these waters, flying the American flag, was the U-111. A few days later the mother ship "Bushnell" arrived at New York with several other

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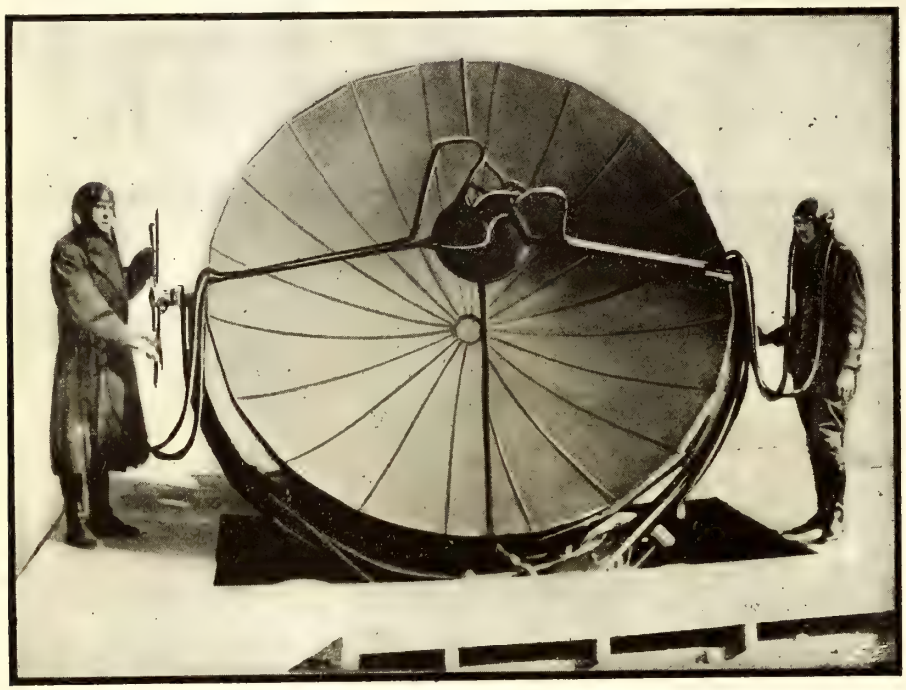
Top:—A remarkable view taken of the interior of the German U-105, one of the submarines turned over by Germany to the Allies.

Lower views—The central part of the U-105 surrounded by an endless chain of wheels and meters. Note the two Diesel engines of U-105.

Photos © by Underwood & Underwood

Locating Airplanes in Night Fighting

THE photograph herewith of the large Paraboloid reflector with two soldiers standing at either side, and equipt with special head phones, which are connected with the sound detecting apparatus mounted in the central focus of the reflector, is employed for locating the direction of approaching hostile aircraft at night. The reflector is balanced and pivoted so that it can be rapidly swung to any angle desired. When the approximate location of the approaching aircraft is determined by means of this sound wave catcher, then powerful searchlights are suddenly flashed on, and their beams pointed in the direction previously indicated by the sound detector. The range of this sound detector, owing to its efficient design, is said to be about 3½ times that of the unaided ear. It is extremely light and portable, and can be rapidly transported to any place desired.



Here Is the "Paraboloid"—the Clever Sound Focusing and Detecting Device Used by the Allied Armies in Locating Enemy Aircraft While They Were Yet Several Miles Away. The Sound of the Airplane Engine Carried Far, and by Carefully Focusing the Collected Sounds and Concentrating Them onto a Sensitive Microphone, the Trick was Done.

Five-Foot Searchlight Added to Terror of Night Fighting.

The accompanying photograph illustrates one of the remarkably light, yet extremely powerful, electric searchlights developed for use in the war. Searchlights of this type were built by the thousand by all of the leading powers, and both sides used them for various purposes, including night battles, the discovery of hostile aircraft, trailing the movements of enemy troops and freight trains, and automobile freight lines.

The searchlight here shown requires about 15 K. W. or 20 H. P. to light it to full brilliancy, and its powerful light will carry from 10 to 15 miles easily. The searchlights that we are usually accustomed to seeing on vessels and in the neighborhood of forts are usually cumbersome affairs, but the exigencies of wartime, where such vast amounts of paraphernalia had to be hauled over by train, horse, or auto-truck, called for the very lightest weight in all such apparatus as these, where there was no real necessity for making such an apparatus of great weight, as is the case with many pieces of machinery, such as guns, dynamos, motors, gasoline engines, et cetera. The searchlight is mounted on light wheels, similar to small auto wheels, fitted with rubber tires. It can be hauled to any desired spot in a short time.

During the period of the war, many novel and startling inventions have come to the fore, especially means for locating hostile airplanes and dirigibles. The majority of these operate on the simple sound wave principle, the waves being transmitted thru the medium of the air from the propellers of the hostile aircraft. Some of these devices have been made in the form of large tubes, provided with a simple microphone method of detection, but they were rather unwieldy, and to a certain extent never gave full satisfaction, due to the fact that too great a dependence was placed on the amplifying of the hum of the airplane engine by means of microphones alone. This new form of locater—the Paraboloid—has several novel improvements over previous apparatus of this type, one of the best features being that it can readily detect the hostile aircraft at great distances, especially valuable when the enemy tries to make a surprise attack at night.

Spotting the Enemy.

Imagine a peaceful village, such as are numerous in the sparsely settled sections on the coast of England, seemingly defenseless. Yet there seems to be an air of mystery about some of these places—and there is, for thru underhand means, the enemy "spies" learn that secret research work is being carried on in this unassuming little hamlet. It would be suicide upon the part of these "spies" to personally attempt to carry out any large exploitation or even to think of attempting to blow up the place with any hope of success. The nearest recourse that they could have would be to get in touch with a squadron of enemy planes, and notify them where these operations are taking place. On a dark night, these enemy planes issue forth and swoop down, like a nest of hornets, upon this defenseless little village. But one thing they have overlooked. Altho they have come unheralded, it is true, the watchful *electrical eyes and ears* of the engineer corps are prepared for any such surprise, thanks to the fact that they have this marvelous invention on hand, whereby it is possible, no matter how dark the night, to quickly and positively locate the approach of enemy aircraft. To their sensitive ears comes the hum of the engines. Word is flashed to every little town, fort and hamlet within the vicinity, and especially planned advance action is arranged. Ere the fliers have reached their destination, the heavens are being explored by gigantic searchlights for the enemy marauders. Trained gunners, using the very latest types of anti-aircraft guns, are soon popping away at the enemy, and what was hoped to be a great surprise and success on the part of the enemy, turns out to be one grand fizzle, much to his discomfiture.

These powerful searchlights, besides being available for enemy spotting, are also much used as a means of signaling. This is one branch of the signal corps work which has proven one of the big factors in helping to win the war. Searchlights of this type mounted on warships helped to protect the American sea coasts.



Photos by Press Illustrating Service

Gigantic Electric Searchlights of the Portable Type Were Used to Expose the Enemy Flier as Soon as the "Paraboloid" Had Succeeded in Spotting Him. The Anti-Aircraft Guns Then "Saluted" Him—and the Allied Planes Finished the Rest.

Jeweled Portal Welcomes N. Y. Fighters

NEW YORKERS, who openly boast "there is nothing new under the sun," had an agreeable surprise in the "jeweled portal" of electric lights erected in Fifth Avenue at Sixtieth Street, on the occasion of the grand review of the Twenty-seventh Division returning warriors. It was designed and erected under the direction of Walter D'A. Ryan, lighting expert.

So magnificent was the illuminated arch that it drew forth the unstinted praise and commendation of everyone who saw it. Frank L. Dowling, President of the Borough of Manhattan, when he first saw the beautiful spectacle, exclaimed: "Like the entrance to Heaven!" And no better description could be given of this handsome testimonial to the bravery, sacrifices and triumph of the sons of the Empire state. The details of the "portal" were worked out by Captain J. W. Gosling, under the direction of Mr. Ryan, who was chief of the department of illumination of the Panama-Pacific International Exposition which took place in San Francisco in 1915, and the success of which became one of the wonders of the world.

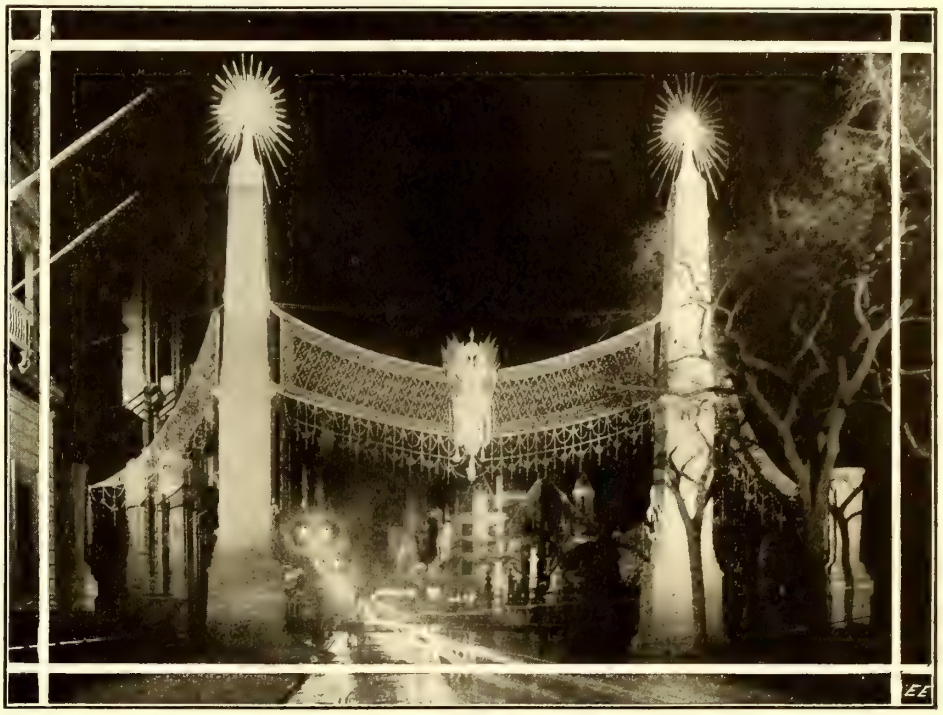
Mr. Ryan carried the same style of decoration here as was used at the Panama-Pacific Exposition. The same jewels, to the number of 31,000, were used in this jeweled portal as were used at the Panama exposition. This is really the first time the people of New York had an opportunity to see something that was really new, and it was the second time these jewels were used, the same ones that hung on the tower at San Francisco for one year.

The "Jeweled Portal" is really a gigantic curtain of jewels draped between two obelisk forms, and spans the street at a height of twenty-five feet at its lowest point, and fifty feet at its highest.

The architecture is simple, bold Roman, and is the kind of thing which might have been built on a street in Rome on the return of their victorious legions, but instead of painted and embroidered banners the modern jewels have been substituted and the whole portal has been given a most modern touch by bringing out upon it the delicate flashings of thousands of points of true light, not the color of pigment but the pure colors of the spectrum, the colors only seen in the rainbow, a bubble or in the sky at dawn or sunset, by illuminating it with arc projectors.

The obelisks stand at either side of the roadway and are flanked by Roman altars, each of which is twenty-six feet high. The jeweled curtain is draped from altar to obelisk across the avenue and down to the

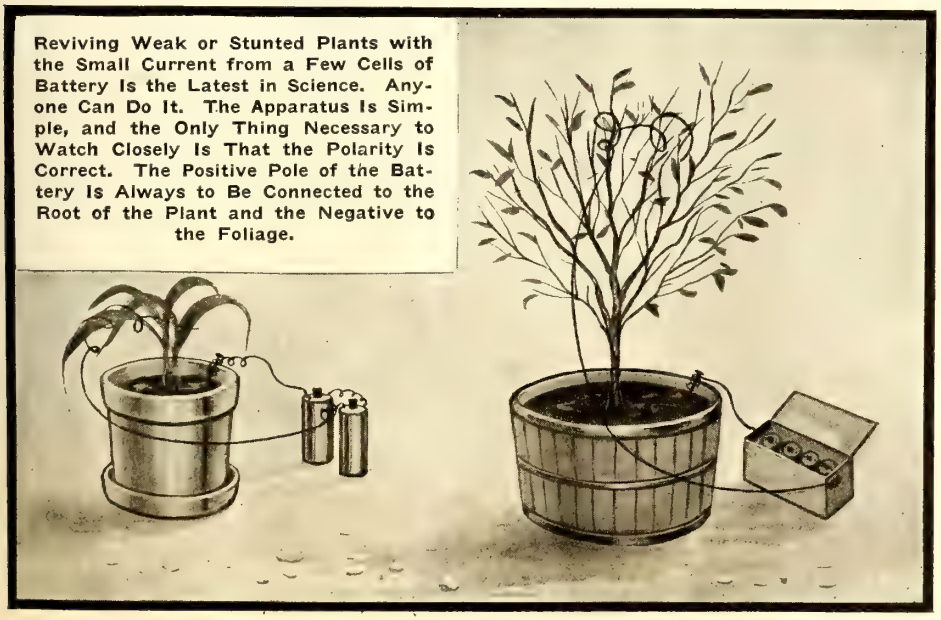
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One of the Most Handsome and Bewitching Electrical Decorations New York Presented to Its Home-Coming Troops. The "Jeweled Portal"—a Mass of Shimmering Cut-Glass Jewels, Illumined by Reflected Spot Lights.

Reviving Plants With Electricity

The accompanying illustration shows a clever scheme devised by a Connecticut flower grower for reviving almost lifeless plants, by the application of low-voltage direct current, such as that supplied from a dry or other battery. One of the experiments was tried on a small cactus plant which had been sent from Mexico, and which seemed to pine away rapidly. The cactus was about dead when the experiment of applying electric current was first tried. Two cells of dry battery were connected up with some fine copper wire, the positive pole being connected to a nail placed in the soil of the flower pot, while the negative pole was secured delicately around the upper branch. The cactus brightened up very sprightly after one week of this treatment, and in two weeks it was plump, green, and growing nicely. Further experiments were tried on a rose bush and a fuchsia with good results, care being taken to see that the positive wire from the battery is applied to the root of the plant and the negative pole to the foliage, so as to promote the flow of sap upward.



Reviving Weak or Stunted Plants with the Small Current from a Few Cells of Battery Is the Latest in Science. Anyone Can Do It. The Apparatus Is Simple, and the Only Thing Necessary to Watch Closely Is That the Polarity Is Correct. The Positive Pole of the Battery Is Always to Be Connected to the Root of the Plant and the Negative to the Foliage.

It may be thought at first that the battery would soon be exhausted, but the resistance of the plant is of considerable value, so that the flow of current is but a small fraction of the ampere, and the cells will thus give quite a lengthy treatment before being entirely exhausted. Those having access to a storage battery will find it very useful for the purpose. The current in this case should be regulated by means of a small rheostat, such as the rotary, porcelain base 10-ohm rheostats available on the market. Several other interesting experiments were tried by the Connecticut florist, notably on a small plum tree, which was electrically treated with 6 cells, with the result that it blossomed out fully, several days ahead of the other adjacent trees. Another experiment was that conducted on an ever-bearing strawberry plant, which was treated with 2 dry cells. This plant was left in the same row with other berry plants, and its increased size and fruit production was very striking.

Popular Astronomy

By ISABEL M. LEWIS
Of the U. S. Naval Observatory

The Nature of Comets

COMETS, along with shooting stars and meteors, are to be clast as part of the debris of the solar system. According to prevailing theories they may have been originally tenuous outer portions of the primitive solar nebula that escaped being swept up by the nuclei of the planets and their moons owing to the fact that they did not share in the general rotation of the system, or they may, possibly, have been the lighter gases ejected from one or the other of two closely approaching suns that furnished, by the disintegration resulting from their close approach, the material wherefrom our present solar system was formed.

The orbits of comets are inclined at all angles to each other and to the orbits of the planets which, on the other hand, lie very nearly in the same plane.

The larger members of the sun's family, the planets and their satelites, revolve from *west* to *east* around the sun. Comets on the contrary frequently *retrograde* or back around the sun in the opposite direction, from east to west.

The paths that these erratic visitors follow in their journeys around the sun bear not the slightest resemblance to the paths of the planets, which are almost perfect circles. The cometary orbits are ellipses of such high eccentricity that it is customary in computing a preliminary orbit of a comet to assume that its eccentricity is unity, *i.e.*, that it is travelling in a parabola. If the eccentricity is less than unity the orbit is a closed curve or ellipse, and if it is greater than unity the orbit is an hyperbola. In the latter case the comet would make one and only one visit to the sun, coming from interstellar space and returning thereto after a brief sojourn within our solar system. Since no cometary orbit has ever been found to be hyperbolic in form it has been assumed that the eccentricity of the orbit is less than unity in all cases and that the comets are all travelling in elliptical orbits and therefore are permanent members of the solar system. The nearer the eccentricity of the orbit of a comet approaches to unity the greater is the path described and the less frequent the comets return to the sun. Since it is very unlikely that the eccentricity of an orbit is exactly unity there are probably no comets that have parabolic orbits tho, for the preliminary computation of the orbit of a newly discovered comet the unknown eccentricity is assumed to be unity. This is generally a safe assumption for the majority of all comets travel in ellipses whose eccentricities approach closely to unity and their periods of revolution around the sun consequently run into the hundreds or thousands or even hundreds of thousands of years. A wonderful study, indeed.



Giacobini's Comet, December 29, 1915, Photographed with 10" Bruce Telescope, Yerkes Observatory, by E. E. Barnard. Note the Unique Sharply Defined Tail With Convex Edges. The White Dashes Are Stars Leaving a White Trail on the Photographic Plate as the Telescope Followed the Comet During Its Exposure of Several Hours.

Donati's comet of 1858, one of the greatest comets of the nineteenth century, had a period of more than two thousand years and its aphelion (the point in its orbit farthest away from the sun) was five times more distant than the orbit of Neptune.

There is, however, a class of comets known as *periodic* comets that are characterized by extremely short periods of revolution around the sun. To this class belongs Halley's comet whose period of seventy-five years exceeds that of any other periodic comet. Encke's comet, on the other hand, has a period of three and a third years which is the shortest cometary period known. Most of the periodic comets are inconspicuous and only visible telescopically even when comparatively near to the earth. Halley's comet is the only one of this class that lays any pretensions to remarkable size or brilliancy and it also is showing the effects of disintegration resulting from too frequent visits to the sun.

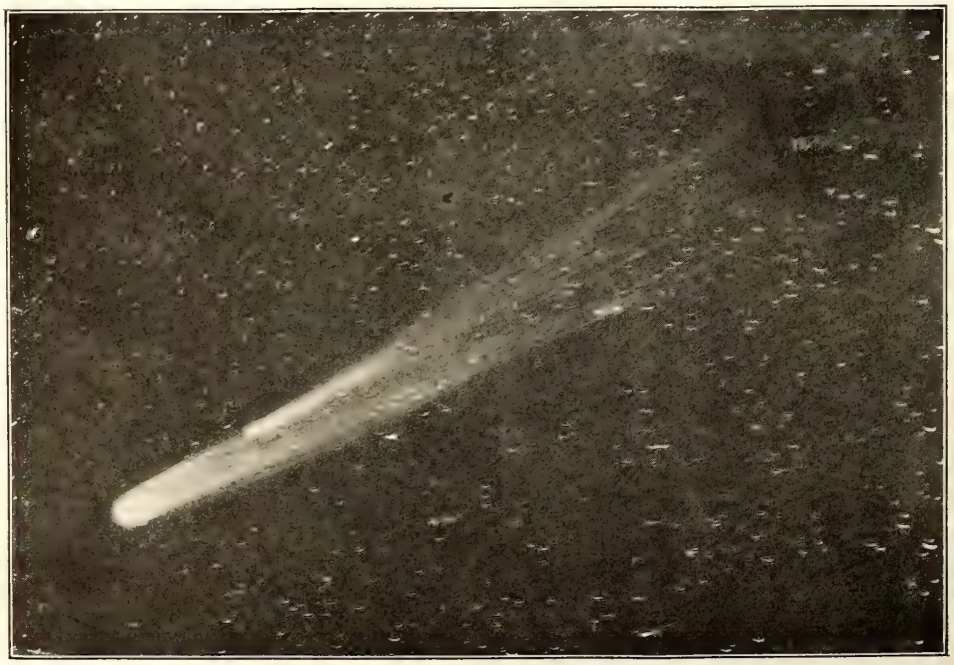
Comets are bodies of *great bulk* or volume and *small total mass.* Their tails, which only develop in the vicinity of the sun, are formed of the rarest gases and the best vacuum that man can produce would not be in as tenuous a state as the material existing in the tails of comets. There are many proofs of the extreme tenuity of comets. The earth has on a number of occasions past directly thru the tails of comets without experiencing the slightest visible effects. Stars shine undimmed in lustre even thru the heads of comets. If the earth should encounter a comet "head on" it is doubtful if it would experience anything more serious than a shower of meteors which would be consumed by friction with the earth's atmosphere. It is possible, however, that matter in the nucleus, the star-like condensation in the head of a comet, may consist of individual particles weighing in some instances a number of tons surrounded by a gaseous envelope and held together by the loose bonds of their mutual attraction.

Since the total mass of a comet is so small a close approach to one of the planets, especially Jupiter, produces great changes in the form of the comet's orbit tho the motion of the planet is not disturbed in the slightest degree by the encounter.

The majority of all the periodic comets have been "captured" by Jupiter, that is, the original orbits have been so changed by the perturbations produced by close approaches to the giant planet that their aphelia lie in the vicinity of Jupiter's orbit. Several of the other planets have also "captured" comets in this sense, and the fact that the aphelia of a number of comets are grouped at certain definite intervals beyond the orbit of Neptune has been considered by some astronomers to be an indication that there are two or more additional planets in the solar system revolving around the sun at these distances.

The most interesting feature of a comet is its characteristic tail which develops and increases in size and brilliancy as the comet approaches the sun. As the tail is always turned away from the sun it follows the comet as it draws near the sun and precedes as it departs. Its origin is due, it is believed, both to electrical repulsion and *light pressure* acting upon minute particles of matter in the coma or head of the comet.

It is believed that the curvature of the tail depends upon



Halley's Comet, June 6, 1910, Photographed at the Yerkes Observatory by E. E. Barnard, Taken With 10" Bruce Telescope, Exposure Two Hours. The Most Remarkable Part About This Comet Is That It Disintegrated. Photograph Shows Upper Part Leaving Main Section

the nature of the gases of which it is composed.

Long, straight tails consist chiefly of hydrogen, it has been found, curved tails of hydrocarbons and short, bushy tails of mixtures of iron, sodium and other metallic vapors. At times the same comet will have two or more tails of different types.

Since the material driven off from the nucleus or head of a comet by electrical repulsion and light pressure is never recovered, it is evident that comets are continually disintegrating. Also, comets that have past close to the sun at perihelion passage have frequently been so disrupted by tidal forces that one nucleus has separated into several parts and the newly formed nuclei have pursued paths parallel to the original orbit, each nucleus developing a tail of its own.

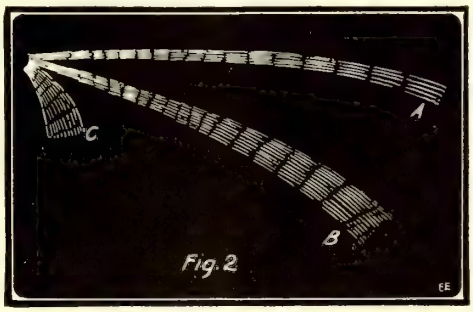


Daniel's Comet, August 6, 1907, Photograph Yerkes Observatory by E. E. Barnard. This Photograph Shows the Full Length of Tail About 12°, Taken With 3" Lens.

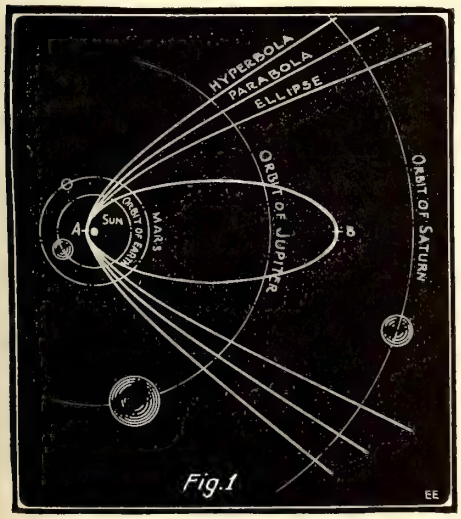
Many periodic comets, it is now known, have gradually been broken up and dissipated into periodic swarms of meteors as a result of the disruptive effect produced by too frequent returns to the vicinity of the sun.

The luminosity of comets is due not only to reflected sunlight, but to certain unknown causes that produce sudden and erratic increases or decreases of brilliancy. The causes of these sudden changes in luminosity are unknown, possibly electrical discharges or chance collisions between fragments of considerable size may account for some of these sudden flashes of brilliancy.

The peculiar behavior of the tails of comets at certain times has frequently been noted and suggests the existence of quantities of finely-divided meteoric or gaseous matter within the solar system that have no appreciable effect upon the huge planetary masses, but offer sensible resistance to the passage of the tenuous gases of which the tails of comets are composed. The fact that the earth daily encounters meteoric dust, meteorites and fire balls also indicates that meteoric matter exists in considerable quantities within our solar system. Tails of comets appear at times to be twisted or brushed aside as if they had encountered some unknown force or some resisting medium.



Different Types of Tails of Comets. A—Hydrogen; B—Hydrocarbon Gas; C—Iron and Other Metallic Vapors. The Majority of the Tails of Comets Belong to Type B and Are Therefore Chiefly Composed of Hydrocarbons.



This Diagram Shows a Typical Cometary Orbit of Short Period. A Marks the Perihelion, or Closest Approach to the Sun, and B the Aphelion, or Point Most Distant From the Sun. The Great Difficulty of Determining Whether a Comet of Long Period Is Moving in an Ellipse, Parabola or Hyperbola Is Evident When One Considers How Closely the Three Curves Coincide in the Vicinity of the Sun.

Up to the present time several hundred comets have been discovered. Nearly three-fourths of this number travel in orbits that are sensibly parabolic with eccentricities approaching closely to unity. Of the remaining number there are about forty that have been "captured" by the major planets, Jupiter, Saturn, Uranus and Neptune, tho Jupiter possesses the lion's share of these captured comets. Scarcely a year passes by that several comets are not discovered. Most of these are telescopic, however, even when they are near the sun and at their greatest brilliancy. Naked-eye comets of great splendor and brilliancy are comparatively rare and there has been a particular dearth of such unusual comets during the past thirty years or so.

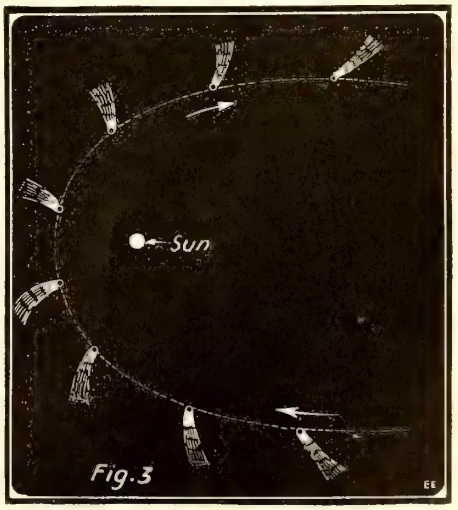
The last spectacular comet, unless we make an exception of Halley's comet, which made its return according to prediction in 1910, was the great comet of 1882 which was visible in broad daylight close to the sun and at its perihelion passage swept thru the solar corona with a velocity that exceeded two hundred and fifty miles a second and carried it thru one hundred and eighty degrees of its orbit in less than three hours.

Some comets approach much closer to the sun than others. The majority of all comets observed have come within the earth's orbit and no known comet has its perihelion distance beyond the orbit of Jupiter. It is, of course, possible that there may be a number of comets that never come within the orbit of Jupiter, but it is very unlikely that any such comet would ever be discovered. The majority of comets are simply small, fuzzy points of light that are only visible telescopically and the greater the perihelion distance of the comet the less likely is it to be seen with the naked eye.

Since comets as well as planets obey Kepler's first law, known as the law of areas, and sweep over equal areas in equal times it is evident that when a comet is at perihelion or nearest to the sun it is moving at maximum speed and when it is at aphelion or farthest from the sun it is moving at minimum speed. Moreover, its speed at these two points in its orbit varies tremendously since the orbits of comets are ellipses of very high eccentricity. The speed with which the planets are travelling is, on the other hand, remarkably uniform since their orbits are nearly circular.

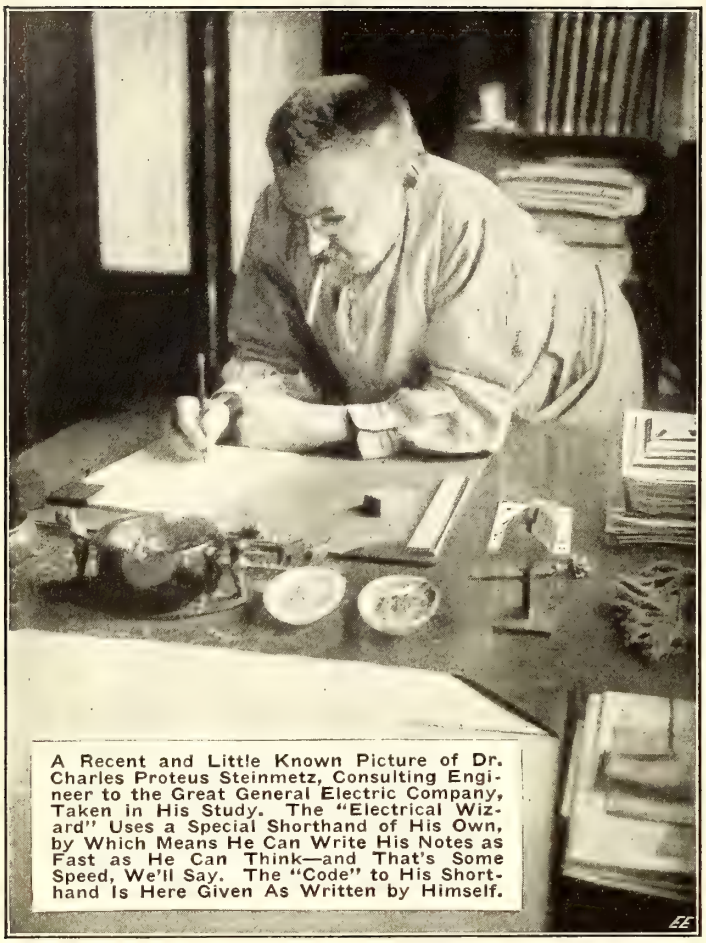
The leisurely speed with which a comet travels thru the frigid outer regions of the solar system is gradually accelerated as the comet draws nearer and nearer to the sun until it has acquired near the time of perihelion passage a velocity that occasionally exceeds two hundred miles a second. Here, also, the great increase in light and heat and the strong magnetic field of the sun produce complex changes in the gaseous and meteoric substances of which the comet is composed until the character-

(*Continued on page* 350)

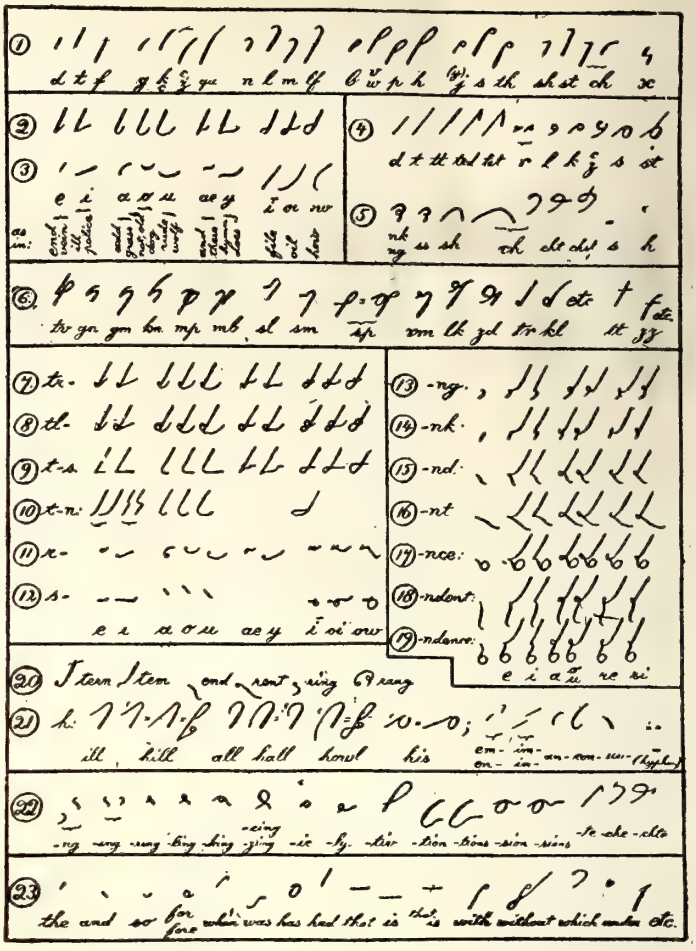


How a Comet Behaves at Perihelion (Closest Approach to Sun). The Tail of a Comet Is Invariably Directed Away From the Sun, No Matter What Its Position in the Heavens.

Steinmetz's Own Shorthand



A Recent and Little Known Picture of Dr. Charles Proteus Steinmetz, Consulting Engineer to the Great General Electric Company, Taken in His Study. The "Electrical Wizard" Uses a Special Shorthand of His Own, by Which Means He Can Write His Notes as Fast as He Can Think—and That's Some Speed, We'll Say. The "Code" to His Shorthand Is Here Given As Written by Himself.



Can you write as fast as you can think? If you cannot, then your efficiency is impaired; and the difficulty of putting down your thoughts at the proper speed constitutes a real stumbling block in your onward march toward your goal.

Dr. Steinmetz, one of the greatest authorities on matters electrical that the world has known, and who is an author of many volumes of useful knowledge which he has given to the scientific world, possesses no "neck in the bottle" when it comes to jotting down the results of his researches in his wonderful laboratory at Schenectady. In a recent interview upon this subject he said:

"With this shorthand I can write as fast as I can think. The only other way in which I could put down my thoughts as fast as I could think would be to dictate to a phonograph, but I have not always a phonograph with me.

"I learned this shorthand while I was in high school in Europe, and took all of my notes while in college in shorthand. All of these notes I have preserved and had bound, and I can read them as well after thirty-five years as I could thirty-five minutes after taking the notes down.

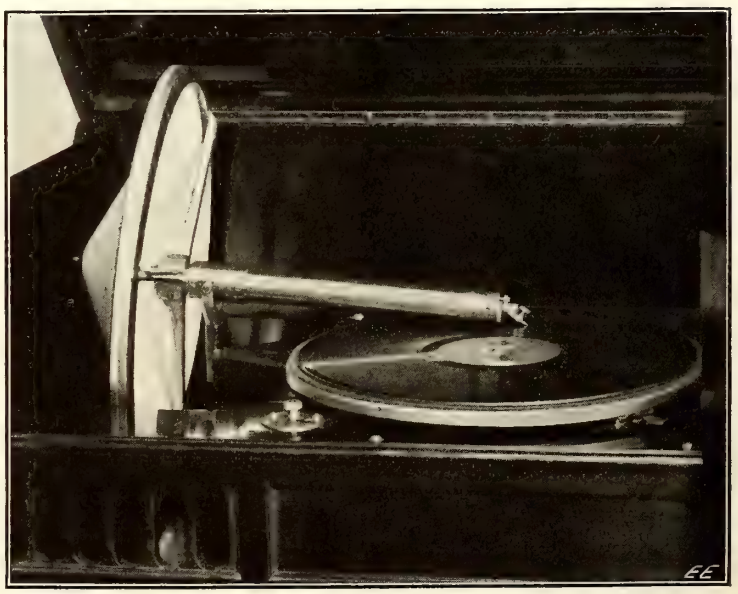
(*Continued on page 373*)

A Hornless Phonograph

This talking machine eliminates the usual tone-arm, sound-box, and horn. Instead of these we have a large cone-shaped diafram of parchment fitted into a large circular aluminum frame. The center of the diafram is connected by a wire, under tension, with the needle holder. The sound as it comes from the record sets up vibration in the wire, and the vibrations are released in the form of recognizable sound directly from the diafram. The volume of sound is controlled by a special attachment on the arm protecting the wire, for those who desire this method, but is more readily controlled by the opening and closing of the doors of the cabinet. There are two doors in front, each of which may be closed separately, and a large door on the side which also gives control to the tonal volume.

The circular frame holding the diafram is constructed of aluminum, heavily gold plated, as is the tube thru which the wire runs from the needle to the diafram as well as the other metal parts of the attachments. The simple twist of the needle holder permits the playing of either hill and dale or lateral cut records on the same machine, and it therefore makes the new reproducer practically universal in its application. It is claimed for the Pathé "Actuell" that, inasmuch as the sound comes in its full volume direct from the reproducer to the ear, it does not suffer from the overtones or conflicting vibrations that sometimes devlop when the sound is carried thru an amplifying chamber and likewise by reducing the number of factors incident to tone reproduction.

Thru the use of this large diafram surface, noise, if not entirely eliminated, is reduced to a point where it is not audible.



The Newest in Talking Machines—No Horn, Just a Large Vibrating Diafram That Radiates the Sound in All Directions Equally.

Experiments in Physics

By JOHN J. FURIA
DEPARTMENT OF PHYSICS, N. Y. UNIVERSITY

1--Perpetual Motion

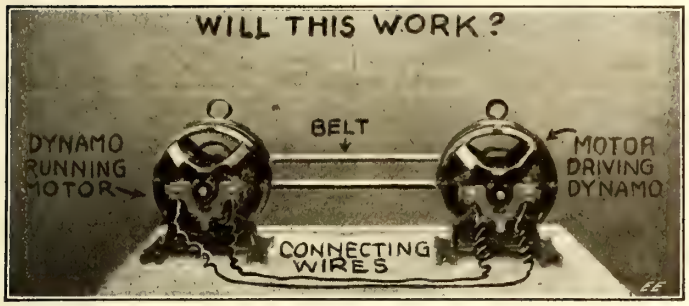
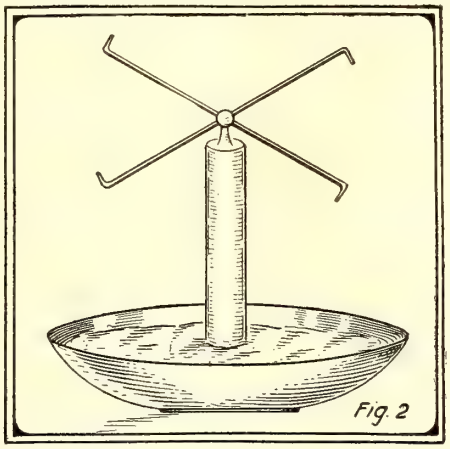


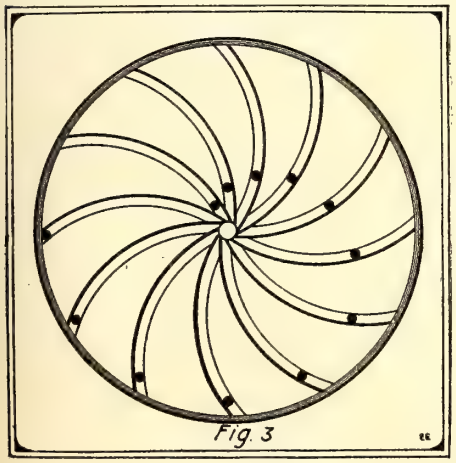
Fig. 5. The Electrical Student's Dream: Belt a Dynamo and a Motor Together. Connect Their Windings Electrically and—Presto! You Have Perpetual Motion! But Do You? Read On, Macbeth, Read On!!

IT is a well known fact that more Time, Energy and Money have been spent and wasted in searches for a machine capable of producing *Perpetual Motion* than for all other scientific pursuits combined. The impossibility of perpetual motion can be demonstrated by the simple elementary laws of Mathematics and Mechanics, and consequently the *truly* scientific mind wastes no time in such a search. Perpetual motion is a direct violation of that fundamental law of Physics, the law of *conservation of energy;* hence in order not to waste time in argument with a perpetual motion inventor, to show him the fallacy in his reasoning (?) one has but to say "it contradicts the law of conservation of energy." The U. S. Patent Office has a sure-fire means of disposing of these would-be inventors—it asks them to produce a working model! That settles it, for if the inventor cannot make the proposed scheme work, who can?

Perpetual motion and perpetual motion machines are defined in many ways, all the definitions conveying the idea of *getting something for nothing, indefinitely.* The getting something for nothing idea, of course, will appeal to the general public ignorant of science, and the natural consequence is "swindling schemes." One definition is—a perpetual motion machine is one which will go on moving without assistance from any external force, except possibly gravity, until the parts of which it is made wear out! The inventor usually adds that his machine will evolve more power than is required to run it. The efficiency of such a machine would therefore be *greater than* 100 *per cent.!* Perpetual motion machines fall naturally into two classes—the *absurd class* and the *frauds.* The second of these classes hold no interest for us scientifically. In general a perpetual motion machine would be invented (the inventor being backed up by publicity specialists). A glowing account of the operation of the machine before a distinguished audience from "Podunk" would appear, together with front page photographs of the machine and of the handsome and distinguished looking inventor—who always spent a life-time and several fortunes in perfecting the ninth wonder. The inventor having spent all his money and all he could borrow would therefore be willing to *sacrifice* a major share in his invention for a few thousand dollars, and some fortunate young heir or widow would perchance acquire an expensive education. Nowadays, if an account of a perpetual motion machine should appear in the papers, some secret service men would keep in touch with the "benefactor to mankind" and in a short time, or as soon as his "gilt edge stock" began to sell, said benefactor would shortly rest behind prison bars.

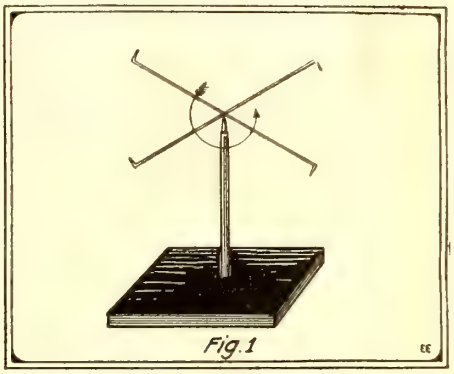


It Should Go on Forever, They Say—This Hydrostatic Marvel. The Atmospheric Pressure of 15 lbs. per sq. Inch on the Water in Bowl Forces It UP Thru the Revolving Arms. The Water Shoots from the Nozzles Back Into the Bowl—Ad Nauseam.



See the Little Balls in the Hollow Spokes of This Wheel? Their Constantly Changing Center of Gravity Was Supposed to Keep the Wheel Revolving—Only It Didn't!

The first class of machines is of considerable interest. Most of us have at some time or other spent much time in thinking up perpetual motion machines and still more time in trying to fathom the reason why our schemes *would not work.* Which one of us has not at some time or other hooked up a small toy dynamo and motor with the intention of causing the dynamo to supply current to run the motor and some lights, bells, trains, etc.—while the motor in turn, belted to the dynamo, drives the latter machine. See Fig. 5. What a great disappointment it was to find that the scheme wouldn't work. To be sure, on connecting the hand drive to the dynamo, we get enough "juice" from it to run our motor and our lights and other things. Also we can run our motor from some cells and by belting cause the dynamo to run. Why then does our perpetual motion machine fail us? The answer is simple—the *law of conservation of energy.* Let us assume that our motor and dynamo were identically made and practically frictionless. The machines of Fig. 5 are of this type. A current of 1/10 ampere is used by each when acting as a motor, at a potential of 10 volts; therefore, 1 watt of power is consumed. Since the efficiency would have to be less than 100 per cent., due to friction and eddy current losses, etc., then when acting as a dynamo *less* than one watt power is given off. Hence one of the machines *can never be made to run the other, let alone do other work besides!*



The Static Electric Motor. A Metal Wire Cross with Pointed Ends Pivoted on an Insulated Upright. Connect It to a Static Machine, Fig. 6, and You Have Perpetual Motion—Perhaps?

Another electrical type of perpetual motion machine familiar to most of us depends for its operation (or rather for its failure to operate) on the action of points.

(*Continued on page* 377)

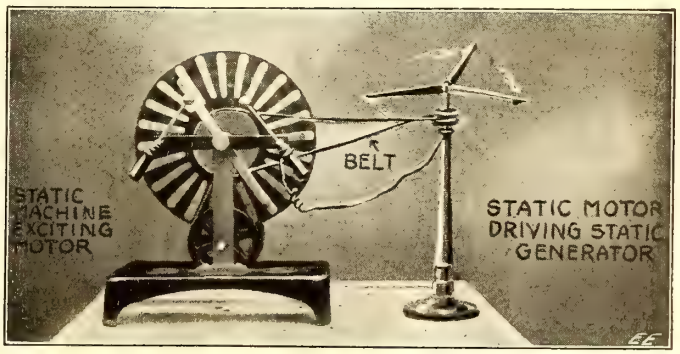


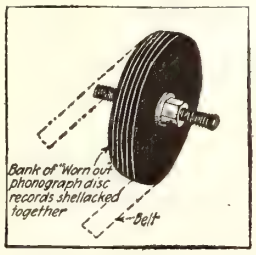
Fig. 6. An Electro-Static Nightmare! The Static Machine Charges the Motor—the Motor, Thru Its Belt, Drives the Generator! Quick, Watson, the Needle.

$50.00 Prize Contest

Uses for Old Phonograph Records

NOT so long ago we ran a "Burnt-out Lamp Contest" giving prizes for the best ideas what to do with the old burnt-out lamp globes. Thousands of suggestions were received from every part of the world, and we all had a lot of fun. We publisht the best ideas and we know that many of them are now actually being used daily.

Your average experimenter is happy only when he can take a lot of antiquated old "junk" and put it to a new use——he'd take an Egyptian mummy and convert it into a rotary spark plug, if it were possible!



Want a Small Belt Pulley? Procure a Few Old Phonograph Records, Shellac Them, Place in a Vise Until Set, and You Have a Fine Pulley.

So the other evening when we stumbled over a lot of old phonograph records that had been played so long that they would "phono" no longer, we said—Ah, what can we do with them? Too good to throw away! So we thunk awhile and ended by making a fine Wimshurst static machine, using two plates to generate the juice. Of course that's old stuff, every "bug" knows that trick.

But we felt we had stumbled into a veritable gold mine. Now we admit that our editorial think-tank becomes clogged up once in a while, so we thought we'd put it up to EXPERIMENTER readers—they have us beat forty different ways as a rule. True, in our younger days ye Editor once made a very serviceable pulley by shellacking eight, old, cracked 7" disks together which made a pulley about one inch thick, and which did gallant work. True, that he also once made a rotary variable condenser from a dozen 10 cent records (tin foil shellacked to one side of the records). True, also, that he once constructed an emergency rotary spark gap using two 7" records shellacked together with zinc plugs screwed to the face of the records——but really all such stunts are commonplace.

Of course you can do much better than this. Somewhere there is a "bug" who will turn in a really good idea. And we're out to find that "bug." Yes it will cost us $25.00 for that prize idea, but we think it will be cheap at that.

Now, then, boys, let's see how much ingenuity there is around. I promise you lots of fun and your fellow-bugs will bless you for generations, because your ideas will be of tremendous value to them.

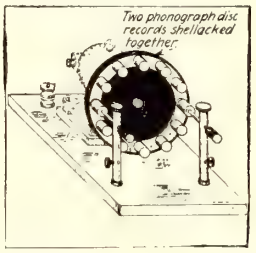
Now listen!

$50.00 IN PRIZES

1st Prize
$25.00 in Gold

2nd Prize
$15.00 in Gold

3rd Prize
$10.00 in Gold



Rotary Spark Gaps Are Quickly Made From Old Phonograph Record Discs.

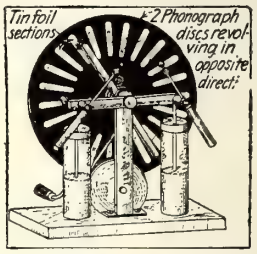
OLD PHONOGRAPH RECORD CONTEST.

This contest is open to every reader whether subscriber or not.

These prizes will be paid by the publishers of the ELECTRICAL EXPERIMENTER for the best useful ideas what to do with old phonograph records.

The two important conditions are that the idea must be a useful and original one. It is not necessary that the record or records be used with electrical devices, *any* use is satisfactory as long as the resulting device is useful and, of course, therefore practical.

Any amount of records, and any and all sizes can be used. Records can be sandpapered, turned down, bent in hot water, etc., it matters not, as long as they are actually used. The final shape does not matter.



Two Old Phonograph Records Make a Good Static Machine, When Drest Up a Little With Some Tinfoil Sectors, and Then Rotated In Opposite Directions.

We shall try and award the prizes to those *who actually have built or made the device which they describe.* Therefore those contestants sending actual photographs of the ideas stand a better chance to win a prize.

Description is limited to 200 words. Use one side of paper only. Use ink or typewriter. No pencilled matter considered. Sketches must be on separate sheets of paper.

Contest closes in New York, September 15th. Prize winners will be announced in our November issue.

Address all letters, photographs, etc., to: Editor: "Old Phonograph Record Contest."

Airplane Parachute a Success

Lieutenant Jean Ors, of the French Army, demonstrated the usefulness of his "aërial life preserver" recently at Atlantic City. This device is an adaptation of the parachute to airplane use, and toward the end of the war was widely employed by the Allied armies, greatly reducing the mortality when machines were shot or caught fire. The test of the device was before a committee of American and foreign experts, and after Lieutenant Ors had proved the worth of the life preserver, he received a special prize of $500.

The aërial device, contained in an oil-cloth packet, is only fifty inches in diameter and four inches thick. It weighs about fourteen pounds. For the test it was affixt to the underbody of the airplane with a rope running into the cowl, so that the lieutenant could make the release at the proper moment. When it was in place "Eddie" Stinson, America's leading fancy flier, tuned up his craft and he and the Frenchman hopped in.

Stinson and his passenger rose well above 1,000 feet, and swinging in a giant circle made two trips around the airport. Then, dipping down to about 500 feet, Stinson ran his machine southeast, directly into the wind, so that the parachutist could gage his distance. As Stinson shot in a 200-yard spurt at eighty-mile speed, the watchers saw the lieutenant crawl cautiously over the cowl of the machine, poise there a second, and raise an arm as he ript the fastenings of the parachute, and then plunged earthward from the streaking airplane.

For the fraction of a second he was enveloped in the smoke of the exhaust. Then he came hurtling at the field. Quick as a flash the life preserver opened, the fall of the Frenchman being checked without perceptible shock *within fifty feet after he made the jump.* Slowly the wide-spreading white silk umbrella, with the army officer dangling at the end of the ropes, swung to earth, the landing being as gentle as the arrival of a raindrop. The descent was made in forty-six seconds.

In August "Radio Amateur News"

Radio-telephoning from Your Auto
By A. H. Grebe

A 15,000 Cycle Radio Frequency Alternator for Radio-Telephone Work

Construction of An Audion Control Panel

Multiple Conical Loose Coupler
By John G. Merne

Loop Antenna and Direction Finders for Amateur Use
By David S. Brown

Low Potential Radio Frequency Arc
By Charles W. Noller

Is the Antenna Doomed?
By E. T. Jones

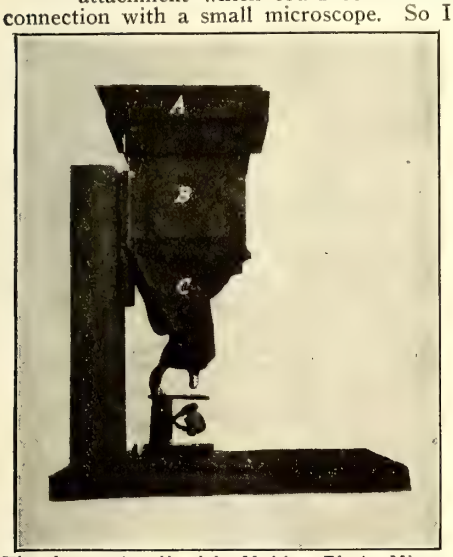
Developments in Wireless Telephony
By Dr. F. B. Jewett

THE CONSTRUCTOR

How to Make Photo-Micrographs

By G. D. LAUDERMILK

BIOLOGY being one of the subjects in which I became interested, and having fitted up a small laboratory, I found that I required a photographic attachment which could be used in connection with a small microscope. So I finally evolved one made in the following manner:



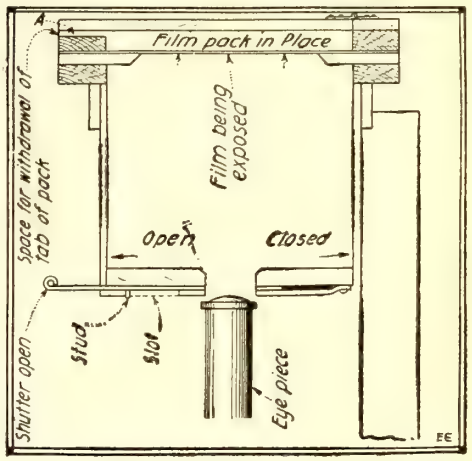
The Apparatus Used in Making Photo-Micrographs, Comprising a Home-made Camera for Holding Plate Holder or Film Pack in Proximity to Microscope Eye-piece

The camera was made in two parts; "A," the plate holder, is a shallow box 6" long, 4" wide and 1" deep. The top of the box is hinged and the interior of the plate holder has a depression of a size to take a No. 320 Premo film-pack. It is modeled after the plate holder of a Premo camera. The camera box is 5" deep, 3" wide and 4⅜" from front to back. The camera has a strip ½" wide around it, ¼" from the top, forming a shoulder upon which the plate holder rests when in place; both the edges of the plate holder opening and the rim above the shoulder are covered with black velvet, forming a light-proof joint.

In the center of the opposite end is an opening ¾" in diameter closed by a simple sliding shutter made of sheet metal. Both the plate holder and the camera box are covered with imitation leather and are constructed of light wood. The hood "C" is of black cloth and serves merely to confine the draw-tube and prevent leakage of light between the eye-piece and the opening in "B." At the base of the upright is a wooden form exactly of the same shape as the foot of the microscope. This form is so placed that it acts as a guide to keep the microscope in position with the eye-piece.

When photographing, the slide is placed on the stage in the usual way and focust so that all details are brought out sharp. The microscope is then placed in position, the hood drawn around the eye-piece and fastened with a hook and eye. The shutter is now opened and the exposure made. The length of exposure will vary with the degree of transparency of the object and the depth of staining. Thin clear objects or objects stained with methyl-violet or blue

(Continued on page 356)



Drawing Showing Sectional View Thru Camera and the Arrangement for Holding the Film Pack or Plate Holder, in Position Over the Microscope Eye-piece

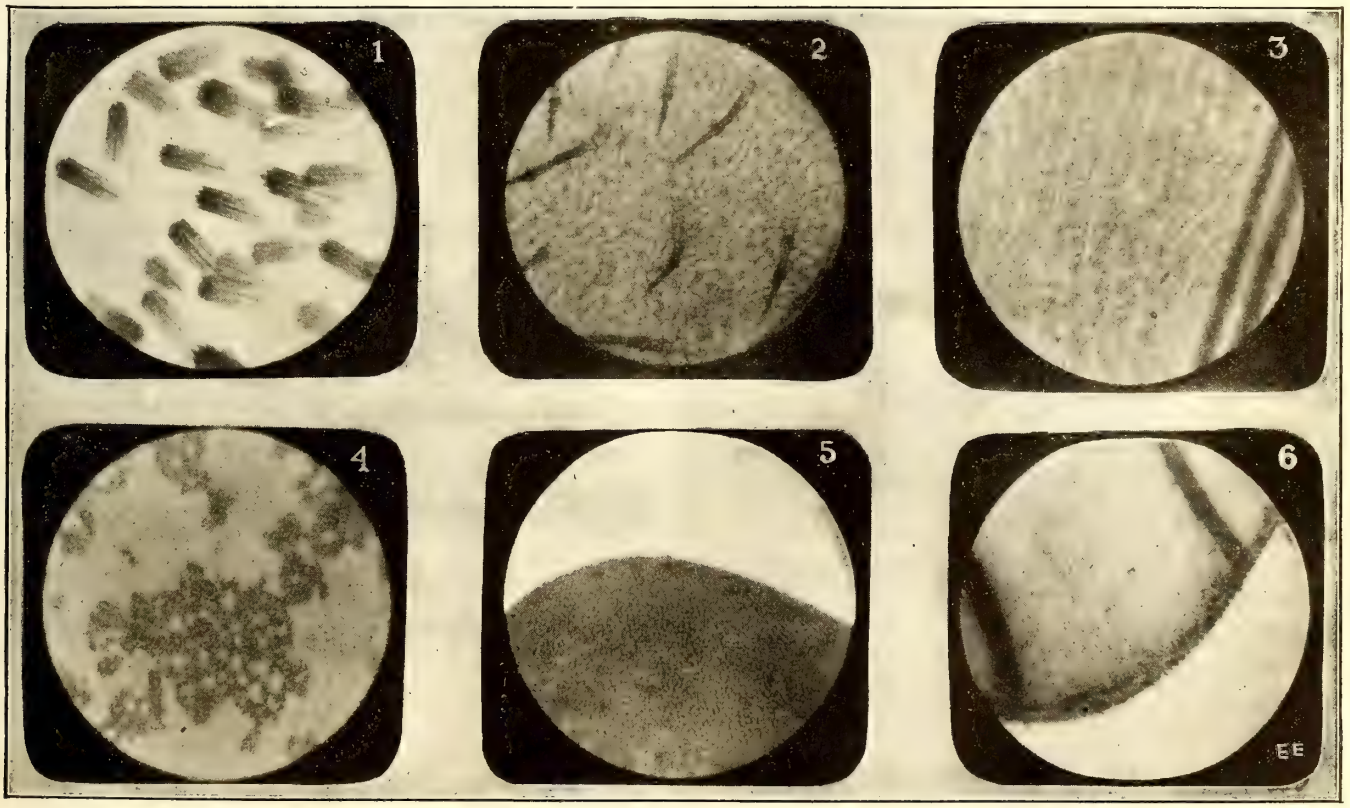


Fig. 1, Microphotograph Showing the Wonderful Wing Structure of the Moth from the Grape-vine Cut-Worm. 2—Parenchyma of Sun Flower Leaf. This Specimen Was Obtained by Stripping a Small Piece of the Epidermis from the Upper Part of the Leaf. The Large Pointed Objects Are Hairs. 3—The Magnified Surface of the Underwing of the Squash Bug; the Dark Line Is Part of the Vein. 4—Nitrogen Fixing Organisms from a Nodule on the Root of a Pea, Which Possesses the Property of Fixing Nitrogen from the Air. 5—Tip of Antenna of a May Beetle. The Short Sharp Bristles Are the Sensory Organs of Smell. 6—Micrograph of a Wing Tip from a Crane Fly, Showing Covering of the Wings.

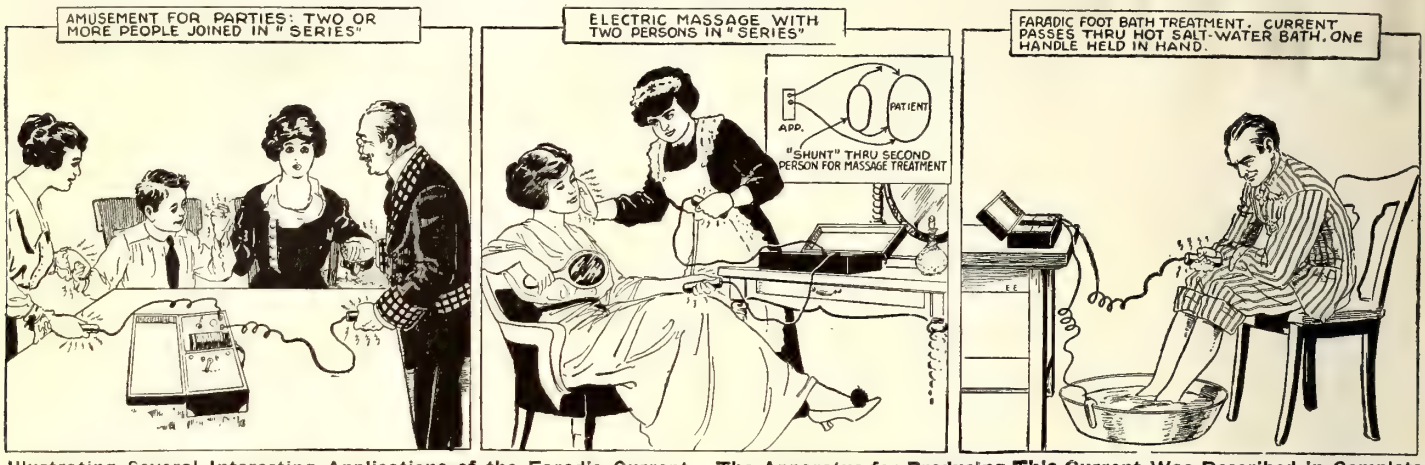
Faradic Currents--How to Apply Them

Sequel to "Building a Medical Coil Set."

AN extensive article accompanied by working drawings and photographs appeared in the June issue of this journal, covering the construction of a high grade electro-medical or faradic coil. Methods were there explained for testing out the polarity of the coil, and thus it becomes easy for even the novice to properly apply the *positive* and *negative* electrodes as required in the following directions for the treatment of various ordinary ills, such as, headache, nervousness, rheumatism, etc.

The accompanying illustrations show how several people may join hands so as to form a *series* connection to the medical or shocking coil, and as many as eight or ten people—or more, may thus join hands in a circle, evolving a great deal of amusement at parties and social gatherings. One of the illustrations shows how a second person may apply the faradic current for facial or other massage with the hand. There are two ways of giving this massage, and one of the accompanying diagrams shows the second method, whereby the person applying the currents forms a *shunt* circuit to the patient. Where a mild current is desired, the shunt method is preferable, while the *series* connection gives a harsher or stronger current. For the purpose of giving massage treatments, there is available on the market special wrist electrodes, which have a binding-post terminal on them, to which one of the secondary wires from the apparatus may be connected. Many other forms of electrodes, including foot-plates, sponge electrodes, hair brushes, massage rollers, et cetera, are shown in one of the accompanying illustrations. The faradic secondary current produced by medical induction coils is, as explained in textbooks, in the form of an unsymmetrical alternating current.*

Where much of this work is being done, it is always best to invest in a sensitive milli-ampere meter which can be connected in series with one of the handle cords, so that the current strength in milli-amperes being administered, can be regulated. The proper current strengths for different ailments is given in any of the works on Electro-therapeutics, which may be consulted at almost every library.



Illustrating Several Interesting Applications of the Faradic Current. The Apparatus for Producing This Current Was Described in Complete Detail in the June Issue of This Journal.

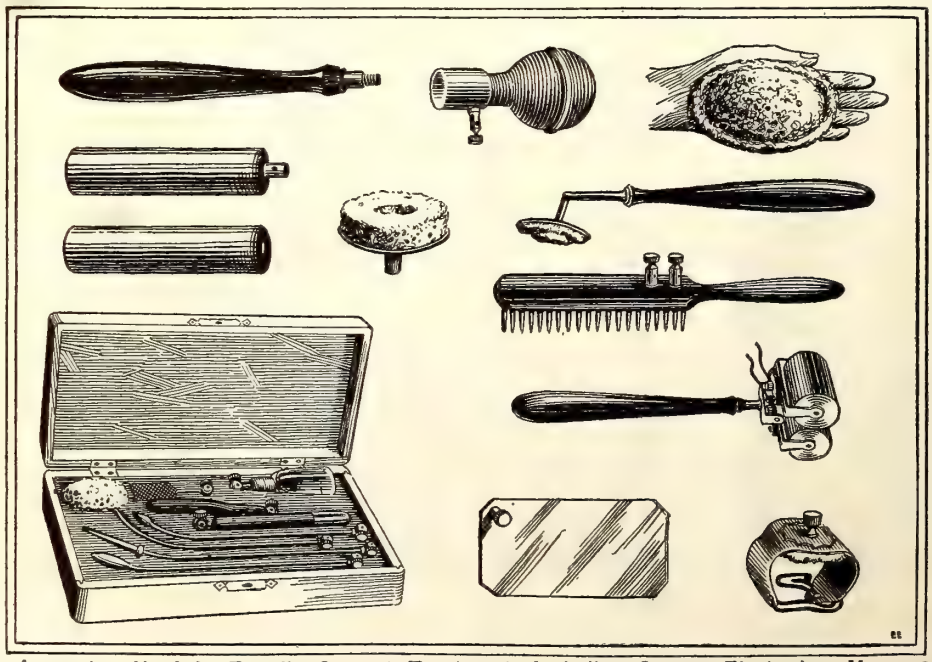
General Considerations.

In treating diseases of an inflammatory nature and fevers the *positive* pole is generally utilized. This includes such ailments as swellings, bruises, sprains, extraneous growths and enlarged glands. In this treatment arrange the poles, if possible, *the positive above the negative:* while in debility, numbness, inaction, tendency to decomposition, treatment is given with the *negative* pole. The rule of the positive above the negative cannot always be followed in this treatment.

The primary current starts at the dry cell, passes thru one coil of wire (primary coil) thence thru the circuit-breaker thru the patient. The secondary is the *induced current* in the finer wire of the coil and is of much greater tension (voltage) than the primary, but not of so much volume (amperage). The *primary* current is used particularly in the treatment of scrofula ulcers, cancers, extraneous growths, enlarged tonsils, enlarged joints, granulated eyelids, enlarged glands, strictures, etc.*

The *secondary* current is applied in the cure of nervous and inflammatory diseases and acts as a tonic upon the system. There are two methods of applying electrical currents to the body viz: 1. General Electrization; 2. Localized Electrization.

By the first method the current is past thru the entire body or part of it. By the second method, the object is to influence special nerves, muscles or organs, limiting the action of currents to these parts, or, instead of trying to influence a muscle, we may stimulate the nerve supplying it, thus reaching the same indirectly. When the refreshing effects of the current are desired to relieve fatigue or ward off approaching paralysis some suitable exercise of the muscles should be combined with the galvanic current. Short sittings are better than long ones. In ordinary cases from two to



Apparatus Used in Faradic Current Treatment, Including Sponge Electrodes, Massage Roller, Wrist Electrode, Foot Plate, Hair-brush, Bust Cupper, Et Cetera.

* For further details on the action of induction coils, including the wave form of the secondary or induced current, as well as the primary current, reference may be made to several works on induction coils including the following: "How To Make Induction Coils and Transformers," by H. W. Secor, and a later revised edition by J. S. Curtis, "Induction Coils in Theory and Practise," by Prof. F. E. Austin, "Induction Coils," by H. S. Norrie, "Induction Coils," by Armagnat, also several other works including those by A. Frederick Collins, Allsop, and Trevert.

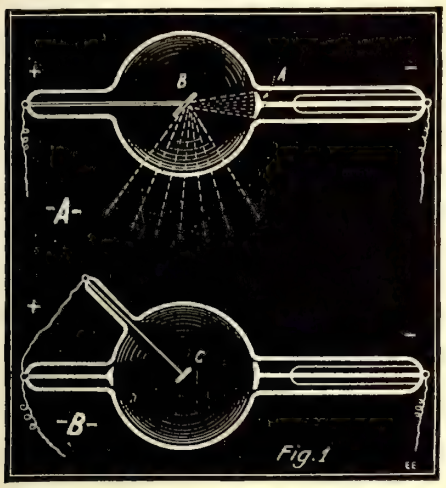
*See Electro-Therapeutics Handbook, by Trevert. Also Handbook of Electrotherapeutics by Dr. Strong.

(*Cont. on page* 366)

X-Ray Experiments

By Ivan Crawford

THE average electrical reader is not ignorant as to the general nature of X-rays, or more properly Röntgen rays, but he usually knows comparatively little about them. Considering the ever broadening field of usefulness of these remarkable rays, it behooves the experimenter who wishes to keep abreast of the times to make himself better acquainted with them and their properties. It is the author's intention in the following article to briefly outline the latest advances in this branch of science and to give some experiments, using apparatus within the reach of every experimenter.



Simple Form of Vacuum Bulb for the Production of X-Rays. When the Cathode Particles Strike the Target, B, They Set Up Etheric Vibrations—X-Rays—Radiating in the Direction Shown by the Dotted Lines.

Röntgen, while experimenting with a vacuum tube, noticed that the sides of the tube exposed to the discharge were brightly phosphorescent, and that if a screen of some phosphorescent substance such as potassium platinocyanid was brought into its vicinity it would become luminous. He also noticed that if a thick piece of metal were interposed a shadow was cast, while a piece of wood or a thin sheet of aluminum cast only a partial shadow, showing that the rays producing the phosphorescence could penetrate more or less easily objects opaque to ordinary light, but that the amount of penetration varied *inversely* as the density. This may be further illustrated by interposing the hand between the tube and the screen. The flesh being less dense than the bones cast only a light shadow while the latter are distinctly outlined. The rays were also found to possess the property of affecting a photographic plate.



Fig. 5. Skiagraph Taken by the Author, Showing Bones of the Hand and Finger-Ring. X-Ray Tube Excited on Two-inch Spark Coil.

Of course, an ordinary vacuum tube such as the one with which Röntgen first remarked the phenomena, does not produce X-rays in any great quantity. Many different forms of bulbs have been evolved but they may be divided into two general classes, namely, those operated on spark coils and those operated on high frequency currents such as those from a Tesla coil. As the spark coil exciter is more within the reach of the average experimenter, it has been selected for description in this article. Those who are interested, however, in the operation of high frequency X-ray tubes are referred to a most complete article on the subject by Dr. Frederick F. Strong, in the September, 1917, issue of this magazine.

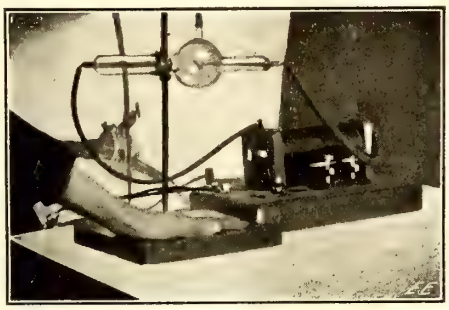
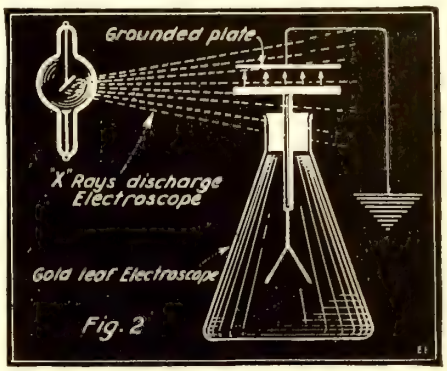


Fig. 4. How the X-Ray Tube, Hand to Be Radiographed, and Covered Photographic Plate Are Arranged.

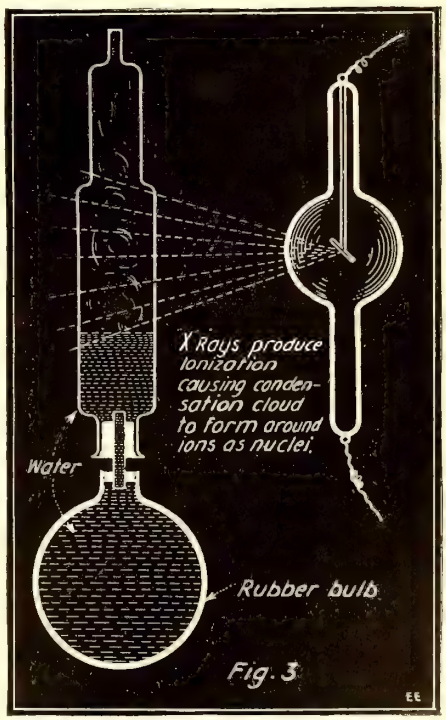
A simple tube for the production of Röntgen rays is shown in Fig. 1A. The cathode A is generally of aluminum and made in the form of a reflector. The anode B is faced with platinum or tungsten and inclined at an angle of 45 deg. to the cathode. Sometimes a third electrode (C, Fig. 1B) is added. This, however, is not necessary in small tubes. The pressure in the bulb must be extremely low. After extended use this tends to become even lower. This, altho producing more penetrating rays, decreases the supply of electrons, making it difficult for the discharge to pass. To remedy this some bulbs are equipt with a small platinum tube fused into the glass. When this is heated it allows the hydrogen to pass. If the bulb is not provided with any means of increasing the pressure it may be done by gently heating it in an oven. When the vacuum is high the bulb is said to be "hard"; as the pressure increases it is said to become "soft." For general work the bulb should be rather "hard."

The nature and properties of the rays will now be discust. When the cathode particles strike the target they set up etheric vibrations which radiate in the direction of the dotted lines in Fig. 1A. The nature of these vibrations has been the field of considerable discussion but has now been practically settled. It is the general belief that they consist of *extremely short ether waves*, similar in many ways to light. The chief points of difference lie in the facts that the objects which reflect or at least refract ordinary light are transparent to X-rays, neither are they subject to polarization. This evidence is, however, not so conclusive as it might seem at first sight. It has been known for some time that X-rays consist of vibrations about 10^{-9} cm. in length. It is impossible to conceive of a defraction grating of suitable spacing to intercept these waves. On the other hand, they have many similar characteristics. They move in straight lines, cast definite shadows, affect a photographic plate, and Brandes and Dorn have shown that they even produce a slight but sensible effect on the retina. Prof. Marx, by a series of complicated experiments showed that they traveled at the speed of light. His results, however, have not been generally accepted and his methods severely criticized. I have stated above that Röntgen rays are not subject to polari-

(*Continued on page 375*)



Experiment Demonstrating the Ionizing Property of X-Rays. A Charged Electroscope Is Quickly Discharged When X-Rays are Past Across the Gap Between the Electroscope and a Grounded Metal Plate.



An Intensely Interesting X-Ray Experiment, Showing How Rain (Aqueous Vapor) Is Formed by Condensation Set Up on Nuclei Created by X-Ray Ionization.

Heat Engines

By JOHN J. FURIA, M. A.

Dept. of Physics, New York University.

THE question often arises, "why is the *hot air* engine not used?" Air certainly is cheaper than gasoline. It takes less fuel to heat air than to convert water into steam. However, it does not follow that the hot air engine

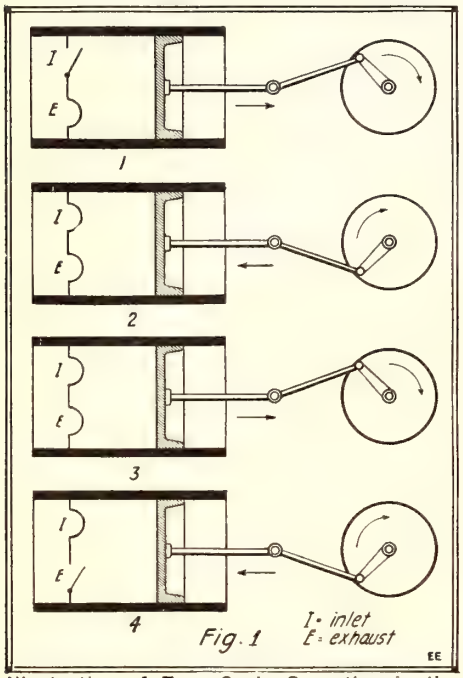


Illustration of Four Cycle Operation in the Gasoline Engine. First the Gas Mixture Is Drawn In. Second, Compression Takes Place. Third Comes the Explosion; and Fourth, the Expulsion of the Burnt Gases Takes Place.

is the cheapest to run and at the same time obtain the necessary power. A little review of the gasoline and steam engines together with the principles of operation of the hot air engine will answer our question, why this type of engine is not used.

The Gasoline Engine.

The gasoline engine (internal combustion) has attained great popularity by its use in the automobile industry. It is flexible, capable of delivering a large amount of power, it develops high speed and power almost instantaneously. It also has an efficiency of about 25 per cent. The engine and the fuel used are light in weight compared with other kinds of engines of similar power. The four cycle engine is typical. Figure 1 is a sketch showing the conditions at each of the four cycles. The first cycle is started by turning over the flywheel (cranking the engine). This causes a *suction* in the cylinder. The inlet valve is either opened automatically or by the suction. The properly mixed fuel (gasoline and air) enters thru the inlet. (During this cycle the exhaust valve remains closed.) After passing dead center, the inertia of

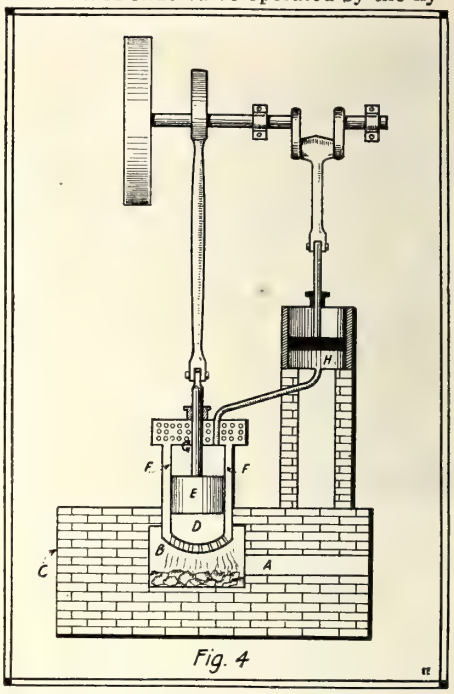
Gasoline—Steam—Hot Air

the moving fly-wheel causes the piston to move inward (cycle 2). The inlet and exhaust valves are both closed during this cycle, and the explosive mixture is comprest, rendering it capable of delivering greater power when it is exploded. As dead center is again reached, and the mixture is comprest to a maximum, the mixture is *ignited* by means of an electric spark properly timed. The mixture disintegrates as a result of combustion and forms a gas of tremendous pressure, this pressure causing the piston to move outward. This is the third cycle or power cycle. (Both valves are closed.) On again reaching dead center, the inertia of the fly-wheel causes the piston to move inward; the exhaust valve is automatically opened and the spent gases are expelled. (The inlet valve is, of course, closed during this cycle.) The four cycles are then repeated over and over again.

It is to be noted that during the whole four cycles, only one power stroke is secured; and that this power stroke is secured as a result of chemical action due to the combustion of the fuel mixture. The *four cycles* occur during *two revolutions* of the fly-wheel. It is therefore necessary to have a fly-wheel with a large moment of inertia in order to cause a steady running of the engine. Smoothness is obtained by using several cylinders instead of one, thus securing *more power strokes per revolution of the fly-wheel.* The high price of gasoline together with the complications arising in the devices for securing the proper mixture and the right kind of spark at the right time are points against the gasoline engine. Because of the high temperatures developed as a result of the chemical action, the cylinders must be cooled by some means, usually water circulation (another complication).

Steam Engines.

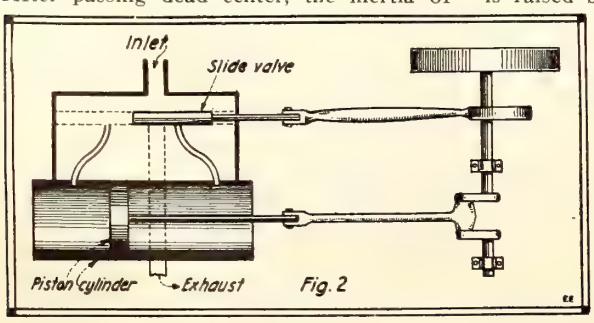
The steam engine is still very much used in spite of its low efficiency (usually ranging from 10 to 12 per cent). It possesses the disadvantage of not being capable of immediate starting; perhaps this is the chief reason for its not being used in automobile propulsion except in one or two special instances. Its bulk is, of necessity, very large comparatively as is the bulk of the fuel used. (A one horsepower engine requires about 2½ lbs. of coal per hour.) On the other hand it is simple in operation and control. Once steam is "gotten up," the movement of one throttle is all that is necessary to cause a change in speed and power. No fuel mixing device is used nor any electrical system. Figure 2 shows the main parts of a typical steam engine. Steam is raised by heating water contained in a boiler (any kind of fuel can be used). The steam is led into the cylinder thru the inlet valve. In the type illustrated below there are two inlets to the cylinder, one on each side. A slide valve operated by the fly-



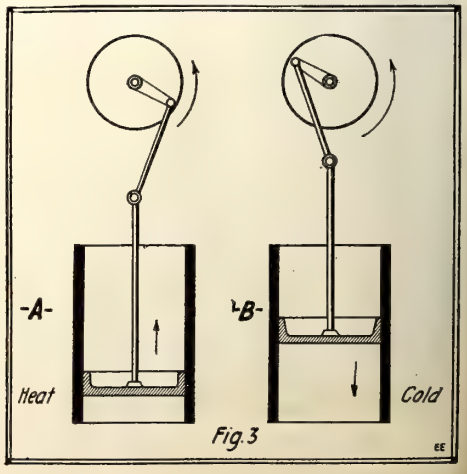
The Stirling "Hot Air" Engine. It Only Consumes 2 lb. Coal per H.P. Hour, Being Therefore More Efficient Than the Steam Engine. These Engines Have Been Built to Develop Several Horsepower.

wheel moves in opposition to the piston, alternately admitting steam to the left and to the right of the piston, thus causing it to move back and forth. It is therefore apparent that there are *two power strokes for each revolution* of the fly-wheel or *four times as many as in the four cycle gasoline engine.* The spent steam is usually exhausted into the atmosphere. In the more modern steam engine the spent steam is condensed and brought back to the boiler, thereby requiring water to be added to the boiler much less frequently besides saving fuel. Because of the high price of gasoline, several automobile concerns have expended a great deal of time and money in research and development on automobile steam engines, and their "selling points" are extremely good ones. Getting up steam is reduced to a matter of only a few min-

(*Continued on page* 373)



Left:—Principle of Simple Steam Engine, Showing Slide Valve Actuated by Cam Shaft from Flywheel Shaft. The Steam Is Successively Admitted and Exhausted from Alternate Sides of the Piston, Causing Rotation of the Flywheel.



Right:—Ideal "Hot Air" Engine, Comprising a Cylinder, Piston, Connecting Rod and Flywheel. Heat Is Applied to Bottom of Cylinder, Driving Piston Upward.

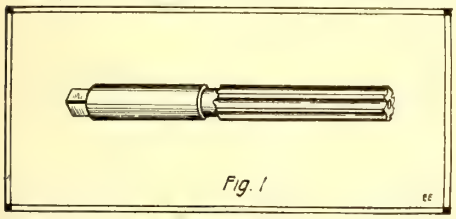
Experimental Mechanics

By SAMUEL D. COHEN

LESSON XIII

REGARDING REAMERS.

IN the last lesson we completed the discussion on the subject of "Twist Drills." The reader is undoubtedly aware by this time that it is quite impossible to drill any size hole he desires with rigid accuracy thru the use of drills in commercial



Standard Form of Hand Reamer. The Reamer Is Used to Accurately Clean Out Drilled or Cast Holes, Especially Journal Boxes and Shaft Bearings of All Types.

practise. For example, it is desired to place a pin into a drilled hole to have a *driving* or a *sliding fit.* The reader will find that nine times out of ten he will be unable to obtain the proper size drill to do the work. In this instance another form of tool is at hand, namely, the *reamer.* This tool is used whenever a hole is to be enlarged just a few thousandths more than the original. Sometimes the reamer is used when a smooth hole is required, in which case the hole being first drilled is made *smaller,* in order to obtain the finally required size after reaming.

As in the case of twist drills, there are a large variety of reamers, varying in size, and each is suited for a definite purpose. Properly speaking, the reamer may be defined as a tool for perfecting holes previously drilled or bored. Fig. 1 shows a standard *hand reamer.* The reamer should never be used to remove any considerable quantity of stock, but merely to eliminate minute imperfections left by other tools. In some cases the hole may be made to within .001 inch before the reamer is applied, but generally the allowance of .002 inch to .010, according to the diameter of the hole, may be left for the standard reamer to cut. If given too much material to remove, the cutting edges of the reamer will wear too fast, and its reliability as a *sizer* will be quickly destroyed.

Reamers may be divided into two general classes: the *side-cutting* or *fluted* and the *end-cutting* or *bits.* Each of these classes are subdivided into *solid* and *adjustable* reamers.

The first well-known reamer is called the *solid fluted* reamer, and is made with slight modifications to suit two different cases, namely, hand and machine use. Fig. 2 illustrates a hand reamer which belongs to the *short set.* Reamers of the same general design are also made longer in regular sets. The cutting edges of fluted reamers taper in diameter for about one-fourth their length, from E to D being about .01 inch smaller at E than at D.

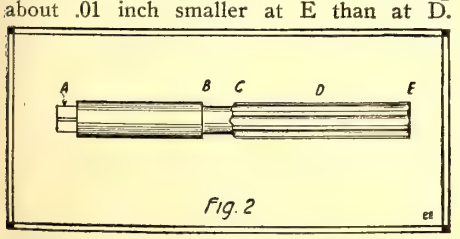


Illustration Showing a Hand Reamer of the Solid Fluted Type for Hand Use. The Letters Refer to Different Tapered Sections Described in the Text.

From D to C the taper is reversed, the diameter decreasing about .0002 inch per inch of length towards C. The part between A and B is usually made about .001 inch smaller than the largest diameter at D. When the cutting edges are worn to such an extent that the blank part, when free from bruises, will not pass thru the reamed hole, the reamer is too small for standard use.

As will be seen, the hand reamer has a square end, upon which a wrench is used to turn it. This is the main distinguishing feature between the above mentioned and the machine reamer of the fluted type. The latter is made with taper and parallel shanks the same as a drill. It may also have a shank of any special shape to fit a certain holder. The machine reamer is generally, tho not always, made straight or parallel, from E to D, Fig. 2.

A reamer having a flute parallel with its axis has a slight tendency to draw in. To overcome this, some mechanics prefer the flutes of both hand and machine reamers, made in the form of a left-hand spiral. The angle of the spiral or helix may be from 4 to 8 degrees.

Another form is the so-called *rose* reamer. Its name is derived from the fact that its cutting end resembles a rose. It is essentially an end-cutting tool and is rarely used for other than machine work. The rose reamer has chip and oil grooves on the sides and is made with any shank required in machine work. This reamer has the larger diameter at its cutting end, and tapers back at about the same rate as the hand-fluted reamer, viz.: .0002 inch per inch of length.

The object of the taper on the fluted reamer is to counteract the tendency of all such reamers to produce a hole larger at the outer end. The rose reamer as well as the twist drill have the taper for the same reason, viz: for clearance.

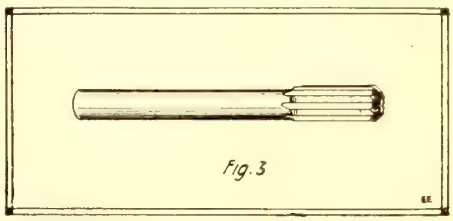
As compared with the fluted reamer, the rose reamer has one advantage, in that when new it will make holes more uniform in size and shape, but has the disadvantage that when the cutting lips are worn, it will bind on the sides and roughen the hole. If the fluted reamer becomes slightly worn at the end, it will still cut on the sides, but because of its cutting on the sides, it is more likely to be deflected by imperfections of the hole, or to cut larger than its fixt size.

As above stated, the standard fluted reamer should be used for *finishing cuts* only. However, the rose reamer can be utilized for roughing or finishing cuts. When the same reamer is used for both purposes, it becomes unreliable as a standard finishing tool. A good illustration of the rose reamer is shown in Fig. 3.

Another type is the *shell* reamer, which is identical in construction to the fluted and rose reamers, with regard to cutting edges, but differs in that the reamer proper is placed upon an arbor, thus saving in cost of material. It will be seen, however, that when the reamer becomes worn to such an extent that its accuracy is destroyed, it should be replaced by a new one, which occupies the same position on the arbor. Fig. 4 illustrates a typical shell reamer. The arbor drives the shell thru the engagement of its key with a rectangular slot cut across the rectangular shell. These reamers are made with either straight or spiral flutes.

The *shells* as ordinarily made are rather short for hand reaming. They are designed mainly for machine work. The taper begins at the cutting end, and the diameter decreases toward the opposite end in about the same ratio as the reamers previously described.

When these reamers wear .0003 inch to .001 inch below standard size, it is necessary to reset or regrind them to a smaller

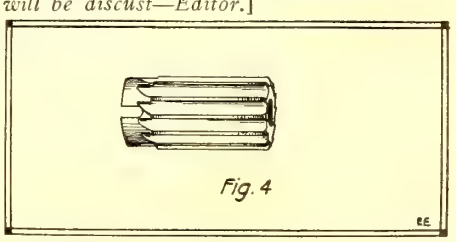


Typical Rose Reamer. This Is Used Considerably for Roughing and Finishing Work, but One Reamer Should Not Be Utilized for Both Purposes, as Inaccuracy Is Bound to Result.

size. Resetting consists in enlarging the diameter of the reamer by hammer blows in connection with a form of *set* or calking tool. The latter, which may be made by grinding a common chisel flat on the end, is held against the front of the cutting edges for this purpose. It is necessary to anneal the reamer for resetting, and each cutting edge must be treated until the diameter is about 1/64 inch larger than the standard. Having completed this work, the reamer is now retempered and brought to final size by *grinding.* This is usually accomplisht by placing the reamer in a Universal precision grinding machine.

Before grinding the reamer, its center should be carefully cleaned of any dirt or other foreign matter that may have adhered to it. A point scraper made from a three-cornered file answers well for this purpose. After scraping the centers it is usually necessary to lap them. For this process we *chuck* a short brass rod in the lathe and turn the end to the shape of the lathe centers. Having smeared this conical end with fine emery and oil, the reamer is placed on the center of the lathe and started at the greatest speed attainable. The reamer center is lapt by alternately forcing it against and releasing it from the revolving brass. This is done by light pressure with the tail spindle, and for each time that the reamer is prest against the brass it should be revolved slightly. By thus revolving it, we distribute the emery and counteract the tendency of the lap to scratch rings in the center. It is sometimes necessary to return the lap before finishing one reamer; but a skillful workman can do this in ten minutes or less. Instead of having to chuck the lap each time it is used, it would be better to make one to fit the hole in the lathe spindle directly.

[*In the next installment the subject of adjustable reamers and grinding of reamers will be discust—Editor.*]



A Shell Reamer. An Arbor or Shaft Supports the Reamer When in Use. They Are Held by a Key on the Shaft and Are Made With Straight or Spiral Flutes.

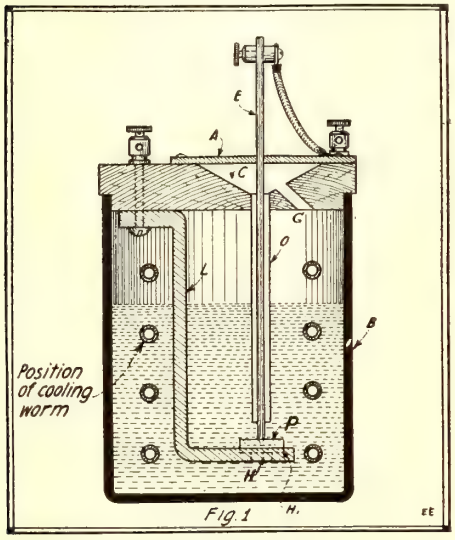
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

Automatic Electrolytic Interrupter

FIRST PRIZE, $3.00

After having experienced considerable trouble in devising a satisfactory electrolytic

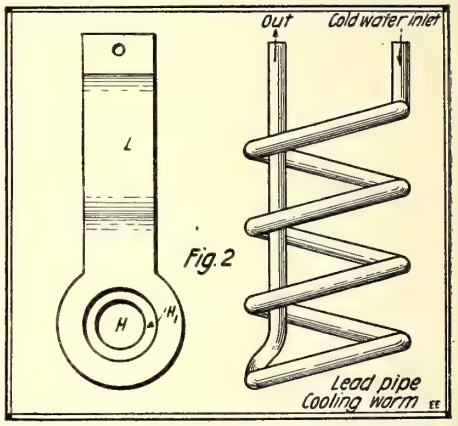


A Really Good Design of Home-made Electrolytic Interrupter.

interrupter, I succeeded in constructing the one described herewith in which most of the faults of its predecessors are eliminated. The greatest of these faults was the dropping of the rod electrode, thus short-circuiting the device. The materials required outside of the battery jar and wooden top, which must be boiled in paraffin to render it impervious to moisture, are: One-half pound of lead, about five inches of glass tubing, having an internal diameter of one-sixteenth inch, three binding posts, a small strip of brass and a small porcelain cup (used for mixing water colors).

The lead electrode is cast in the shape shown in Fig. 2. A hole somewhat smaller than the cup is bored in the large end. A rabbet, H^1, is cut around the edge of this hole so that the cup will fit into it. The lead electrode is now completed and fastened to the top with a machine screw and binding post. The top has a cup-shaped cavity reamed out as shown at C, Fig. 1, which is as deep as one-half the thickness of the top. A hole is bored in the center to receive the end of the glass tube, which should fit tight. The bottom of the tube is about three-sixteenths of an inch above the porcelain cup. The cavity also has a small hole G, Fig. 1, in one side to furnish an outlet for the solution which rises in the tube. A brass strip about one-quarter of an inch wide is fastened across the top of the cavity with a wood screw, binding post and a small screw. This strip has a small hole in the center for the rod electrode to pass thru. The rod is best made of phosphor bronze, and should fit the tube loosely. It has a binding post on top to serve as a weight and for connections. The interrupter is now complete, and should be filled to within an inch and a half of the top with a 10 per cent. solution of sulfuric acid.

The action of this interrupter is as follows: As the rod is worn away by the action of the solution, it is impelled downward by the weight on top, the porcelain cup preventing it from going too far. In case it



Detail of Lead Electrode and Lead Cooling Worm for Home-made Electrolytic Interrupter.

is desired to operate this interrupter continually for any length of time, it may be cooled by immersing in a large jar of water, or else by inserting a cold water cooling worm in the solution, after the design here pictured.

Contributed by SCOTT E. VANCE.

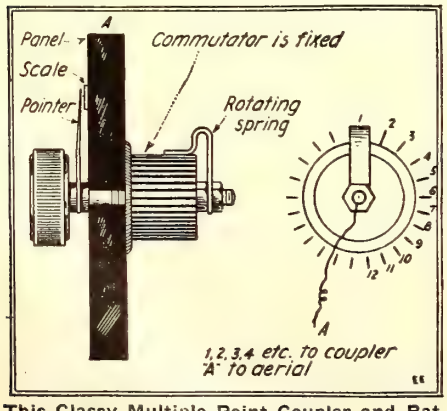
Clever Multiple Switch

SECOND PRIZE, $2.00

I submit herewith an idea for using a motor commutator as a rotary multiple point switch. This sort of switch is useful where it is desirable to economize on space, as on the secondary of a loose coupler.

This switch is, moreover, thoroly dust proof, as it is always on the inside of the cabinet.

Contributed by R. C. SMOLLEN.



This Classy Multiple Point Coupler and Battery Switch Is Constructed From a Small Commutator.

Send us some of your good ideas. We pay for all articles publisht. Address the Editor How-To-Make-It Dept.

THE PHONOGRAPH AS A TEACHER.

Many amateurs object to the use of a phonograph for learning wireless telegraphy because of the fact that the sound coming from the phonograph is in no way similar to the actual wireless message.

Close the doors of the machine and place a telephone transmitter on the inside. Or, better still, place the transmitter directly on the end of the tone arm. This latter method can be used with any make of phonograph. Then connect a telephone receiver (or a number of telephone receivers in parallel) in series with the transmitter and a few batteries.

This method overcomes all objections to the phonograph method and is much better than the omnigraph method since the phonograph records can be made to represent two stations of a different pitch sending at the same time, interference, etc. When you tire of listening to radio signals put on an ordinary record and have a "wireless" concert. What?

Contributed by PAUL G. EDWARDS

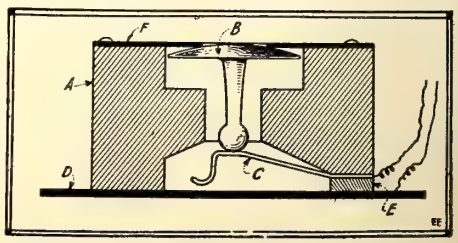
"Collar Button" Push Button

THIRD PRIZE, $1.00

Here is a push button designed to use up all your waste material and make you buy more collar buttons. Bore the holes as shown in a two by one-half inch block of wood, screw on the metal plate D, with the brass spring C insulated from it by the wood or fiber E, slip in your collar button B, glue on the thin piece of wood F, and Eureka! there you have it!

I know my friends will surely bless me for this valuable contribution to Science in the Home. Pa can rest his mind hereafter —when the shirt button drops, he will know it's gone to help the cause of true Science.

Contributed by RAY BILLINGTON.



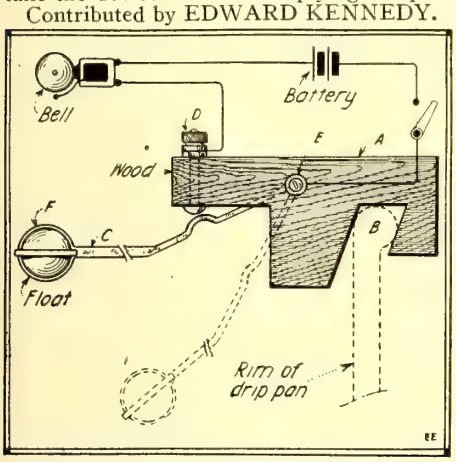
At Last! The "Collar Button" Push Button. Papa Will Never Find His Collar Buttons Now, When They Roll Away Under the Bed. Little "Willie" Will See to That!



TELL-TALE FOR REFRIGERATOR DRIP PAN.

This tell-tale for an ice box drip-pan consists of a piece of hard wood or fiber cut into the form (A). A piece of No. 14 copper wire is bent into the form (C). This form is allowed to turn on pivot (E), which is a current carrying part of the circuit. When the pan is full of water, the form (C) floats up by means of a piece of wood (cork is good) attached to the end. The copper wire makes contact with (D), and the bell rings, indicating that the pan is full. The notch (B) makes it possible to take the device off when emptying the pan.

Contributed by EDWARD KENNEDY.



Simplicity Is Stamped All Over This Home-made Refrigerator Drip-pan Alarm. It Costs But a Few Cents to Make and Will Save Your Carpets and Hard-wood Floors.

HINTS ON LABORATORY APPARATUS.

By Eugene McGowan

To most experimenters chemistry undoubtedly proves a most interesting study. However the chief fault lies in the fact that things mess up so easily. The following is intended to overcome this difficulty.

First of all the laboratory should be arranged so that the one who uses the room may be able to find everything he wants.

A gross of empty wooden boxes, 12 inches x 8 inches x 4 inches, will be found convenient for keeping dry reagents in.

Labels should be used freely, and all unlabelled bottles washed out. Paper labels on bottles may be protected by a coating of paraffin wax varnish or shellac. But most bottles should have some label in the substance of the glass. These are made in two forms. Enamel labels are melted on the glass. They last well, but white enamel is not always distinct when white crystals are in the bottle. Sand-blast labels are made by roughening the surface of the glass with a jet of sand driven by a blast of air. They are apt to be indistinct when wet, if not made with a really rough surface. They can be made more distinct by rubbing over with crayon or chalk. Sand blast labels cost only about half as much as enamel labels.

Retort stands should be firm and substantial. The sliding collars for the rings should be slotted at the sides, so as to move easily; and a good clamp should be chosen with well-made screw threads.

Deflagrating spoons can be cleaned by holding the cup in the Bunsen flame for a few seconds.

Bunsen burners occasionally get blocked by some molten substance falling into the inner tube. They may be cleaned by washing with water. After washing blow thru the burner to remove any drop of water which may clog the exit. The revolving tube or ring should be frequently turned, so as to keep it in order; otherwise they get jammed and it is impossible to change quickly from a yellow to a blue flame.

Balances should turn with much less than a centigram. Balances with steel knife-edges, if protected from the air of the laboratory, will remain serviceable for years. Those with agate edges set in steel are more durable, but are more expensive. Weights less than a centigram are needless, and cause trouble to beginners. More exact weighing can always be done by watching the pointer, if the weights are accurate.

Management of mercury. Mercury is difficult to manage, on account of its weight and the ease with which it picks up impurities. Stone-ware mortars are better for holding mercury than glass beakers, which easily crack when set down. All operations with mercury should be conducted over a tray or on a table with a groove around the edge.

Dust on the surface of mercury may be removed by allowing the mercury to run thru a dry filter paper in which a few pin holes have been made. Or the mercury may be washed in a current of water, and then past thru a separating funnel. The little moisture on the surface may be removed with a blotting paper. Many metals easily dissolve in mercury; and a very little tin or zinc will spoil its fluidity. They are best removed by shaking the mercury in a bottle with a little nitric acid; the tin or zinc will then dissolve, leaving the mercury pure.

A few words of caution concerning the care of reagent bottles are in place here. A good reagent bottle must have its stopper ground to fit it, and this stopper will not fit any other bottle you may have. Consequently the stoppers should never be interchanged. Again, the stoppers of all reagent bottles, excepting sulfuric acid, should be paraffined, otherwise they are apt to stick.

Do not lay down the cork of a reagent bottle while pouring out a solution, as the stoppers may become changed. Again, no solution but the one corresponding to the name on the bottle should ever be placed in the bottle.

Another important item is that each bottle shall have its own particular place on the shelf, and always be put in its place; thus the amateur chemist will know exactly where to find the proper reagent, just as a printer knows where to find the letters in his case, by prearrangement.

USE FOR AN ATOMIZER.

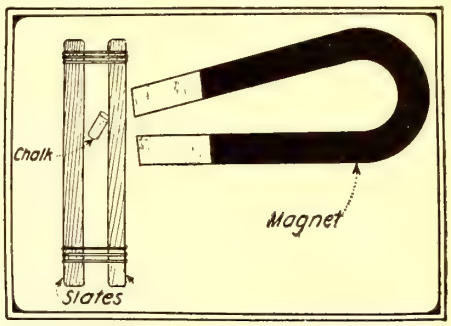
An atomizer is a handy appliance to furnish a draft of air when drying precipitates or evaporating solvents like ether or chloroform. The drying of precipitates and crystals can best be carried out when same is placed on a blotter to help absorb the liquid.

"SPIRIT" SLATE-WRITING.

Two thin slates are brought forth and offered for examination by the audience. The operator then places in between the two plates a small piece of chalk and hands the two slates to some-one (it does not matter whom) to tie with a string or seal all around with sealing-wax. After a few minutes or so, the slates are taken apart and Presto! there is found a message from the "spirit world" written with the chalk, which was placed in there by the "Medium."

The way it's done is this:

The chalk is of special formation; it is made of chalk dust mixed with iron-filings and a little glue. A strong (need not be very big) magnet is used to make the chalk move and write the message. The "Medium" located the chalk by tipping the slates to one corner and placing the magnet under it.



"Spirit" Slate Writing May Be Performed With This Simple Apparatus. The Chalk Container Could Very Well Be a Small Perforated Ball Filled With Powdered Chalk. The Slates Should Be Held Horizontally.

This works better in the dark for the simple reason that the people will not notice the magnet and its use. The darker the better.

Contributed by GEORGE PASTO.

MAKING THE MOST OF A LITTLE SPACE.

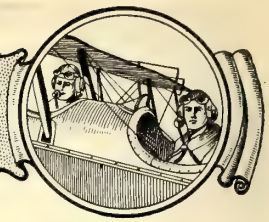
It is most discouraging to have to spend half-an-hour finding tools and impedimenta before starting an hour's work in the evening. The remedy is to have a place for everything, and keep everything in its place. Also, keep them as compactly as possible. A good deal of extra room can be got out of an ordinary cupboard by the exercise of a little ingenuity. Things not often required should be kept on the top shelf. Perhaps there is still some space to spare. Then tack a piece of cloth or a large handkerchief inside the top of the cupboard, and screw in a couple of brass screw hooks a few inches from the ends. Sew a brass ring to each of the free corners of the cloth and you have a sort of cradle in which many odd things may be suspended by slipping the rings over the hooks.

A dozen wooden soap or sugar boxes, stood one above another in a corner of the room, preferably in a recess, will do duty for a cupboard. Capital shelves can be made inside the boxes, using wood from the lids, while the whole structure can be effectually disguised during the daytime by covering it with a piece of dark colored material. Extra room can be made by fixing hooks to the outside edges of the boxes for things that can be hung up, while other odds and ends can be dropt into cocoa tins and the like tacked to the sides of the boxes.

Contributed by H. J. GRAY.



RADIO DEPARTMENT



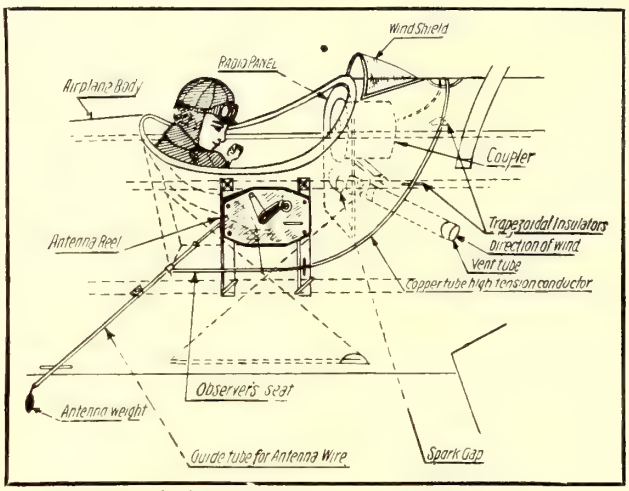
Airplane Antenna Reels

By LESTER F. RYAN

ONE of the most important parts of the antenna system in connection with airplane radio work is the *antenna reel*. Electrically, the antenna system of a radio transmitter consists of a single trailing wire and a counterpoise. The antenna wire is lowered from the airplane during flight by a hand reel and trails out to a distance of about 300 feet, at an angle of 20 degrees to the fuselage.

The antenna reel, as illustrated in Fig. 1, is so designed in order to stand all mechanical and electrical stresses under difficult service conditions.

It is constructed entirely of the highest grade insulating material and will therefore stand the high antenna voltages which are developed by the high power of the transmitter without leakage and danger to the operator.



Arrangement of Airplane Antenna Reel On Outside of Cockpit. The Reel Is Self-locking and Also Indicates At a Glance How Many Feet of Aërial Cable the Aviator Has Let Out. The Cable Runs Thru a Guide Tube As Shown. Thousands of Sets Like Those Shown Were Used During the War.

The drum of the reel will hold 600 feet of stranded phosfor bronze or other antenna cable, i.e., if one antenna of 300 feet of wire is lost, an additional antenna of 300 feet is still available. It is provided with a revolution counter as shown in figure which indicates the number of turns or feet of antenna wire in use.

It is also fitted with a *brake* or locking device, which is used to lock the drum when the reel is not in use. This brake may also be used to control the speed of the unwinding. The antenna wire is of tinned copper, and has a breaking strength of 400 pounds.

To prevent chafing and breakage of the antenna wire near the weight when the antenna is reeled in, due to the swinging of the weight, a stiff phosfor bronze wire is connected between the antenna wire and the swivel hook. A swivel hook is placed at the end of the tail wire to prevent spinning of the weight during flight. The weight is of lead, and weighs 1¾ pounds. It is of stream-line form to reduce wind resistance to a minimum.

The insulators used are of trapezoidal shape and serve the purpose of insulating the guide tube from the airplane. The flattened end of the trapezoid is made fast to the copper tube; the opposite base is made fast to the airplane fuselage.

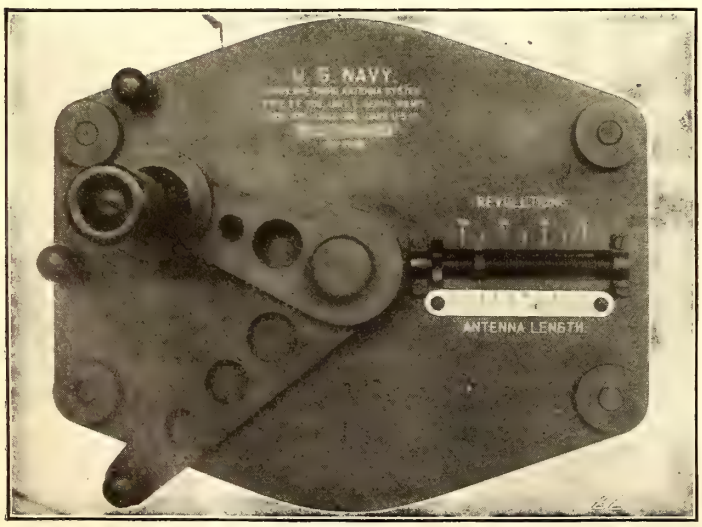
To prevent *sparking* or *grounding* of the antenna to the cowl a *cowl insulator* is used. It is made of bakelized canvas, six inches in diameter, with holes near its perifery for lashing to the cowl.

When installing the antenna system on a 'plane, great care must be taken to provide sufficient insulation against the high voltages developed by the transmitter. As a rule, the antenna reel is mounted outside of the fuselage on the right-hand side of the plane, as here shown. It is attached to two vertical pieces of wood which are lashed to the upper main and seat *longerons*. These pieces contain holes corresponding to the four attachment legs of the reels, and thru which these legs extend to the inside of the fuselage. The circular bakelite nuts, as shown in figure, secure the reel posts to these uprights. The copper guide tube thru which the antenna cable slides after leaving the reel is supported beneath and rearward from the antenna reel at an angle of about 20 degrees to the fuselage. It extends 6 inches beneath the fuselage, and is separated by insulators.

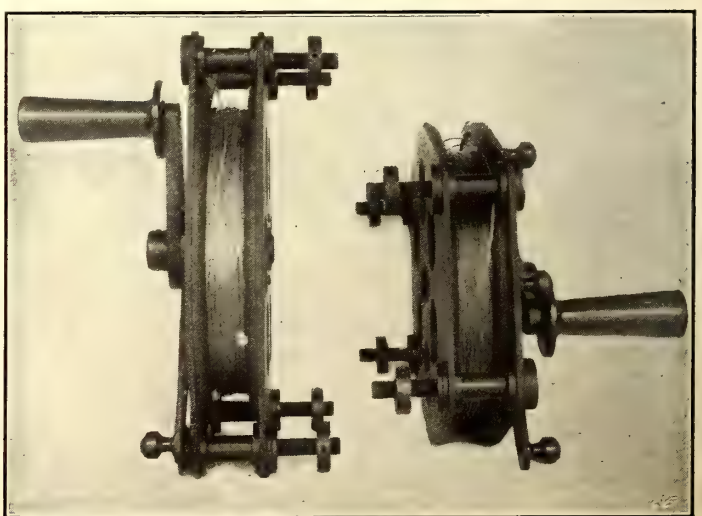
The connection between the antenna helix on the set and the antenna guide tube is as follows: The antenna helix is connected to the lower end of the cowl insulator as shown in figure by rubber-covered cable. The cowl insulator is connected with the antenna guide tube by means of a six-foot length of 0.180-inch copper tubing. The antenna wire is connected to the antenna reel by means of a hole thru the bakelite shaft on which the handle is fastened.

When properly installed, the antenna system should cause no trouble. The antenna reel may safely be operated while sending and is without doubt one of the most ingenious and novel features developed in airplane radio transmitters. This type of antenna reel is used in conjunction with the airplane transmitter described in the July issue of the *Radio Amateur News*.

The modern practise in airplane radio-telegraphy and telephony calls for the use of two antenna cables, let out from either side of the airplane. These cables have weights as usual.



View of Indicator Panel of Antenna Reel Device Fitted On Airplanes. The Length of Aërial Let Out Is Read Off Directly.



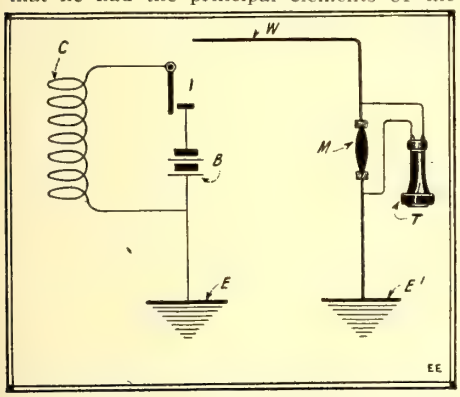
Two Sizes of Airplane Antenna Reels Are Here Illustrated. Note the Heavy Insulating Support Studs by Which the Device Is Supported.

How I Invented the Crystal Detector

By GREENLEAF WHITTIER PICKARD

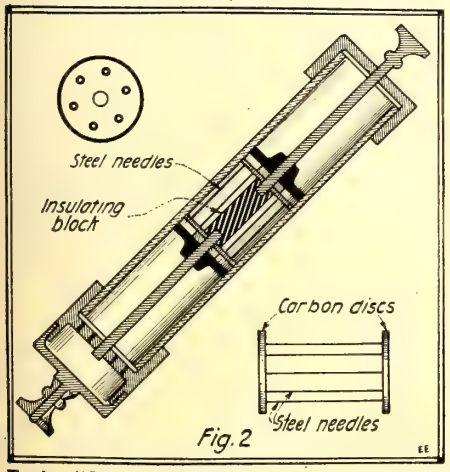
SPECIALLY WRITTEN FOR THE "ELECTRICAL EXPERIMENTER"

IN 1874 Prof. Ferdinand Braun discovered *unilateral conductivity* in a number of the natural metallic sulfids, such as pyrite, galena and chalcopyrite His observations were limited to the application of battery current to metallic contacts on the minerals, and he noted that a materially larger current would flow in one direction than in the other. Five years later, in 1879, Prof. D. E. Hughes, while experimenting with a carbon microphone, discovered that it was affected by a distant spark discharge, altho there was no wire connection between the circuits. Altho Prof. Hughes did not publish an account of his experiments until 1899, he exhibited his apparatus in operation, over distances as great as 1,500 feet, to many of the prominent English physicists, including Preece, Crookes, Stokes and Dewar. A glance at the circuit employed by Prof. Hughes in 1879 will show that he had the principal elements of the



Hughes 1879 Detector System. B Is the Transmitting Battery, C an Inductance Coil, I a Mechanically Operated Interrupter and E a Ground Connection. W is the Receiving Aerial, M a Carbon Microphone, T a Telephone Receiver and E¹ a Ground Connection. Hughes Discovered that the Carbon Microphone Was Affected by a Distant Spark Discharge. Fig. 1.

system re-discovered by Marconi in 1895. Undoubtedly, if Prof. Hughes had had proper encouragement at the time, he would not only have anticipated Hertz in the discovery of electric waves, but also Marconi, in their wonderful application to Radio-telegraphy, and so have altered considerably the course of scientific history. Our immediate interest in Prof. Hughes' work is, however, his detector. As my illustration shows, it consists of a microphonic contact, directly connected to a tele-



Early "Carbon-Steel" Microphone Detector Used by the Author in 1902 at the Cape May, N. J., Wireless Station.



Dr. Greenleaf Whittier Pickard, Inventor of the Crystal Rectifying Detector. He is Well-known as an Electrical, Telephone, and Radio Engineer and Has Taken Out Numerous Wireless and Other Patents. He Has Tested 31,250 Crystal Detector Combinations.

phone receiver, and without local battery. It is the germ of the crystal detector.

The Coherer

In 1898, when my work in Radio-communication began, there was but one detector—the coherer. To the early workers in this field, the coherer was the *bête noir* of radio-telegraphy; the principal obstacle to

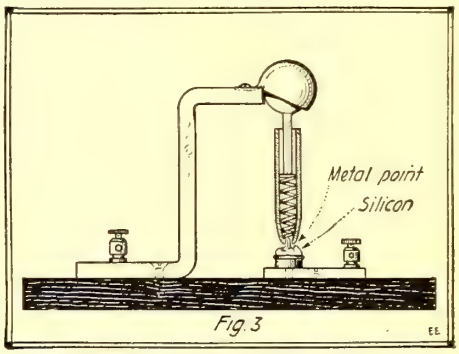
FEW inventions in radio have been made which proved of such tremendous importance to the young art than the Crystal Detector, invented by Dr. Greenleaf Whittier Pickard. In the olden days of the coherer, when we were still groping in the dark, only comparatively small distances could be bridged. The invention of the Crystal Detector may be said to have opened up an entirely new era in radio, for with the coming of this detector great distances were easily bridged and almost perfect communication was possible at all times. "Wireless" had arrived.

But you will want to read the story of how Dr. Pickard invented the Crystal Detector yourself. It is a historical classic. We promise you twenty minutes of most unusual as well as instructive reading.—EDITOR.

assured and speedy communication without wires. Despite its unpleasant idiosyncrasies, the coherer had our deep respect, first because it was the only thing then known which worked, and second because of its *supposed* extreme sensitiveness to electrical oscillations. In the absence of any quantitative measurements, it was generally assumed that the received energy in radio-communication was so infinitesimal as to absolutely preclude its measurement or even detection by ordinary means, such as galvanometers or telephones, even if by some means it could be converted into a form suitable for these instruments. Altho in some of the early laboratory work with electrical waves various forms of thermo-couples and bolometers were used, the practical workers never considered these as possibilities in actual radio-telegraphy, because of the supposed extremely minute character of the received currents, to which such a device as the coherer could alone respond. In common with the other workers at that time, I held the same view of radio reception, and spent much time in attempts to improve the coherer as to regularity of action.

The Microphone Detector.

Much of the trouble in coherer working arose from the adjustments of the coherer adjuncts, the relay-tapper-recorder trio. Realizing this, in the latter part of 1899 I began experiments with a *single contact coherer,* in series with a battery and telephone receiver. I soon found, as several others did at about the same time, that a simple carbon steel microphone consisting of a sewing needle resting lightly against a carbon block, in series with a cell or two of dry battery and a telephone receiver, formed a most effective detector, exceeding the coherer in sensitiveness, speed of working and reliability. And, best of all, I found that this combination permitted a

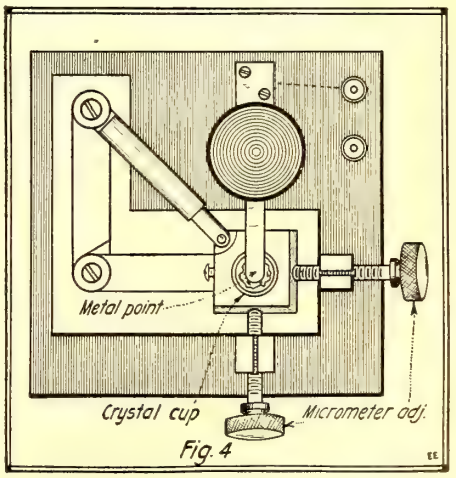


The "Silicon" Detector—A Good Old Standby of All Radio Operators. Invented by Dr. Pickard at an Early Date. It Involved a Sharp Metal Point in Spring Contact With a Piece of Fused Silicon.

considerable degree of discrimination between Morse signals and static, which was not possest at all by the coherer-relay-tapper-recorder combination. All was fish that came to the coherer net, and the recorder wrote down dot and dash combinations quite impartially for legitimate signals, static disturbances, a slipping trolley several blocks away and even the turning on and off of electric lights in the building. Translation of the tape frequently required a brilliant "imagination!"

Altho the *microphone detector* was a

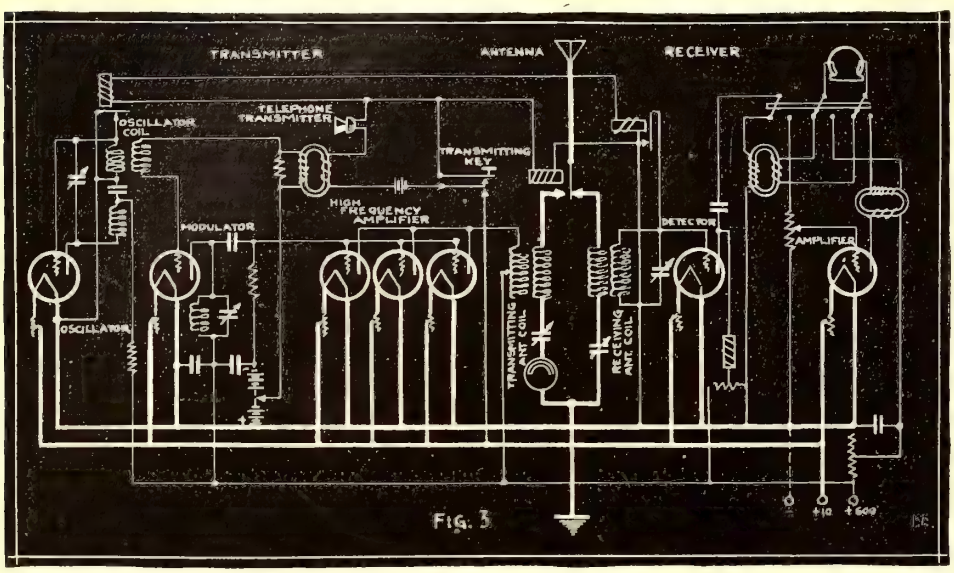
(*Continued on page* 360)



Dr. Pickard's "Micrometer Adjustment" Detector. Can be Used With Any Crystal and the Cup Adjusted With Precision in Any Direction While in Use.

A Review of Radio-Telephony

RADIO-TELEPHONY has been before the public so frequently of late that an article describing the modern scientific apparatus that has made it possible would not go amiss, it is believed. No one man can claim the credit for *discovering* "radio-telephony," but electromagnetic waves of so-called "radio" frequency were first intentionally produced and studied by Hertz who was guided by the electromagnetic equations deduced by Maxwell, constructed some twenty years earlier. The first radio telegraphic outfit was produced by Hertz, and improved by the discovery of the coherer by Brown, and of the invention of the present form of antennae first by Tesla, followed by Marconi, which allows the radiation of large power by long waves.



Battleship Radio-telephone Set—Schematic Circuit Diagram. Showing Microphone Modulator Circuit, Talking Key, etc. Note How the Vacuum Bulbs are Connected on Parallel.

At an early date it was realized that a crystal detector in combination with a telephone would produce in the telephone, currents whose amplitudes varied approximately as the amplitudes of the received high frequency wave, and consequently if the amplitude of this wave could be varied at the transmitting station in accordance with speech, radio telephony would be possible.

The receiving apparatus was therefore in existence and all that was necessary was a means of *varying the amplitude* of the transmitting wave. In regular wire telephony, the amplitude is so varied by *microphones*, and of course this device was at once applied to radio-telephony. The great trouble lay, however, in the fact that microphones, even when especially designed, cannot easily be made to carry large currents and still function properly. Because of this handicap, numerous voice-operated resistance-varying devices appeared. Using methods of this kind, considerable success was obtained, and in 1912 Vanni succeeded in telephoning 1,000 kilometers.

During the years of 1912 to 1914, a great deal of research work was carried on in connection with the use of the audion in radio-telephony, and in 1914 it was decided that the apparatus was sufficiently developed to warrant an attempt at long range wireless telephony. These tests were so successful, that the Navy Department erected an experimental station at Arlington, Va. The type of power bulb used is shown in Fig. 1. The current, by which the filaments were heated, was supplied by a local power company and brought by underground cable to the station.

Alternating current was used for heating the filament and any possibility of the superposition of a 60 or 120 cycle note, due to the frequency of this current, was eliminated by the use of a special scheme of connections. Between the plate and the filament of the power tube a constant voltage of about 500 volts was imprest. It was obtained from one of the motor generators used by the Navy in operating the large Poulsen arc, with which they were then transmitting to Darien and other remote points.

The immense racks containing the power tubes are shown in Fig. 2. At the left in this figure is the remote control for operating the motor generator set in the main Navy radio station at Arlington, and also for metering the currents used for lighting the plant and other such auxiliary purposes.

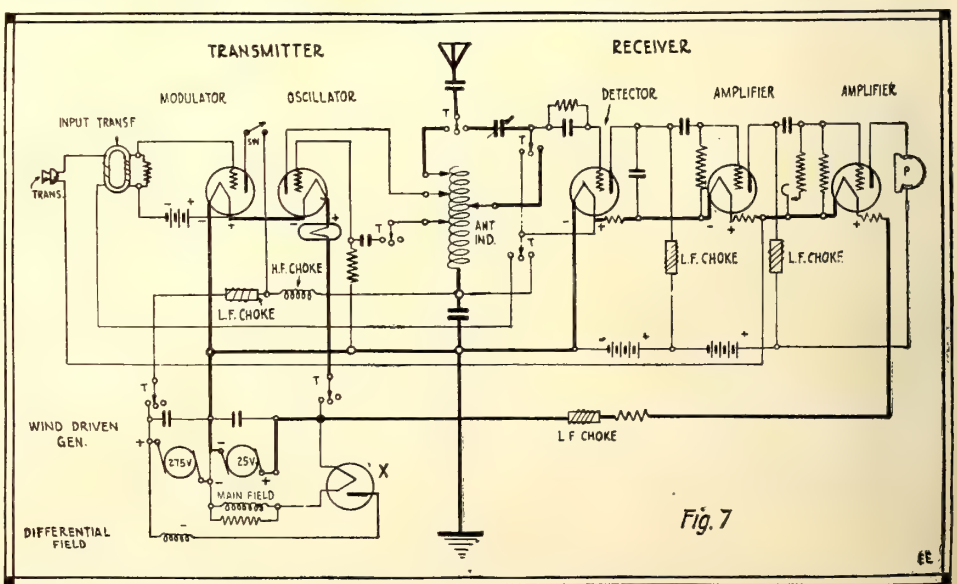
The first opportunity to demonstrate the use of wireless telephony in war was presented early in 1916. After several trials and experiments, the first radio telephone set installed on a battleship was placed on the U. S. S. *New Hampshire*. This set differed from the one in Arlington only in size. The set was installed on the lower bridge deck, and the telephone transmitter and receiver were mounted on the bridge itself. This allowed the captain, while on the bridge, to converse without leaving his post.

After many successful trials, it was decided to install two experimental sets on other battleships and give the operating staff an opportunity to investigate and criticize them. These sets were installed on the battleships *Arkansas* and *Florida* at Guantanamo, Cuba, the first part of February, 1916. It was found entirely practicable to hold a two-way conversation between vessels over 30 miles apart. There is no reason to think that this was the limit of communication as some of these conversations were overheard in Jamaica, a distance of 175 miles. No attempt was made for range as that was not the object in building these sets.

Each set consisted of a transmitting and receiving set complete with motor-generators. An extension circuit was provided so as to allow placing a hand set in the captain's cabin. The normal position of the antennae was connected to the receiving set in order to hear incoming signals. When it was desired to talk, a push button operated a solenoid switch which connected the antennae to the transmitting set and started the motor-generator. This operation consumed only a fraction of a second. The wave length range of this set was from 600 to 1,200 meters. The complete circuit is shown in Fig. 3.

The greatest success with radio-telephony has been accomplisht in connection with military work in the air. On May 22, 1917, Major General Squier, Chief Signal Officer of the Army, called a conference at Washington to consider the feasibility of intercommunication between airplanes while in flight by means of radio-telephony. There were present at this conference, besides General Squier, Colonel Rees, of the Royal Flying Crops of Great Britain, Captain, now Colonel, C. C. Culver, of the Signal Corps, and Major, later Lieut. Colonel, F. B. Jewett, and Captain, later Major, E. B. Craft, who had been assigned

(*Continued on page* 369)



Schematic Circuit—Airplane Wireless Telephone Set, U. S. Signal Corps—Type SCR-68. Transmitting and Receiving Circuits Are Shown. "X" Indicates the Clever Vacuum Bulb Regulator for Maintaining the Dynamo Voltage Constant.

American Radio-Telephone Apparatus



AMERICAN WIRELESS TELEPHONE APPARATUS DEVELOPED AND USED DURING THE WAR.

Fig. 1—Type of Vacuum Tube Oscillator Used in Long Distance Radio Telephone Work. Fig 2—Remarkable View Showing the Vacuum Tube Rack in the Radio Experimental Station at Arlington, Va. Note the Large Number of Rheostat Regulators for Controlling the Filament Currents of the Various Tubes. Several Hundred Tubes Were Available in This Laboratory, Any One or All of Which Could Be Used at One Time. Fig. 4—Front View of Transmitting and Receiving Set Used for Wireless Telephony by the U. S. Signal Corps. The Vacuum Tubes Are Safely Enclosed Within the Cabinet, and Their Degree of Luminosity Is Visible Thru the Oval Glass Windows in the Upper Right Hand Corner in the Panel. Fig. 5—This Shows the Complete Radio Telephone Equipment for Two-Place Airplane Service. Note the Two Helmets Fitted With Wireless Receivers and the Breast-Plate Transmitters, Specially Designed to Shut Out Noises From the Engine. The Wind-Driven Generator Is Shown at the Left. Fig. 6—View of Wind-Driven Radio-Telephone Generator with Stream-line Cover Removed, Showing Vacuum Tube Which Regulates the Voltage and Keeps It Constant at All Speeds,—an Extremely Clever Invention Due to an American Engineer. Fig. 8—An Assembled View of Various Apparata That Go to Make Up a Standard "Submarine Chaser" Radiophone Equipment. A Loud-Speaking Receiver Is Connected to a Three-Stage Vacuum Tube Amplifier. Fig. 9—This View Shows the "Submarine Chaser" Type of Transmitting and Receiving Set for Radiophony. Fig. 10—Shows One of the Gigantic Antenna Tuning Transformers at the Radio Experimental Station, Arlington, Va. The Secondary of the Tuning Transformer Is Moved In and Out of the Primary, by Means of Cables Which Run to Control Wheels in the Apparata Room. Some of the Most Important Radio-Telephone and Telegraph Researches Carried Out During the War Were Performed at This High Power Government Wireless Station.

Concentrated or Loop Aërials

By Prof. Lloyd M. Knoll, A. M.

SEVERAL freaks and dreams of radio experimenters before the war have been realized in a device developed by the writer, in connection with the 4th Naval District. Not only does the device eliminate a large amount of interference from other stations of the same wave length, but like the Rogers underground system, eliminates

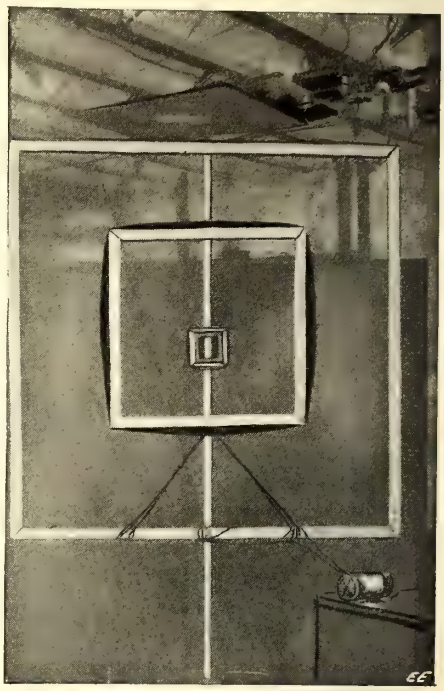


The Author and One of His Loop Aërial Radio Receiving Sets.

static as well, and being in a highly concentrated form it brings the outfit within the reach of the Radio Amateur. It is specially useful for the city wireless "Bug" who has limited space or a fussy landlord to contend with. It is no longer necessary to put poles on some high building, string aërials over large areas of ground nor even to tap an old 'phone line. The dream of the experimenter that some day he might put a nail in a flower pot for a ground and run a wire to a nail on the wall of his room is eclipsed and now the camper or tourist can pack a grip and be sure of always being in radio touch with the world.

Many operators will recall how it was easier to get certain stations when the aërial was disconnected from the set. This freak (?) set the writer and his friend, Mr. T. Appleby, to work to solve the problem of receiving regularly without an aërial and their results were put at the disposal of the government with the declaration of hostilities, and is only now being made public. Mr. (now Lieut.) Appleby discovered that the device had a strong *directional effect*. Later the writer concentrated the apparatus and discovered the way to eliminate static as well.

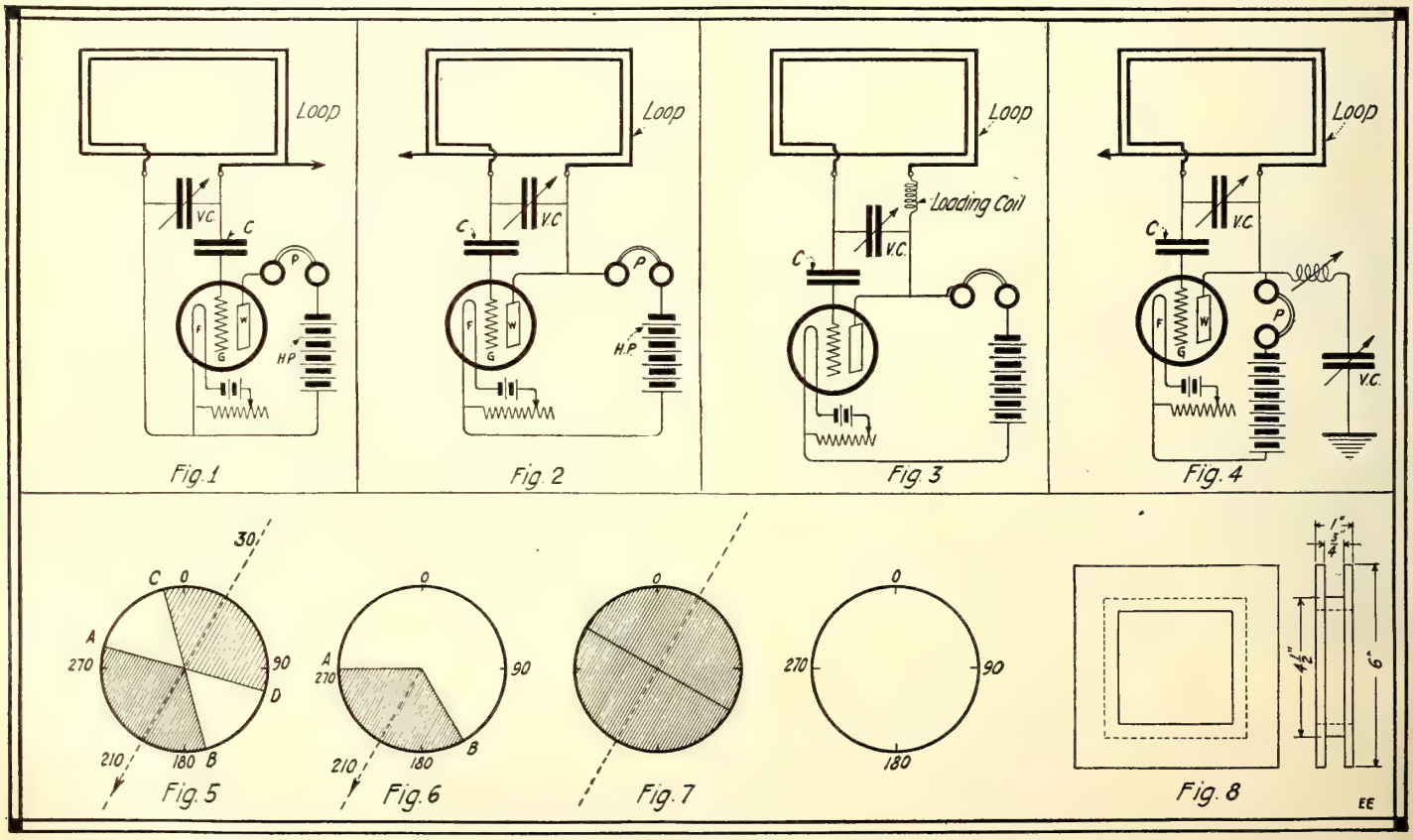
The extreme simplicity of the outfit is one of its most striking features. In fact the amateur has all the parts needed and early systems employed very much the same features but on a large scale. A loop of wire of proper proportions, a detector (a vacuum tube is most sensitive but not necessary), a pair of 'phones, the proper connections, and there you are. In the photograph may be seen a set in operation receiving on 2,500 meters wave length. Fig. 2 shows the receiving hook-up employed. As stated before there is a decided *directional effect* and if the loop is mounted in a vertical plane and rotated around a vertical axis, a remarkable fact is noticed. For example, suppose Fig. 5 to be taken as the circle described by the loop. Now if the signal is coming from a point along a line 210° from North, then if the end of the loop connected to the



Some of the Author's Loop Antennae. A Small Aërial of This Type Has Picked Up Messages From Stations 200 Miles Away.

grid of the audion or v. t. moves from A to B, there will be an increase and then a decrease in the intensity of the signal;

(*Continued on page* 362)



Various Hook-ups of Prof. Knoll's Radio Receiving Apparatus Involving Loop Antennae. The Lower Circle Diagrams Show the Relative Activities of the Loop Antennae.

To War on an American Destroyer

A Radio Operator's Experience Chasing the U-Boats

By A. H. WHEDON

TO begin with, let it be known that the author spent sixteen long, weary months with the United States Destroyer flotilla based in Queenstown, Ireland, and therefore feels competent to write the following few remarks.

The American destroyers arrived in Queenstown, Ireland, on the fourth day of May, 1917, after a ten-day trip across the Atlantic, during which time our radio transmitting apparatus was not used more than three or four times. You see, when we left the States we had no idea of what we were going into. Our idea of the German submarine question had been entirely derived from reading the newspapers. Consequently, we imagined that we would see a *dozen or so a day,* and that when a merchantship used her radio, several submarines got her position by a direction-finder, and sallied forth to attack her. Naturally, we were very quiet with our own radio instruments, and were terribly disappointed when we reached port without seeing a single "sub."

When we reached Queenstown, the British Admiralty Authorities came aboard to look us over and to hold a conference with our officers. One of the results of the conference was the determination to use the British method of radio-communication. They called it W/T (Wireless Telegraph). Of course, the code was the same, but there the resemblance between the two systems ended. And perhaps you think it was easy to forget, after years of thoro training, the things that came as second nature to us and to substitute absolutely new stuff—it was not very simple.

And when it came to working with the "Limy" (British) ships and stations—my, my! They sent at the terrific speed of sixteen to twenty words per minute. Twenty words was their high speed limit. The American operators who first went over there were all picked men, and their speed varied from twenty-seven to thirty-four, and to come down to sweet sixteen, once again meant hard work!

But gradually, as we operated with them, their receiving speed increased, and likewise did their transmitting speed, and again our troubles were increased. Very few of you, probably, have ever heard a "Limy" spark in action, but most of you are fairly familiar with the sound of a low frequency buzz-saw, and believe one who knows, there is not enough difference between them to be happy about. And then, when they started to speed up on a spark like that—can you imagine it?

Another trifling (?) detail (?) that bothered us was the fact that everybody and everything dashed off on the one wave length—600 meters. And altho there was an order out to the effect that radio work was to be reduced to a minimum, very few people ever took any notice of it. Consequently, in the Irish Sea there was an awful mixup, for on the English coast there are Liverpool, Fishguard and Land's End. Opposite them, a few miles away on the Irish coast, there are Belfast, Dublin and Queenstown, and when all of these stations are trying to work on the same wave length, to say nothing of all the ships in the Irish Sea, there is, to say the least, a *little* interference. But as the English boats are not equipt with an efficient wave changer, as are all our boats, nothing was ever done about it. Gradually the problem resolved itself into the equation: "The guy with the most power wins," for nobody would ever keep quiet long enough to let the other fellow work. There was a time when I, personally, had a message to send to Liverpool. It took 5 K. W. for 100 miles.

The English are not renowned for their quick perception. We found that fact out to our sorrow. Altho "playing flats" (unauthorized conversation) is not permitted in either Navy, there are times when it is necessary to talk to the other fellow about a message, or on similar subjects. Of course, such conversation must necessarily be as short as possible. In the U. S. Navy every word is abbreviated in this unofficial conversation. For instance, one operator wants to ask another "What is the check on message number one?" It would be transmitted: "Wht ck msg one." After the answer would come "Tks" for "Thanks."

There was an occasion when my ship, the U. S. S. *Conyngham* was in company with the H. M. S. *Snowdrop,* a boat of the "sloop" type, developed during the war. My sending set wasn't working any too well, but as I had a long message to send him, I decided to make a try at it. So I opened up and started. Very shortly I began to miss sparks, so I signalled over "ST BI 5 TRANS BRKN DWN," meaning "Stand by for five minutes. My transmitter is broken down." There was complete silence for a few seconds, while he tried to puzzle it out. Then he came back with a great big question mark. I thought it possible that I had been a trifle speedy for him, so I made a hasty connection and sent it again, more slowly. More silence. Then more question marks. By that time I had fixt my set up, and was just about to start in on friend "lime-juicer" with the message, when he came across with the conventional signal for "Your Morse is unreadable. Put a competent W/T operator on watch." That was all the thanks I got for trying to tell him to wait a minute.

There may be some of you who think that radio in the Navy is a soft job. Well, it is—on a decent sized ship that knows enough not to roll and pitch *all* the time.

(*Continued on page* 367)



A "Lime-juicer" (English Sailor) Radio Operator Trying to Decipher What the Blankty-Blank the Yank's Code Message Means.



Don't Look at this Scene too Long or You'll Get Seasick. It Represents What the Radio Room on a "Destroyer" Looks Like In a Heavy Sea.



The Radio Room on the "Destroyer" Had a Leaky Ventilator in the Roof. What Didn't Happen in Those Two Awful Days Off Brest, France,—COULDN'T.

How to Develop Your Inventive Ability

By JAY G. HOBSON

(Author of "How to Finance and Manufacture a Patent")

AFTER many years of careful research into the mysteries of the human mind psychologists have concluded that every normal person is an inventor by nature, having inventive faculties to a certain degree.



The Automatic Restaurant Is a Clean Place To Eat, Isn't It? But Why Must We Allow People With Dirty Hands To Fumble Around In the Spoon, Knife and Fork Receptacle? Why Not Invent a "Dispenser" for the "Eating Tools?"

Many have developed these talents further than others, but the fact that we are all inventors naturally is of great importance to every one aspiring to create something of value to mankind and themselves. While we are assured that each individual is capable of creating, improving and originating new and useful things, yet most of us find considerable difficulty in deciding upon the best and surest course to pursue in order to develop our inventive qualities to a point of efficiency necessary to cash our ideas for their full worth.

Inventive ability is simply the power of close observation, scrutiny, imagination and analyzation of material things as they exist with the way they might be made to exist, if constructed in a different form. All things have at some time or other been the result of some dreamer's or some thinker's imagination and—observation crystallized into a mental picture, then developed until it has merged into actual form, a complete, improved article of practical worth.

The practise of observation, imagination,



Why Can't We Go to the Theatre and Find a Clothes Compartment in the Back of the Seat That Disappears Into the Basement When You Sit Down? Nobody Ever Thought of It!

constructive investigation and analyzation will develop this inventive ability and in time make it both perfect and prolific. But there are certain proven ways that help this development more than others. Idle curiosity over things will not promote the inventive training and is not constructive observation or investigation. Investigation, observation and analyzation must be done systematically and with a sincere aim in view. There must be a serious desire for betterment and improvement in mind to find that improvement or invention worth while.

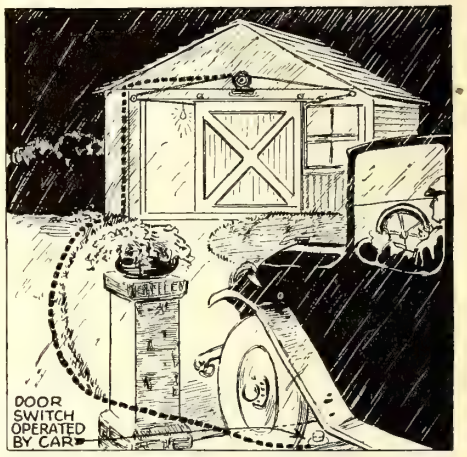
The great revolutionary inventions are few and far between, but when they do appear it is evident that some sincere mind has striven to create a working device of his mental picture which was undoubtedly conceived by a fervent desire to produce an improvement over unsatisfactory conditions as they were in the time of the conception. Or probably it was the aspiration to give the world a device that would save unnecessary labor, prolong life, or improve commercial intercourse for big business. However, it is establisht that to originate or create improvements of value, one must train his mind and imagination to picture things as they should be and then stick to his mental idea until it successfully matures into a practical device of certain operation.

There are numerous examples of inventive development but for illustration we will consider only a few. Elias Howe first observed the pressing need for a machine to do the tedious labor of sewing that in his day was entirely done by hand. After observation came investigation of his idea, then a mental picture or imagination of a machine capable of producing the desired result, then came analyzation of mechanical movements necessary to replace the human hand, and finally after years of discouraging effort he succeeded in designing and perfecting a model that not only did what the human hand would do but did it in one-fifth the time. It took Howe years to perfect his first machine mainly because in those days the art of mechanics was only in its infancy, which necessitated his working out of every mechanical detail. Today it is far easier for the inventor. He can conceive the idea, sketch plain plans and drawings and secure assistance to perfect the mechanical details. There are more and greater opportunities to become inventors today than ever. There is more money to be made and quicker. Elias Howe did not labor in vain as his invention made nearly two million dollars in royalties.

The incident of the hair pin and how its inventor observed his wife bending a straight hair pin to prevent it from coming out of the hair is a much hackneyed experience. But only recently an alert young man in Chicago conceived the idea of placing a hump in the neck of the old-fashioned hair pin to prevent it from coming out of the hair. A patent was obtained upon this extremely simple idea, they were offered to the feminine public in attractive packages and now sell by the millions. To date the inventor has made hundreds of thousands out of his simple little improvement, which only goes to prove that nothing is too small or too simple for our consideration and observation, if we would become successful inventors.

The simple ideas are, as a rule, more prolific and prevent infringement to a greater degree. After an idea is received the inventor should strive to picture it in the simplest possible form. *Simplicity in invention is the secret of patent success.*

There are five distinct ways in which the mind receives inventive ideas, namely thru the five human or physical senses; sight, taste, smell, feeling and hearing. A



Why Not Invent a Simple and Reliable Garage Door Opener? Thousands of Autoists Everywhere Will Not Only Bless You for It, But Will Buy Them by the Hundred. But It Must Be Cheap in First Cost and Maintenance.

person may see an improvement and patent it, or taste a flavor and create a better one, or smell an odor and design a device to eradicate it, or hear a situation and replace it with a different one.

All inventions have entered the inventor's mind thru one or more of these five ideas-carrying channels before materializing into completed form. The mind is the oven or incubator for hatching these inventive germs and forming them into practical articles for earthly use. Therefore to develop one's inventive faculties it is necessary to develop both the five human senses and also the mind that controls them.

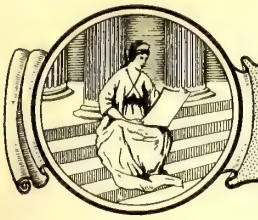
For the purpose of suggesting an effective method of development I will now ask the reader to join me on a little inventive expedition up among the clouds of creation.

Our first imaginative stop will be in the office of a modern business man who is branch manager for a large eastern corporation. It is noon time and our friend decides to go out to lunch. We follow him down the avenue to a cafeteria. He en-

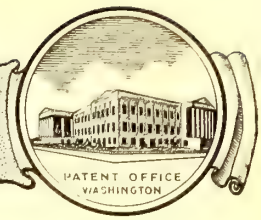
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Can You Identify Yourself In a Strange City? You Could Do So With the Simple Pocket Case Here Shown, Containing Your Photo, Signature and a Cancelled Check Endorsed By You.



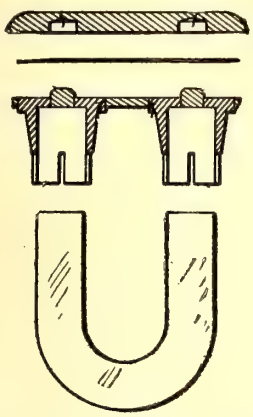
LATEST PATENTS



Magnetic Razor.

(No. 1,299,096, issued to Butler Ames.)

A very ingenious idea is this magnetic razor, which makes the cleaning of safety razors a very simple

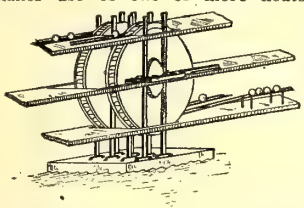


process, as the retaining cap over the razor blade may be instantly removed by pulling it off the magnet cores. The cap and blade members of the razor are adapted to be held in position by a guard member, by magnetic flux passing from one pole of the bi-polar magnet to the other pole, thru the blade and cap, which members are made of steel or other magnetic material.

Tidal-Power Motor.

No. 1,304,238, issued to Judson E. Wright.)

In this tide-motor the inventor makes use of one or more floats,

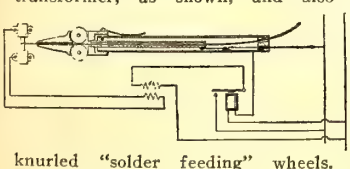


which rise and fall with the tide. The alternate up-and-down movements are made use of thru a pair of gear racks, acting alternately on a pinion or gear wheel as shown. One of the racks acts on the "upward" motion and the other on the "downward" motion, thus preserving a continuous rotary motion in the power wheel. When the action of the tide is low or nil, the power is maintained by a series of spherical weights acting on a bucket wheel connected with an auxiliary power member. These weights are carried to a higher level by the regular tidal motor thru a bucket conveyor.

Electric Soldering Device.

(No. 1,304,545, issued to Frederick A. Costello.)

This soldering device comprises a tubular holder resembling a pencil or pen holder, thru which the wire or strip solder is applied to the work to be united. This holder also carries a circuit-closing switch for the primary of a step-down transformer, as shown, and also

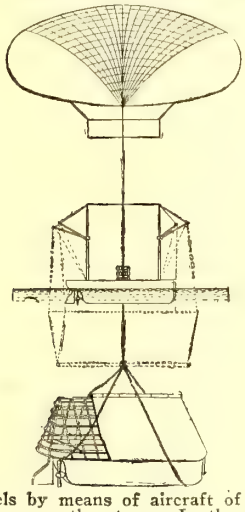


knurled "solder feeding" wheels. The electricity is used only in actually heating the solder when the same is placed in contact with the work to be united by this clever arrangement. A relay serves to open and close the primary circuit of the transformer in the manner evident.

Raising Submarine Vessels.

(No. 1,303,912, issued to Hideo Katayama.)

A clever idea for raising sunken

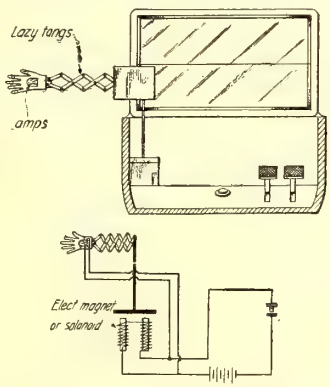


vessels by means of aircraft of the balloon or other type. In the first place, the surface of the upper deck portion of the sunken vessel is covered with a wedge of special pyramidal structure, so that when the balloon or other aircraft is connected with the wreck, as by means of slings, the buoyancy of the balloon may be utilized to greatest advantage. The slanting roof structure reduces the resistance of the body as it is lifted up thru the water.

Electric Semaphore for Autos.

(No. 1,299,361, issued to Hyman Lieberman.)

An electromagnetically operated semaphore for automobile signaling, two of which may be used on the car, one on the right and left, respectively. The device works by

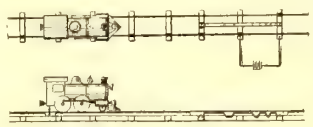


means of a lazy-tongs arrangement connected up to an electromagnet or solenoid. The driver has simply to close the electromagnet circuit with a foot-controlled push-button, when the electromagnet, becoming excited, causes the lazy-tongs to act, thus projecting the hand about two feet. At night the hand may be illuminated by an electric lamp in the palm, which can be seen from either front or rear, and also the fingers can be illuminated by a small electric light placed on each finger.

Electric Whistle for Toy Railroads.

(No. 1,303,117, issued to William C. Roe.)

This invention covers a design for a small electric whistle simulator,

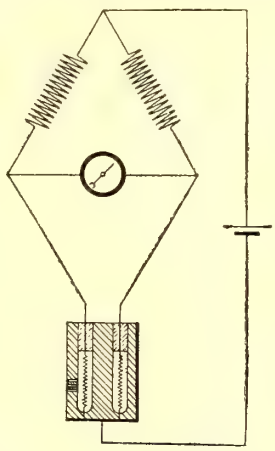


for electric toy railroads. A special circuit controller in the form of an auxiliary track member is provided, in the design here illustrated and described, so that as the locomotive and train pass over this auxiliary contact placed between the rails the whistle simulator circuit will be closed and the device actuated. The instrument is constructed in the form of a buzzer so as to give a high, shrill note, similar to a whistle.

Electric Gas Detector.

(No. 1,304,208, issued to Gilbert A. Shakespear.)

The definite rate of loss of heat from a body exposed to the gaseous mixture is employed as the detecting and measuring agency. A Wheatstone bridge circuit is utilized, including a pair of electrically heated

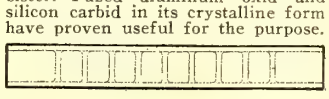


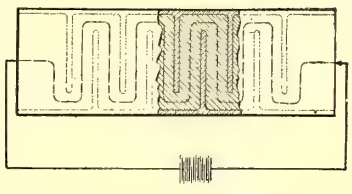
wires, one of which is surrounded by the gas to be tested, while the other is surrounded either by air or by any other gas, which can serve as a "standard" for comparison. A galvanometer is used to adjust the Wheatstone circuits to a state of balance.

Zigzag Carbon Resister.

(No. 1,298,421, issued to John Thomson.)

The present resister device renders the carbon element of the resister immune to oxidization, thus restoring the slotted member so as to maintain its original resistance at all times. To do this the slots of the resister are filled with a material having coefficient of expansion and contraction nearly identical to that of the carbon forming the resister. Fuzed aluminum oxid and silicon carbid in its crystalline form have proven useful for the purpose.

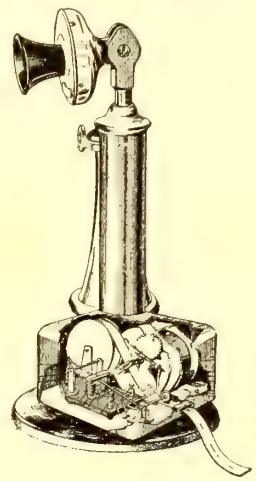




Telephone Call Recorder.

(No. 1,299,154, issued to Arthur Engelberg.)

This invention relates to an electromechanical device comprising a spring motor which will unreel a paper tape, and at the same time, by means of an electromagnet, cause to be recorded on the tape any telephone numbers of parties which may have called while the owner was absent. This device would seem to

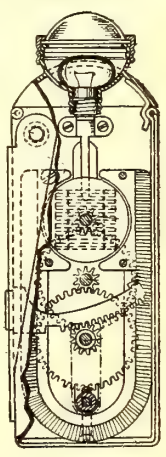


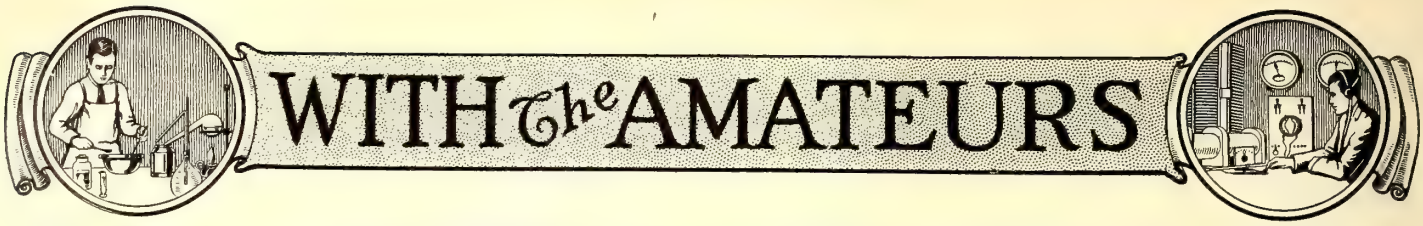
have considerable promise, and if taken up by the telephone companies should prove of great value as a time saver. The spring motor and electromagnetic recording device is controlled from the telephone exchange by "Central." Many times people call a party, only to find "that the line is busy" or else that "they do not answer," all of which wastes a good deal of time in the busy man's day. If the number calling was recorded in the office of the absent party, then upon their return they could call back the number in question.

Magneto Pocket Lamp.

(No. 1,301,595, issued to Marc A. Pattay and Eugène Jaquemont.)

This is a clever idea in magneto electric pocket lamps, and represents several improvements over those heretofore proposed. Not only is it provided with a mechanism for spinning the armature of a small magneto generator, which develops the necessary current for lighting the lamp, by means of a reciprocating rocker arm, but it is also provided with a continuous circular movement crank operated independently and whenever desired by means of a change-over attachment. The device is ingeniously worked out, so that for ordinary lighting purposes it is but necessary to squeeze on the flexible casing of the pocket lamp, which causes the armature of the dynamo to be spun rapidly. No batteries are necessary, and by the arrangement of the mechanism in this lamp it would appear that the light should be practically continuous.





Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $3.00 each month for the best photos. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $3.00 PRIZE WINNER—H. C. SMITH

I PRESENT herewith two photos of my laboratory and one of myself. My chemical laboratory has over 150 solid chemicals and about 100 different solutions. The glassware consists of beakers, Erhlenmeyer flasks, funnels, condensers, burettes, hydrometers, evaporating dishes, crucibles, graduates and retorts. It also includes a "French" microscope, a balance, and many other apparata too numerous to mention here. My "Electrical Laboratory" consists of various motors, generators, condensers, wireless transmitting and receiving apparata now in construction, also a switchboard under construction, ½ K.W. transformer coil and a two-inch spark coil. Unfortunately all of my "Electrical Laboratory" did not get into the picture.—H. C. Smith, 3816 S. Honore St., Chicago, Ill.

HONORABLE MENTION (One Year's Subscription to the ELECTRICAL EXPERIMENTER)—ROBERT NIESSNER and ROBERT BOHATY

HEREWITH are several flash-light photographs of the electrical laboratory and experimental machine shop of Robert Niessner and myself. In this laboratory we do all kinds of experimental and research work in chemistry, electricity, high frequency and wireless. This laboratory was started in 1917, and it is still growing very rapidly.

One of the photos (left) shows Robert Niessner, and the other (right) shows myself. Another shows a corner of our "office," where we do all the figuring and correspondence. One of the views illustrates our electrical testing bench and switchboard, and part of our chemical bench. We possess a large screw-cutting lathe on which we do all kinds of machine work. We have had this lathe only a short time and it has turned out quite a few dollars worth of work for us.

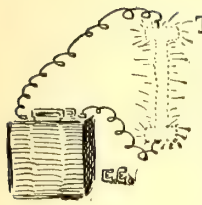
These photographs show only a small part of our equipment. We have all kinds of electrical motors, dynamos, generators, gasoline engines, steam engines, electrical testing apparata and a complete set of wood and metal working tools.

Among the magazines that we have in our "office" there is the ELECTRICAL EXPERIMENTER, which is of great value to us in our work. We also have many books pertaining to chemistry, electricity, steam and gasoline engines, et cetera.—Robert Bohaty, 434 East 77th St., New York City, N. Y.



Science in Slang

By EMERSON EASTERLING



IT was an Italian car, the chauffeur was an Italian, and he was delivering long accented discourses in galloping Italian. To be concise, the ignition system had gone on the "fritz" and the wop was "cussin" over the layout. Jazz Stokes and party, we, sat in the tonneau while the driver fingered and swore and smoked Turkish cigarettes.

"The name 'storage battery' is a misnomer," commented Jazz. "The juice is not stored as commonly conceded, but is generated or caused to circulate by the chemical action set up in the plates of the cell."

"How did the storage battery or secondary



Camille Alphonse Faure, Who Pasted Us a Hot One When He Handed Us the First and Original Pasted Gridplate.

cell come about?" asked "Rat" Morehouse, the bow-legged boy from Berkeley, California.

"Volta and Galvani started the ball in that direction when they got to monkeying around in the dynamic field, but the original storage cell was developed by a bird by the name of Planté. Gautherot got to shooting juice thru platinum wires in water and other electrolytes and observed that the little contraption was capable of kicking back a light current when the juice was cut off. The fact of the case was that he stumbled onto the accumulator idea when he was only trying to jerk the H_2O into O and a couple of packages of H. Electrolysis, that was his game. You remember, a lot of the scientists thought that ions was as far down as matter could be boiled—electrolysis did that. Like a lot of other things, the secondary cell was a secondary discovery—the inventor was not fishing for the cell.

"Two years after Gautherot's stunt, in 1803, Ritter constructed a secondary pile much like Volta's. By charging for a few moments with a strong galvanic current the pile would give quite a kick. The plates were copper disks separated by cloths moistened in sal ammoniac.

"Count Volta, Bequerel and a stack of other researchers became aware of the fact that gold, silver and platinum and some other nice metals would give secondary currents when subjected to electrolytic action in certain solutions.

"In 1842 Grove slipt us his celebrated gas (no, not mustard) battery. The big idea was the difference in polarity in the two gases, oxygen and hydrogen.

"Mike Faraday had the idea in his hand but did not close up on it when he found that peroxide of lead at the negative pole had a relative high conductivity. The old boy makes note of the fact in his *Researches.*

What Makes the Storage Battery Store?

"Until 1860, when Gaston (without the assistance of dear Alfonso) Planté threw a bunch of coiled lead plates together into a jar of solution, the old-timers never had the pleasure of seeing a *real* secondary cell. Gaston, with his plates of lead, lead peroxide and spongy lead, and finally lead sulphate in the sulphuric acid electrolyte, was able to run his battery down to where she took the count and then give her a shot of electric hop and watch her hump again. Metzger, Brush and some of the other highbrows boosted the Planté idea along until they had a fairly decent battery out of it."

"What do you mean by lead, lead peroxide and spongy lead, and finally lead sulphate?" inquired Fred Cochran.

"To begin with, the plates are lead, unless the makers build up the plates from lead oxide and sulphates. The charging current turns the positive plate to peroxide of lead. The negative plate of lead sulphate is converted to spongy lead. The electrolyte is about 23 per cent. sulphuric acid in water. When I said that 'finally lead sulphate,' I was referring to the state that means curtains for the cell. A sulphated cell is like a car without gas or a ship on the rocks. Get the idea?"

"What chemical action goes on in the cell during charge and discharge?" asked Velt.

"It is like this," returned Stokes. "When the juice is sent through the cell, entering at the positive plate, the water is changed to its components, hydrogen and oxygen. The oxygen combines with the positive plate, forming lead oxide or peroxide. The hydrogen forms at the negative plate.

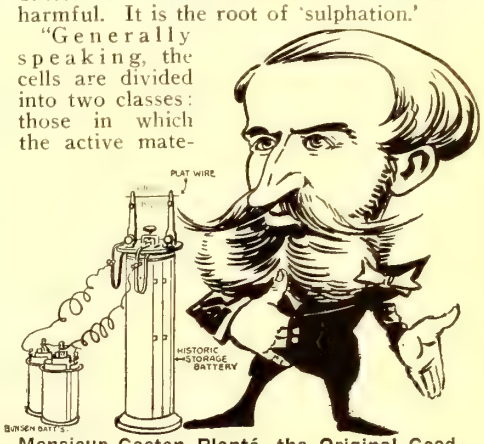
"On disconnecting the source and again closing the circuit, the water is again decomposed. The oxygen uniting with the



Tommy Edison Stept Off the Lead and Sulphuric Trail and Handed Us the Nickel-Iron Storage Battery.

hydrogen collected at the negative plate and with the plate itself, and the hydrogen uniting with the oxygen of the oxide of lead at the positive plate, causes a current to flow in the circuit that is closed. That is the simple explanation of the operation. There are minor and subsequent actions and reactions that take place, but the only one that makes any difference is the white insoluble sulphate formed by the red or yellow sulphates with the litharge. This formation is a non-conductor and otherwise bothersome and harmful. It is the root of 'sulphation.'

"Generally speaking, the cells are divided into two classes: those in which the active material is formed by chemical or electro-chemical action, and those in which some easily reducible salt of lead is applied mechanically. Planté types are examples of the former and Faure types of the latter. The Gould batteries are made from the slow former process. The Willard batteries are also of the Planté type, while the Exide cells are of the Faure. The Faure type has a little better output for the weight, but the other has it over on them in sturdiness.



Monsieur Gaston Planté, the Original Goodness-to-Honest Storage Battery Kid.

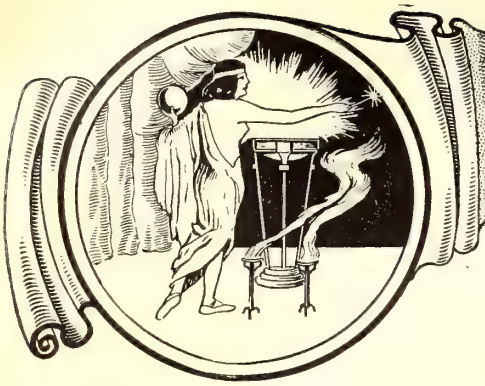
"Tommy Edison stept off the lead and sulphuric solution train of thought and handed us a new one with nickel and steel and iron plates and a twenty per cent. solution of caustic potash (omiting Perlmutter) for the electrolyte. The electromotive force is not as great as the lead type, but the ampere hours per pound is about half—the bulk being the same, practically, as the old line of cells. Upon discharging, the Edison cell shoves as high as three volts and higher onto the line, but decreases after the load sits on her. You are aware of the fact that the old lead accumulator gives out about two and four-tenths volts at the beginning of the discharge—if you did not know of it before, you do now. The old heavy type has it over on the Edison for constancy of current, but the selling point for the Edison is the lightness and mechanical robustness.

"There are other secondary cells that employ plates of bimetallical composition. The most satisfactory are the *zinc-lead, copper-lead,* and the *copper-zinc,* besides the Edison *nickel-iron* cell.

"Sacramento! Puerco! Blankety Blanko!" And a string of other stuff ending up with the statement that the *"automobile no bono"* and *"a infierno con todos!"* The wop broke in on our discussion—of Jazz's.

"I guess I will see what is the matter with the motor," said Stokes as he walked around the hood. "I've got a date with a blind man for a game of craps to-night."

In less than five minutes the Italian was saying *"gracias, signor"* and we were leaving a cloud of dust behind us.



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

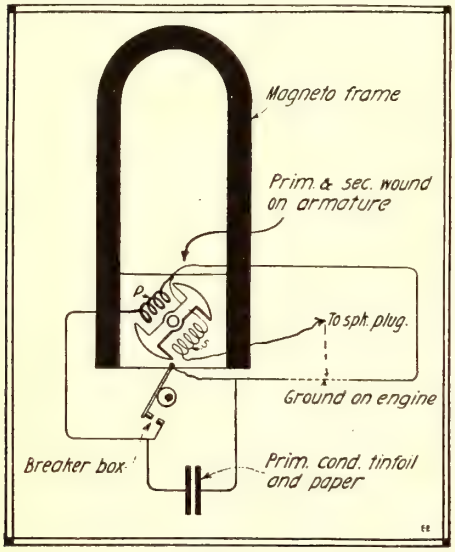
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

MAKING HIGH TENSION MAGNETO FROM LOW TENSION TYPE.

(1016) J. G. Whitfield, Goldsboro, N. C., inquires:

Q. 1. How can I change a low tension magneto into a high tension type?

A. 1. It is rather difficult to change a low tension magneto of the ordinary type into a high tension magneto unless you are quite familiar with the make-up and appa-



How a "Low Tension" Magneto May Be Converted into a "High Tension" Type.

ratus of the latest type machine. We are pleased to give you herewith diagram showing how most of these high tension magnetos operate.

In one of the modern high tension magnetos there are no revolving coils or commutators of any kind, but simply a rotating mass of iron, which is so formed as to cut the magnetic flux in the field many times per second. In this machine the primary and secondary windings are stationary, and undoubtedly you can obtain some information on this machine, as well as other high tension types, which may be of interest to you, by communicating with the various high tension magneto manufacturers.

RADIO ANTENNA QUERY.

(1017) Rolf Carbo, Minneapolis, Minn., asks:

Q. 1. For data on a radio antenna for amateur requirements.

A. 1. Regarding the type of receiving aerial which would be best, should be about 125 feet long, 75 feet high, and at least 4 to 6 wires spaced about three feet apart, which will prove very satisfactory for average long-distance reception and commercial wave lengths.

If you intend receiving amateur wave lengths it will be necessary for you to interpose a variable condenser in your ground circuit.

About the best thing for an all-around set, we advise a small coupler and audion, adapted to a great many ranges of wave lengths. Unless you intend to build a set to receive only undamped wave stations, we would suggest a very large loose coupler.

We refer to our September, 1915, issue of the ELECTRICAL EXPERIMENTER for excellent data on loose couplers.

To Our "Oracle" Friends

Do you realize that not one day passes when we do not receive from 150 to 250 letters addrest to "The Oracle"? If we were to publish all the questions and their answers we would require a monthly magazine five or six times the size of the ELECTRICAL EXPERIMENTER, with no other matter but questions and answers. Of late the influx of letters has become so heavy that several of our associates have been forced to discontinue important editorial work, in order to answer the mail. This we are certain you do not wish. You do not want your magazine to lower its present high standard. You want the best, the very best, and you know we never have failed you yet.

Moreover the multitude of letters are wholly unnecessary. Most of the questions Readers ask every day have been answered before in "The Oracle." Therefore, ere you sit down to write us, look over your back numbers, and nine times out of ten you will find the answer.

We strive hard to publish only such matter as has not appeared before in our columns, and for that reason, only a small fraction of the queries received by us are actually publisht.

Your magazine is steadily coming to the fore as the greatest publication in the scientific world. To keep up its present high standard and to make it a better and bigger magazine requires a tremendous amount of untiring effort on the part of the Editors. Therefore, in the future, we CANNOT in your own interest, answer questions by mail, free of charge.

For questions requiring an immediate answer our fee is 25 cents for the first three ordinary questions, and 25 cents for each additional question. We will gladly advise fee for special questions entailing considerable research work or calculations.

Stamped and addrest envelope should be enclosed with the queries, and moreover, any sketches accompanying them should be drawn in ink on separate sheets. Write plain and, PLEASE, PLEASE BE BRIEF.

Editor of "The Oracle."

STORAGE BATTERY QUERY.

(1018) B. W. Dresser, Homedale, Idaho, asks:—

Q. 1. Several queries on storage batteries, etc.

A. 1. Answering your first question, would advise that water for storage batteries should be distilled and kept in glass containers, as no matter what form of metal you might use, it is only natural that minute particles of the container will mix with the water. It is absolutely necessary for storage batteries, to secure perfect satisfaction from the same, to use pure distilled water absolutely free from any elements which might contain iron or any other metals.

The difference between the current and voltage for static machines and high-tension transformers does not vary very greatly, the designs of the machines and transformers having much to do with their outputs, tho the currents are about practically the same.

It is unnecessary to insulate the conductors of a rotor in a squirrel cage induction rotor. In the usual cases bare solid conductors are merely wedged in the slots of the rotor.

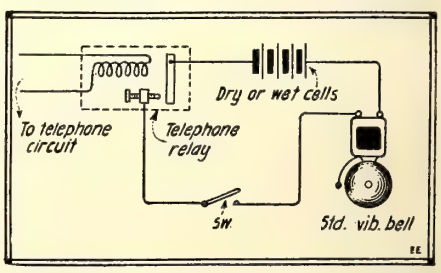
RINGING ALARM BELL FROM TELEPHONE CIRCUIT.

(1019) Theodore Mucha, Terlingua, Tex., writes:

Q. 1. How can I hook up an alarm bell to a regular telephone circuit?

A. 1. With reference to an alarm device for waking up a sleeping person, and to be connected to a telephone circuit, would say that several years ago the Editor installed a very successful form of alarm which will wake the dead.

In order to work this alarm, as the accompanying diagram shows, you will require a telephone relay. This can be pro-



Scheme for Ringing Extension Call Bell from Telephone Station by Means of a Telephone Relay. The Latter Instrument Can Be Obtained from Your Local Telephone Exchange or Supply House.

cured from any supply house at a cost of about $1.00.

The telephone relay is connected directly across the telephone line so that when the current is sent over the circuit, the relay will close the secondary circuit, in which you can connect batteries, electric horn or alarm bell, etc. You can also obtain, if you so desire, a large 6- to 8-inch telephone extension bell, which may be connected across the telephone line.



Copyright 1919
by R. J. Reynolds
Tobacco Co.

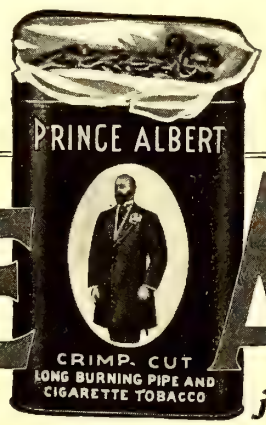
SAY, what a trick you'll turn for your tongue and taste and temper when you finally get down to bed-rock smokes and let some of that topjoy Prince Albert float into your system! Just will put the quiz into your thinktank as to how much pipe or cigarette-rolling fun you've gone shy on—and, you'll work in a lot of double headers for quite a spell to get all-square!

What's the idea kidding yourself when you know what P. A. will do for your smokespot; when you know what it is doing for men all over the civilized world! You can't hit a happier job than to stock a supply of Prince Albert, jam that joy'us jimmy pipe chuck-full and blaze away! Why, it's like falling into feathers when you've been batting-it-out-on-a-board!

Prince Albert just can't help doing you a clever turn because it won't bite your tongue at any stage! Bite and parch are cut out by our patented process. Want you to know right here, and now, that Prince Albert will be as gentle with your tongue as a toy purr-kitty is with a stuffed mouse! You can rip champeen-smokespeed-records right up the back with P. A. for packing!

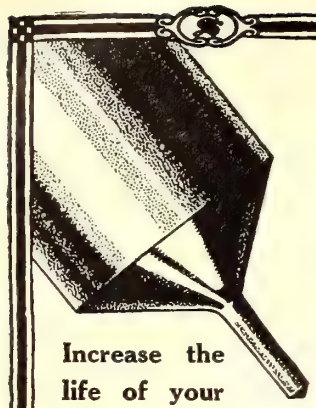
You don't need a percentage table to figure out what Prince Albert's quality and flavor and fragrance will do for your happiness every time the clock ticks! You'll get the answer quick! And, now it's your draw! Prince Albert is sold in toppy red bags, tidy red tins, handsome pound and half pound tin humidors, and, in that classy, practical pound crystal glass humidor with sponge-moistener top that keeps the tobacco in such perfect condition!

R. J. REYNOLDS TOBACCO CO.
Winston-Salem, N. C.



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Solving the Transportation Problem

(*Continued from page* 303)

two main tracks, while a revolving pinion engaged with this rail rack. The train derived its energy from an electric third rail and shoe which operated the electric motor; this in turn worked the pinion.

In Fig. 3 is shown a later type of hydraulic shoe also operated under the water pressure and water suction plan. With this shoe very little water is lost.

100 Miles Per Hour—Safely.

From what has appeared, it will be seen that being that there is no friction, enormous speeds can be obtained with such railways. As a matter of fact one hundred miles an hour is a conservative figure. Nor is it dangerous to run such wheelless gliding trains at such speeds for two reasons. One is that there is no friction. There is no wear and tear of material, and if the flat rail with its guard rails (see Fig. 2) is constructed right, it will be impossible for the shoes to jump the track. And now we come to the most important point as far as the speed is concerned.

These trains it was found could be stopt almost instantly, and *very simply by cutting off the water pressure.* This maneuver brings the hydraulic shoe in direct contact with the rail and an enormous friction sets in. No brakes are needed to stop such a train. *The train is its own brake.* Nor is that all. Such trains can be stopt where *the rails dip at an incline of* 40%, a thing unheard of on regular railways with wheels. You see in a train of this kind there is nothing to roll and the minute the water pressure is taken off, the train must stop at once even at the worst incline. Inversely if the right tractive method is used to propel the train, it will run up almost impossible inclines at angles no regular railroad would ever think of attaining. Furthermore, in view of what has appeared, it will be realized that the cars do not have to be of such ponderous weight as are the present day ones. They can be constructed of aluminum alloy and could weigh one-quarter of the weight of the ordinary car and still be safe.

Former Disadvantages.

There was only one real disadvantage on a railway of this sort. During the winter the formation of ice and snow on the rails tended to put the entire road out of business because no means could be found to do away with the forming ice and its consequent unevenness or roughness of the track. This, however, would not worry our present day engineers for the simple reason that our trains would probably carry some electric heater in front of it, each train thus melting the ice as fast as it formed.

New Ideas by Mr. Gernsback.

We have today a means for propelling the gliding railroad, which is as simple as it is efficient. Our cover illustration as well as Fig. 5 show the means proposed. Fig. 6 also depicts the various methods used. The writer proposes the use of a single track, each car having two hydraulic shoes of the kind shown in Fig. 3. The car is held upright by means of the gyroscope shown. This gyroscope is to be driven by an electric motor and the energy is to be taken from a third rail running alongside the track. This also furnishes the power for the electric lighting system of the train and for the motors which drive the compressors as well as supply the power for the suction pipes. The propulsion of the train is accomplisht as follows:

Electro-Magnets Pull Trains.

The entire track must be supplied with *power (tractive) electro-magnets* sunk or led into the rail which latter should be of some non-magnetic material such as brass or bronze. The power electro-magnets are placed about six inches or so apart and run thru the entire length of the track. Normally these electro-magnets are not energized as will be seen by referring to Fig. 6. When it is desired to start the train, the conductor moves his *magnet-control lever* inside of the car. This lever at the lower end has a contact shoe, which when sliding over the contacts as shown, energizes its particular electro-magnet. In Fig. 6 it will be seen that two of these contact shoes are used. This is done so as not to have any dead points, as otherwise the train could not start. In this figure it will be seen that the rear magnet contact shoe has just closed its contacts, and the rear hydraulic shoe comes now under the influence of the energized magnet. This will tend to pull the rear shoe over the energized magnet. But the instant the pull starts, the train moves along as well and the contact is broken.

The momentum of the train, however, is sufficient to carry it along, and by this time the forward contact shoe will have energized the electro-magnet at the extreme right, shown at Fig. 6. The forward hydraulic shoe now comes under the influence of the energized electro-magnet and the train is pulled forward again. This play is repeated constantly and of course very quickly; within a few seconds the train has obtained a terrific speed. This speed increase can be regulated simply by an arrangement which lifts the electric contact shoe away from the contact rail, and by this means the speed of the train can be

(*Continued on page* 338)

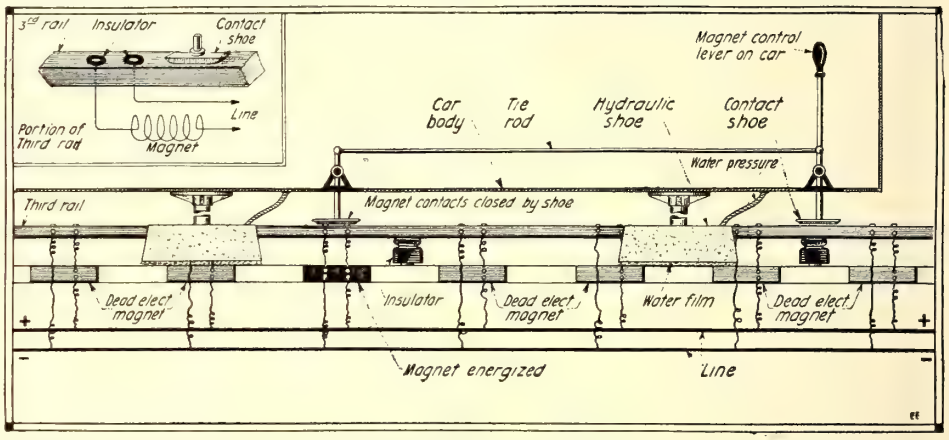


Fig. 6. Showing Mr. Gernsback's Arrangement for Propelling the Train by Means of Electro-Magnets. As the Train Moves One Electro-Magnet Is Energized at a Time, Which Exerts Its Traction on One of the Shoes, Thus Pulling the Train Along. Insert Shows Method of Making Contact with Power-Magnets.



Pres. Alonzo S. Thomas, Santa Fe Watch Co.

LISTEN MEN!

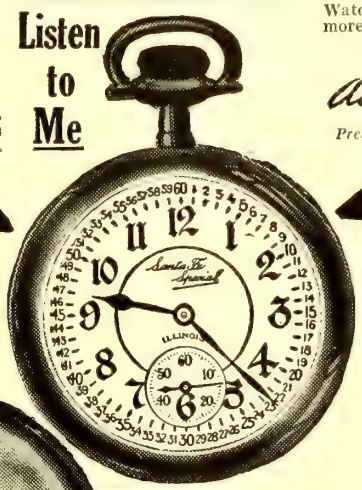
I HAVE determined to make 1919 the banner year in the Watch Sales of my Company. To do this I must distribute 5,000 "Santa Fe Specials" to 5,000 men in different communities this year. I must do this REGARDLESS OF PRICE OR PROFIT. Therefore, I have Cut the Price of these 5,000 Watches to ABSOLUTELY ROCK BOTTOM. This means that if you act at once you can get one of these Guaranteed Watches on this CUT-PROFIT PLAN, and pay for it in small monthly installments. MY OBJECT:—I know that every Watch sold on this Cut-Profit Plan will sell at least one more at the regular price, so I make this STARTLING, UNHEARD OF OFFER to men who will tell their friends of this remarkable Watch Value, if they find the Watches all and more than I claim for them.

Signed,

Alonzo S. Thomas

Pres. Santa Fe Watch Co.

Listen to Me



For the Man Who Acts Quickly



I SAY

Unless you already own a Watch that you are sure is just as good as they make them, this is a money-saving opportunity you positively cannot afford to miss. It is a Bargain such as you do not meet every day. For that reason you will have to act promptly or this allotment of 5,000 Watches may all be gone before you get yours. To make sure you get one, suppose you write me personally, care Santa Fe Watch Co., right NOW before you forget it. I want you to join my **"5,000 Watch Club"** and carry one of these beautiful Standard "Santa Fe Special" watches.

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Tropical Climates Make No Difference with the "Santa Fe Special" —Four Seconds in Five Months.

I feel it my duty to let you know how my "Santa Fe Special" is standing the tropics. It is the best watch I have ever carried, with no exception. It has not lost over four seconds since I received it, about six months ago, comparing it with Naval time. I wouldn't sell it for $50.00 and take chances of buying another make half as good.

B. H. GABBARD, Tutuila, Samoa.

I received the watch and think it is one of the finest pieces of work I have ever had. I am pleased very much with it.

A. RATHOFF,
U. S. S. Jupiter, Atlantic Squadron.

Likes It Better Than a Watch that Costs $85.00.

I find my watch to be the best timepiece I ever owned. I owned an $85 watch before, which was stolen from me, and to tell you the truth, I can see no difference, so far as keeping good time is concerned, between it and my "Santa Fe Special." The "Santa Fe Special" comes up to the mark of efficiency in every respect. I put her through some severe tests this winter, and she hasn't lost or gained a second yet, as far as I know. If anyone knows the value of a good timekeeper, it is we people here in the Coast Artillery Service. The watch is worth more than you ask for it in my estimation.

FRANOIR L. WALLOW,
Cpl. First Company, C. A. C.,
Fort McKinley, Maine.

A Watch to be Proud of.

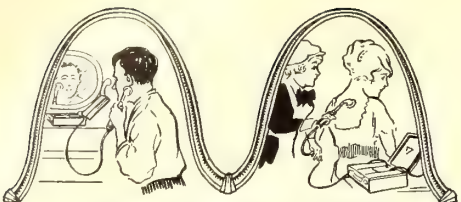
Received the "Santa Fe Special" watch today, and am more than pleased with it. I must say that the engraving is the best workmanship I ever saw, and I know I have a watch now that I can be proud of.

J. C. FAHNING, U. S. S. Washington.

Says It's Worth Sixty Dollars.

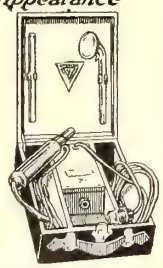
I want to say that the watch which you sent me is far above what I expected for the money. A friend of mine with a $50.00 Hamilton, almost new, offered me his watch and $10.00 for my "Santa Fe Special." A local jeweler tells me that my watch ought to have cost me $60.00.

T. E. DAVIS, Hurlburt, N. Mex.



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Send us One Dollar, for which we will mail one button prepaid under our money-back guarantee.

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To clear up any misunderstandings that might arise in connection with our offer of last month to pay for suggestions as to uses to which the Skinderviken Button may be put (see our July ad), we wish to announce the following rules:

1. **The offer extends only until August 30 and will close on that date.**
2. **The first prize of $10 will remain as announced. But instead of paying for all accepted suggestions in proportion to their value, we will pay $1 for every suggestion we accept.**
3. **By the words "best idea" we mean the most practical and the one having the most commercial value.**
4. **Anyone can compete whether you have purchased a button or not. Borrow your friend's—try it out—and send in your suggestion.**

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You can be quickly cured, if you

STAMMER

Send 10 cents coin or stamps for 70-page book on Stammering and Stuttering, "Its Cause and Cure." It tells how I cured myself after stammering for 20 years.

Benjamin N. Bogue, 757 Bogue Building, Indianapolis

Solving the Transportation Problem

By H. Gernsback

(*Continued from page* 336)

regulated to a nicety. In order to overcome the difficulty of starting the train with a bad jerk, it is in the power of the conductor to move the contact shoe forward or back, for a few inches. Thus the hydraulic shoes can be brought under the gradual pull of the electro-magnets by being a greater distance away from the energized magnets as shown in Fig. 6. For, the further the hydraulic shoe is away from the electro-magnet, the less the tractive effect will be.

In the writer's system, the train is stopt the same as by the French method, simply by withdrawing the water pressure. The hydraulic shoe then comes into contact with the track and the train stops almost immediately.

System Not Expensive

It will be argued that this magnet arrangement is a very expensive method, but this is not the case. These railroads are not intended for great distances, but will be mostly used in cities where first cost is of no consequence. Witness for instance the truly enormous cost of subway construction where the cost per mile frequently runs into millions of dollars. In the electro-magnet tractive scheme, like in all other railroads, it is only the first cost that counts, and it is very much doubted if the idea advanced here will make this railroad cost even one-quarter as much per mile as an ordinary elevated railway.

Another important plan which the writer advances, and which is shown impressively on our cover illustration, is that this railway is not intended to run thru the streets, *but rather over the house tops.* This is quite practical with such a railroad for the following reasons: Firstly, the single track will take away practically no light where it crosses over the streets. The track can be very light because the cars themselves are light. Also, there is but a single track, and consequently the structure that carries it can be exceedingly light. Secondly, there is no noise whatsoever. You cannot hear the coming or going of the gliding wheelless trains. They make absolutely no noise and *there is moreover no vibration.* The pillars supporting the track can be placed on two adjoining house walls as shown in our cover illustration; therefore no foundations are required. Stations can be located on the roof tops if desired, where they will not be as unsightly as at present. Elevators will take the passengers up and down.

Being that these railroads can be run safely at a speed double or triple the present day ones, it should be possible to provide a seat for everyone, no matter what the increase of the population will be. We cannot transport in the future many more people than our present day transportation facilities provide. Airplanes are out of the question for obvious reasons and so are airships for the reason that they cannot be operated quickly enough, and also they cannot carry enough passengers no matter what their size. Take for instance a New York Subway car when packed full will accommodate often as many as two hundred passengers, while a ten car train carries two thousand souls. From this it can be seen that neither the airplanes nor the airship can ever hope to compete with the wheelless trains as outlined above.

How to Develop Your Inventive Ability

By Jay G. Hobson

(*Continued from page* 330)

ters, steps in line, picks up his tray and proceeds to obtain his knife, fork, spoon and paper napkin. Directly ahead of him is a man with dirty face and hands who also fumbles around among the silverware probably touching our friend's knife and fork as well as his own. Our friend notices this and frowns, but sees nothing of importance about it other than the unsanitary annoyance for the time being.

At five-thirty P. M. we return to our friend's office and find him all prepared to drive home in his eight cylinder flyer; so feeling the need of fresh air we invite ourselves to go along. We haven't gone far until it begins to rain in torrents, but we don't bother as the top is up. Arriving home our friend turns into the driveway and as he nears the garage observes both doors tightly closed which means that he must get out into the wet to open them and that's no joke. He simply jumps out, gets wet and mutters things we can't record here.

Our friend's wife meets him at the door with the usual welcome and he feels greatly relieved amid the comforts of his cozy little home. Supper is served with our friend enjoying a good meal. During dessert his wife expresses her great desire to see a certain good play at the opera. Husband frowns inwardly for it is his preference to keep within the shelter of his home this wet evening. But observing his wife's earnest desire for additional amusement he strives to show some enthusiasm over the suggestion. They leave for the show about seven-thirty.

Arriving at the theater thirty minutes later they enter, taking their wraps with them to their seats. Past experience with the check room service has convinced them of this wisdom. The theater is crowded, every seat is occupied. There is no empty seat near them to lay their hot wraps on. Our friend must hold the collection upon his lap which doesn't add to his comfort. Along about the third act when the exciting part of the play makes everyone sit rigid with expectation, our friend is simply sweltering under the many woolen garments over his knees but he just sits there and suffers without one idea concerning the uncomfortable situation.

Returning home after the show our friend finds a telegram waiting for him. It is from headquarters instructing him to make a special business trip up-state to a city that he has never visited before. He prepares for the trip and leaves the following morning. But before leaving he acknowledges the company's wire and at the same time requests them to send him an expense check.

While en route to his destination he takes the hotel directory from the Pullman Library and selects what appears to be the best hotel in the city. He proceeds to this hotel and registers as usual. The following day the company's check arrives

(*Continued on page* 340)



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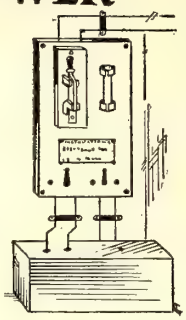
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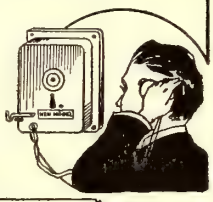


The wonder of the twentieth century inexpensive electric power, this is possible with our new electric power system, a new idea in electricity. With the aid of our instruction and chemicals you can make and install a power battery as shown in the illustration, absolutely safe and simple. **Stop wasting money** on buying batteries, install the new electric power battery. It is not an acid or dry battery, it is a new combination of wet and dry elements which produce electricity. These batteries are **powerful and cheap** to operate, they produce a direct current of more than 10 volts, cheaper than any other form of battery. They are wonderful for operating all kinds of experimental work, for lighting purposes and for many other uses where electric current is needed. Any user of batteries knows the value of an inexpensive high voltage electric current. These batteries should be in every home, office, shop and factory, no matter how small a current is needed; to reduce or raise the current of the battery, simply move the volt regulator on the switch board. The beauty of these power batteries is, that they do not evaporate or lose current when not in use, therefore, with every day use recharging the battery is necessary about every month or so, it can be recharged at home in a few minutes, **no electricity or machinery is required** for this operation, recharging material can usually be obtained around your home or can be bought for a few cents. These batteries when charged weigh about 34 pounds and if properly installed **will last for years.** Each battery making outfit consists of a completely wired switch board, battery connectors, wire, instructions and plan for making, installing and recharging the battery and complete chemicals. **Special introductory price, $1.00, prepaid.** Outside the U. S., $1.25.

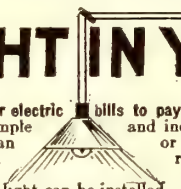
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The latest electric light, no batteries to buy or electric bills to pay. Anyone can install and maintain this midget electric light. Safe, simple and inexpensive. No more smoke and smell, no wicks or oil, no chimneys to clean or break, just as safe in the barn, garage and clothes closet as in any open room, always ready for use, day or night. A touch on the switch and you instantly have a **bright electric light.** No matter where you live this light can be installed. It is not affected by heat or cold. Many homes have installed this electric light in their halls, closets, pantries, barns, sheds, cellars, garages, etc., with good results. It is an extremely useful light which no household should be without. The reason for this bright electric light is that the lighting bulb is fitted with a drawn Tungsten filament wire which is much more efficient and durable, besides giving a **300% increase in light** as compared with the ordinary carbon lamp. The power system furnished with this lighting outfit is somewhat similar to the electric power battery described above. Each electric light outfit includes the following: Complete directions and plans, copper wire, insulated wire holders, knife switch, drop light fixture with socket, friction tape, battery protector, maroon shade, national mazda globe. Our dry battery compound, which assists in renewing and supplying the current and our current renewing system with which you can **renew the current at home without expense.** With every day use one recharge usually lasts two to three weeks. This electric lighting outfit is undoubtedly the most practical and durable electric light of low cost and long service ever devised. **Special price to introduce these electric lighting outfits $1.00, prepaid.** Outside the U. S. $1.25.



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BUT YOUR NOSE?

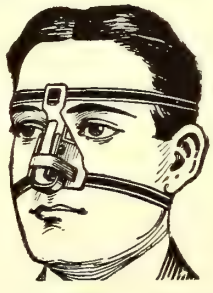




BEFORE



AFTER



IN THIS DAY AND AGE attention to your appearance is an absolute necessity if you expect to make the most out of life. Not only should you wish to appear as attractive as possible, for your own self-satisfaction, which is alone well worth your efforts, but you will find the world in general judging you greatly, if not wholly, by your *"looks,"* therefore it pays to "look your best" at all times.

Permit no one to see you looking otherwise; it will injure your welfare! Upon the impression you constantly make rests the failure or success of your life. Which is to be your ultimate destiny? My new *Nose-Shaper,* "TRADOS" (Model 24) corrects now ill-shaped noses without operation, quickly, safely and permanently. Is pleasant and does not interfere with one's daily occupation, being worn at night.

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HEADACHES FLU NEURALGIA WOMEN'S ACHES

ASK FOR A-K TABLETS

How to Develop Your Inventive Ability

By Jay G. Hobson

(*Continued from page* 338)

as requested. Being a total stranger in the city he asks the hotel manager to kindly cash said check, explaining who he is and the integrity of his superiors.

The manager very diplomatically explains that he has often heard of his fine company and would be pleased to accommodate him if he will just have some one identify him so that he can be sure our friend is the proper person. For it is possible, from the manager's point of view, that our friend could have found the check—that had happened before! Of course, the hotel does not mean to doubt our friend's honesty for one moment!

Turning around he rams the check deep into his pocket with a vow, to himself, that he will get that check cashed by the first bank he comes to.

Walking slowly down the main business street he runs into a friendly looking bank and he decides to try his luck in there. Approaching the cashier's window deliberately he shoves the check for a hundred toward the cashier with the remark that he would appreciate the favor. The cashier excuses himself for a minute and retires to one of the financial reference books for information about the company.

Promptly returning to his money cage the cashier politely informs our friend that he would be pleased to favor him if he will obtain additional identifications. Our friend is almost desperate by this time and requests the cashier to take him to the president of the bank. The president is courteous but assumes the same stand about further identification as the others. Our friend's spirits drop very low from this last retort. But glancing down on the expensive mahogany desk of the president he accidentally observed the national emblem of an organization to which both he and the president belong and quickly makes this known. The president's face softened and after a few hand shakes the cashier is summoned with instructions to honor our friend's check which was accomplished among expressions of appreciation.

Now shifting our minds into reverse we will return to our friend's first experience in the cafeteria and see what, if any, improvement was suggested by things that transpired. This simple little test of observation will help to show how far your inventive abilities have been developed. The more observing mind would have received an idea of value after seeing that man with dirty hands mussing over the silverware. A mental picture of a sanitary dispensing machine for knives, forks and spoons would have appeared. A machine with levers to operate the dispensing of the silverware so that only one pair of hands would touch the silverware to be used by them. This would be an improvement of worth.

The incident at the garage should have suggested a device to automatically open the doors as soon as the automobile came near enough to put it into motion. Possibly a small electric motor attached to the doors with a bumper switch to come into contact with the front tires of the auto. After the small motor had propelled the doors sufficiently to allow the auto to enter, there would be a cut-off switch on the end of the door that would stop the motor.

Then at the theater our friend's discomfort should have suggested an improvement in seats. One with a clothes compartment in the back that would open when the seat was bent forward and close and disappear thru the floor when the seat was pushed backward.

Being check-bound away from home in a strange city without anyone to identify you is no joke, for I speak from experience.

The trained observer's mind would have pictured a device in the form of a small pocket case with his picture in one side and across the picture would be signed his official signature. In the other side would be secured a cancelled company's check bearing his signature, the stamps of the different banks and clearing houses it has past thru on its way back to the company; and on its face it is marked PAID. This old check would be compared to the new one. The signature on the picture and on the old check and on the hotel register would be compared together, which would be all the identity necessary to obtain the money needed.

A few months ago I was visiting friends in the evening. They owned a popular phonograph that they played for hours each evening and fully enjoyed every moment of it. This particular evening that I called they refrained from playing even as much as one short record, and I could not quite understand the unusual situation. Being by nature somewhat nosey about unusual conditions I inquired of the cause for their abstinence. The husband frankly confest that he had neglected to stop by the music store for a very important accessory necessary for proper playing of their instrument. This explained, I exprest my regret but immediately an idea flashed thru my mind that there was a great need for a small device to make this important accessory.

For weeks I kept turning that spark of an idea over in my mind trying to picture a machine that would be satisfactory for the purpose desired. Finally I pictured it in detail and soon constructed a working model that proved efficient. Then I applied for broad patents both in the U. S. A. and foreign countries. It is about ready for the market now, but in justice to the manufacturers it isn't possible to explain definitely all about the construction and origination until ready for public announcement. However in a later article I shall show several drawings and give a complete explanation of the invention.

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Bomb Expert Eagan

(*Continued from page 296*)

use among the Italians. These bombs were made by Italians who had been employed in fireworks factories in Italy and in America. The cause for the placing of the bombs was feuds among the Italians. A section of the city became known as the "bomb centre."

While walking in a section of the east-side on a fair May day, in the neighborhood of East 11th and 12th Streets, I was stopped by a policeman from the East 5th Street Police Station House. "I was just up to the station house and sent a call for you," he said. "Why?" I queried. He answered, "We have located a big package down in 11th Street, which looks like a bomb, and the people in the house have left their apartments, fearing it will explode."

Upon arriving, I ordered all the children away from the place, and then started to operate upon the bundle. To my great surprise I came upon *two fulminate of mercury caps attached to two fuses, and twelve sticks of* 40 *per cent. dynamite put up in two separate packages!* To each six sticks of dynamite, a fulminate cap was attached. The bundle was surrounded on all sides with heavy pieces of iron, bolts and small pieces of slugs. It was then covered with burlap, which in turn was covered with newspaper and bound with

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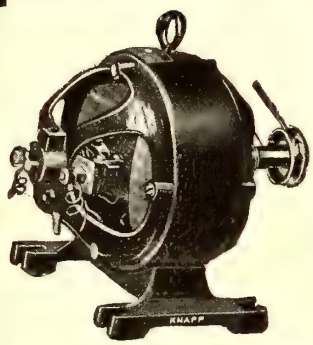
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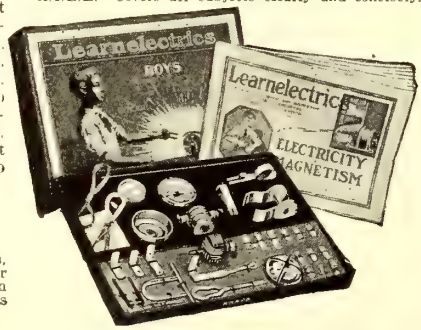
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a heavy wire. In all, the bomb weighed about thirty pounds.

With the development and common knowledge of explosives of the nitro-cellulose group, chlorat and nitrat mixtures disappeared and the number of composite nitro-cellulose and nitro-glycerin bombs has increased and many ingenious combinations of the above mentioned methods of ignition have been devised, showing that much keener minds and men well trained in chemistry and the use of explosives have made these later type bombs.

Speaking of Large Bombs.

The first bomb of this type, the "Cunard Bomb," discovered in 1902, was the largest bomb I ever handled. This type was very rare then, but it is now "the usual garden variety." The Cunard bomb was of the nitro-glycerin class mechanically detonated. The bomb consisted of 100 lbs. of 60 per cent, dynamite, placed in two boxes, each containing 50 pounds. These boxes were set inside a larger box within which was set a *timing device* which would set off the fulminating caps and detonate the explosives. The timing device was set to explode when the ship had proceeded two hundred miles from the coast. The man who made the bomb was discovered in a tenement and was found to be insane.

The O. K. Bottling Works Bomb was of the nitro-cellulose type, mechanically and electrically operated, as was evident from the circumstances, weight and size of container, the express charge and the debris. On the morning of December 12th, 1913, a small pasteboard box was delivered by the Adams Express Company and was received by the stenographer, Miss Anna Amusewitz, who laid it aside until she had opened the mail. The bookkeeper who was in the office when the bomb exploded and who survived his injuries, stated that Miss Amusewitz cut the string, thereupon an explosion occurred. The office was wrecked, Miss Amusewitz was hurled into the corner and died within ten minutes. The perpetrator was never discovered.

The Herrara Bomb was of the nitro-glycerin group, chemically ignited. The circumstances were similar to those of the O. K. Bottling Works Bomb, which killed Miss Amusewitz. Mrs. Herrara was killed outright and her husband was totally blinded.

The Taylor Bomb, the second manufactured by Klotz, was of the same type and made by the same person. This bomb killed Mrs. Taylor under the same attendant circumstances as noted above.

My own fingers were blown off by a bomb of the same description and manufactured by the same man who sent it to a prominent man in New York City, (Judge Rosalsky), related Inspector Eagan.

Shortly after the third bomb, Herman Klotz, a draftsman and former employee of the City of New York, was mortally injured by a bomb he was making. Klotz confest to these outrages before his death in the Fordham Hospital.

Since the beginning of the European War, bombs have been of an improved type and are modelled along the lines of munitions used by the European Belligerents.

The Fay Bomb manufactured by Lieutenant Commander Fay, of the German Imperial Navy, was of the alkaline metallic nitrat and chlorat type, mechanically detonated. The bomb case was of steel plates welded together by 100 rivets, and a riveted cover with a water-tight gasket. The interior was filled with a chlorat, nitrat, sulfur and antimony mixture. There were two detonating devices, one within the steel case and the other one the exterior. The exterior mechanism was attached to the propeller shaft of the steamship and the rotation of the shaft tightened the spring on the interior me-

chanism so that when the spring automatically released, it tript the firing pin which exploded the percussion cap, thus detonating the chemical mixture.

The Recent "Gimbel Bros." Bomb.

The late nation-wide Post-Office Bombs were composite bombs of the nitro-glycerin, alkalin, metallic, chlorat type, manually, mechanically and chemically ignited, and were the work of a trained, experienced expert, who knew chemistry, explosives and the psychology of his victims. These nineteen bombs were similar in composition, but not in operation, to the bomb which killed Governor Steunenberg of Idaho. See photo of bomb.

The latest bomb outrages known as the "Anarchist Fighter's Bombs" were of the *high explosive* type. The details cannot be divulged at this time, but the destruction surrounding the residences where the bombs were set off tells the tale all too well.

There are many foolish bomb scares—from diamond studded wrist watches, sent without notice, to one of the Four Hundred's latest debutantes, to a piece of copper ore sent to a mining engineer or a new kind of cheese sent to a prominent patron of the Waldorf-Astoria, who is a connoisseur of famous cheeses, or it may

***INSPECTOR OWEN EAGAN** holds perhaps one of the most unique positions in the world. Mr. Eagan is the official bomb opener in New York City, where during the last decade more bomb outrages have been perpetrated than in any other community in the world. Mr. Eagan has consented to publish some of his experiences in the columns of the ELECTRICAL EXPERIMENTER, and we feel certain that every reader will be intensely interested in Mr. Eagan's experiences. Inspector Eagan has opened thousands of bombs in his past career, only once being injured, when he lost a finger of his left hand due to the premature explosion of a bomb.*

be a box of coals containing a ticking alarm clock which has been sent to the Italian barber in the corner barber shop. These jokes cause much worry and excitement and should never be perpetrated. In one case I found a woman in a serious condition, due to the receipt by messenger of a package the inner wrapper of which was decorated by skull and bones and a warning of death. Arriving there and removing this cover, I extracted a bottle of plain "Pluto Water"!

The latest bombs were not the only ones sent to prominent persons.

Carnegie Mansion at Ninety-first Street and 5th Avenue was the scene of a bomb discovery. Another bomb was discovered outside the offices of the Italian Consul at 212 Lafayette Street. These were of the nitro-glycerin class, manually ignited by the application of a match to the fuse.

The late Honorable Mayor Gaynor was the recipient of a similar bomb which was discovered outside his office window with three burnt matches, and a piece of Chinese lighting punk which showed evidence of having been ignited.

The wealthy and prominent persons of our city are not the only victims to have these unreliable and unexpected packages sent to them. Two bombs were placed in churches in this city. Two bombs were placed in moving picture houses on the East Side. One bomb tore away the stairway and gallery. Even tenements suffer as much as mansions and private residences.

Bomb-Making An Unhealthy Vocation.

The "bomb maker" is not particular where he manufactures his infernal ma-

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It is now made easy by a new system, and interesting.

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A business principle applied to the home—that's what the Budget System is.

It shows you in advance the minimum amount you can save.

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That's getting ahead.

You can do the same.

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Take that last $50.00 you spent.

What have you got to show for it?

How much of it can you account for?

Can't you account for *all* of it?

No?

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Just such methods keep millions poor.

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I kept tab on house expense for 6 years, when I told my folks it averaged $40.00 a week they just laughed at me. We are 10 in the family. Taking the book home I told one of my daughters to put everything down from January 1st to date, when we closed the month of January it amounted to $174.79. It surprised them all. I am sure I can save what I paid for the book in a week; don't need to wait two years as it is an eye-opener to the folks at home. Be sure and send me another book in December, 1920.
R. K., Odebolt, Ia.

I am very much pleased with same. Enclosed please find money order to pay for two copies of this great book, kindly send me another copy by parcel post as I desire to turn same over to a close friend.
D. O. R., Frankfort, Ky.

Will you please accept this check and forward one copy of this book? I have seen a copy of this book and it is just the article I've been looking for for the past year or so.
W. L. F., Alexandria, La.

I gave the book to a friend of mine for a wedding present and if I am not mistaken it will prove the most valuable present I could have given him. Kindly send me another of these books for my own use.
W. G. V., Kansas City, Mo.

Attached herewith you will find check in payment of your account against me, and for the balance request that you mail your Household Money Saver to the following four parties.
A. E. K., Cleveland, O.

KRIEBEL & CO., 643 Home Insurance Bldg., Chicago.

You may send me Mr. Palmer's book, prepaid. Within five days after receiving it I will send you $3, or mail the book back to you.

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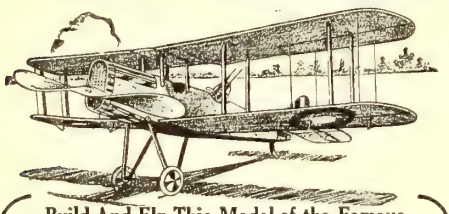
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chine. A cellar in an East Side tenement, the laboratory of a prominent hospital, an abandoned shack in the marshy sections of the suburbs, the servant's room of the mansion, a suite in the most modern apartment house, perhaps in the next apartment wherever you may be living. *Bombs, strange as it may seem, have been made by many types of men, in all degrees of education, wealth and state of life.*

In the bomb factory in the rear of a quiet and prosperous barber shop, the proprietor was killed by an explosion and upon the examination of his body, a little carelessness in placing a too highly reactive chemical in his pocket was found to have caused the end of his career. This rear room contained enough chemicals to stock a small drug store, sufficient dynamite to clear Long Island of tree stumps and enough modern fire arms and ammunition to make envious a "would-be" Jesse James.

The making or setting of bombs is not a safe and lucrative occupation or hobby, as many of these men meet destruction by their own bombs. The greatest death toll paid by bomb makers occurred in the top floor of a six-story apartment house on Lexington Avenue, between 102nd and 103rd Street. Three anarchists, Hansen, Carron and Berg were killed. A brother of Louis Berger, who used a fictitious name "Murphy," escaped death with severe injuries. The force of the explosion destroyed the three upper stories of this building.

During the war I was kept busy with the routine work of the Fire Department cooperating with the Police, Federal authorities, Defense authorities and in the instruction of agents who were assigned to the investigation of various enemy activities. The signing of the armistice brought its train of trouble with shells, rifle and hand grenades, fuses and every imaginable war relic which contained explosives. Many fingers were torn off by grenades exploding in the hands of children."

Mr. Eagan Only "Official Bomb Opener."

At this point we ventured the question: "How many men are engaged in this kind of work, Mr. Eagan?"

Mr. Eagan's answer is illuminating: "The only official bomb opener other than my own unique position, was the Imperial Chief Inspector of the late Czar of Russia, who held an exalted place in court circles and received a fabulous salary. I am one of the hard working, loyal American citizens in the Civil Service of this City, accepting an humble salary and have secured my position by long and trying experience, constant study and research."

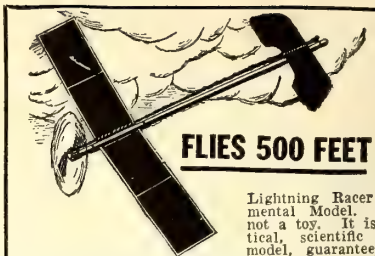
To the question: "How did you engage in this mysterious and dangerous work?" Eagan's answer is to be found in the indomitable spirit of his race.

"As a boy, my Mother would relate to me the mysteries of Cleena, the Fairy Queen of County Cork, Ireland, whose invisible palace was on my great grandfather's estate near Fermoy. The spirit of delving into the occult and mysterious was early developed and not lacking the necessary nerve and grit, I went to it."

The telephone bell rang. "Another bomb," laconically said the inspector.

"Here's my card. Ring, if you get a package," were his last words as he dived into the express elevator. I looked at his card. This is what it says:

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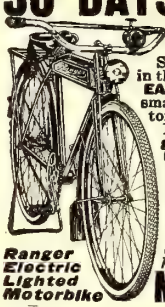
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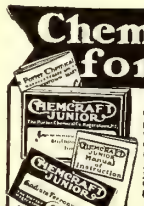
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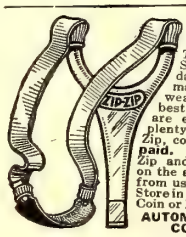
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The U. S. super-dreadnaught Tennessee is a sister ship of the California, now being built at the navy yard, Mare Island, Cal., and which is to be launched in the fall. The Tennessee is 624 feet long, 97 feet 5¾ inches in width, and has a draft of 30 feet 6 inches. She displaces 32,600 tons and has a speed of 21 knots. She has eight water tube boilers and a fuel capacity of 1,900 tons. Her armament will consist of twelve 14-inch guns, fourteen 5-inch guns, four 6-pounders, four anti-aircraft guns, and two torpedo tubes. She will be manned by a crew of 58 officers and 1,024 men. She will burn oil exclusively and will be equipt with electric drive.

Man's Greatest Curse--Infected Teeth

(*Continued from page* 301)

"Tooth infection is undoubtedly transmitted from person to person in the same family, from parents to children, by means of kissing, the use of common drinking and eating utensils, and many other ways. So, if one has infected teeth, he is not only dangerous to himself, *but may transmit this infection to other members of his family, especially his children,* and produce serious conditions which are difficult to explain. One is appalled at the condition of the first teeth of children, many of whom have to have their first teeth filled. Often the second teeth become infected from the first set and the child carries thru life the result of the neglect of the teeth, on the one hand, and the transmission of the parent's infection, in addition.

"Consequently, we feel justified in advocating radical measures in eliminating the infection from children as well as adults, and that means extracting all infected teeth, whether in children or adults, as soon as there is evidence of infection.

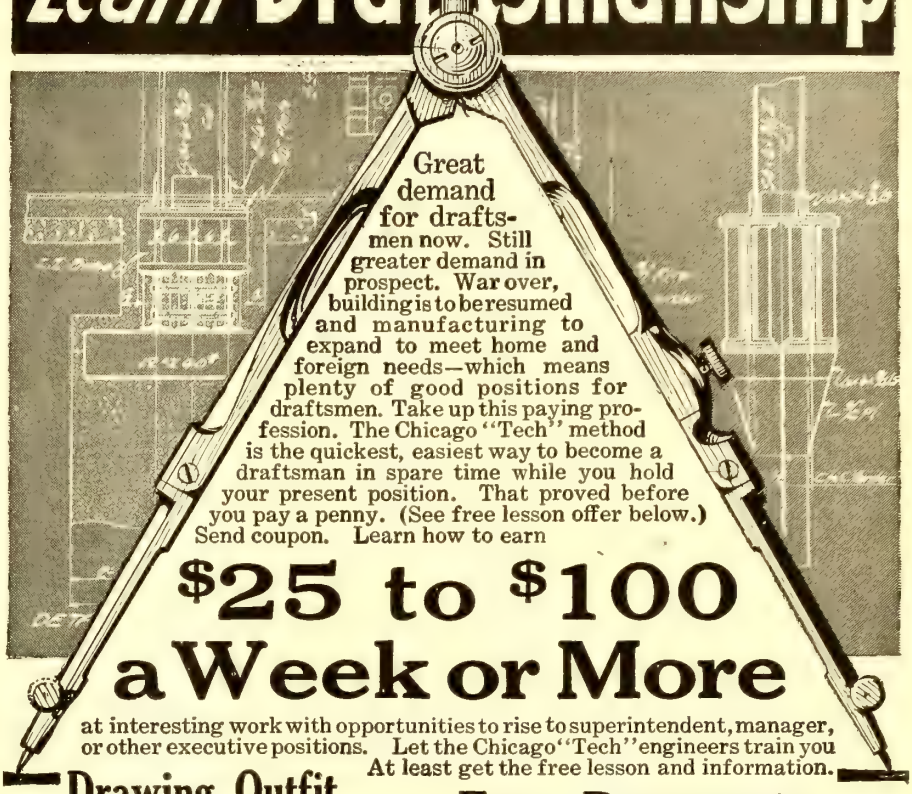
Conditions Resulting from Infected Teeth.

"As we give further attention to the subject of chronic infection of the teeth, we are finding more and more conditions resulting therefrom. At first, *the relation of infected teeth to rheumatism* was demonstrated by Hastings in 1914. This was a very important discovery, for this disease had baffled physicians who could find no definite cause for it and many fanciful theories were put forward to explain the cause. *Not only can rheumatism be prevented by intelligent care of the teeth,* as outlined above, *but in many cases it can be cured by the simple method of extracting infected teeth.* Possibly the most common ailment of people in general today is summed up in the general term 'stomach trouble,' and often this condition resists all attempts at eradication by the ordinary methods and may persist for years, causing the patient to drag out a miserable existence. In the majority of cases, infected teeth are at the root of the trouble, and if the condition has not progrest too far, extraction of those teeth, so fondly cherished for years, may clear up the chronic stomach trouble.

"We have proven conclusively that the infection of the teeth, after years, may spread to other organs of the body and cause disease in these remote regions, which disease has apparently no relation to the teeth, but, nevertheless, the infected teeth are directly responsible for the condition. The bacteria which grow and propagate

(*Continued on page* 347)

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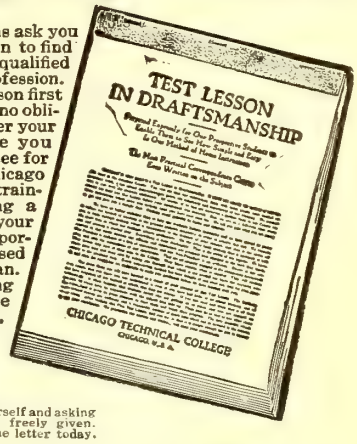
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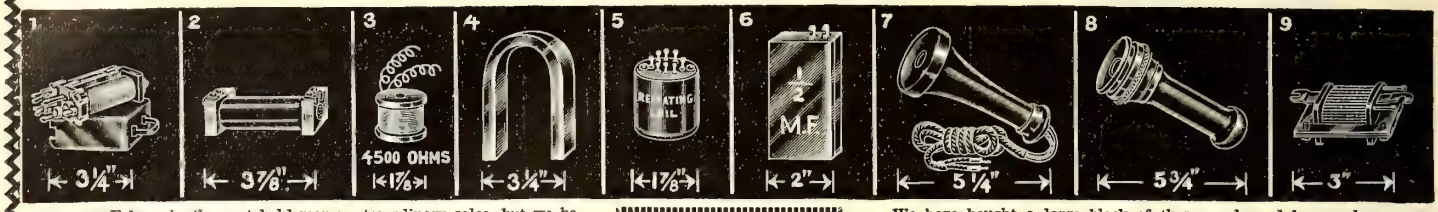
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WE have in the past held many extraordinary sales, but we believe that the present one eclipses all by the wonderful values we are offering. The goods which we offer on this page are all standard telephone apparatus. Every piece we are offering is equipment that for one reason or another was discontinued by the telephone companies. If you wanted to buy any of the pieces which we offer herewith, from the manufacturers, the price would at least be ten times what we are asking for it. You can readily ascertain this for yourself by looking over our wonderful prices.

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No. 1 TELEPHONE RELAY, 1500 ohms—has two silver-contact springs and is very sensitive. Can be used wherever a sensitive relay is needed. It is adjustable and can be used for a variety of purposes.
No. 1 Relay—shipping weight, 2 lbs. Price..... **$1.50**

NO. 2 STANDARD TELEPHONE Induction Coil, primary 1 ohm, secondary 55 ohms. Used wherever you need a good induction coil. Has primary and secondary and iron wire core; fibre heads.
No. 2 Induction Coil as described—shipping weight, 2 lbs. Price..... **$0.50**

NO. 3 STANDARD RESISTANCE wound with German silver wire—4,500 ohms, can be used as a choke or plain resistance, and has many other uses that readily suggest themselves to the experimenter.
No. 3 Standard Resistance as described—shipping weight, 4 oz. Price..... **$0.40**

NO. 4 HORSESHOE MAGNET, size 3¼ inches wide x 5 inches high. Will lift about 1 lb. Quality such as used on magnetos, which means the best.
No. 4 Horseshoe Magnet — shipping weight, 2 lbs. Price..... **$0.30**

NO. 5 REPEATING COIL (Transformer). This is a standard small repeating coil and is used by all telephone companies. It has 4 different windings and eight contacts. Entirely enclosed in iron. The resistance being respectively 72 and 120 ohms, and 90 and 100 ohms. Diagram is furnished. Can be used for wireless, for boosting signals, etc.
No. 5 Repeating Coil—shipping weight, 2 lbs. Price..... **$0.50**

NO. 6 ½ M.F. CONDENSER. This is a standard telephone condenser and has ½ microfarads. Condenser comes in neat metal casing. This condenser is used in connection with spark coils to absorb the vibrator spark. Invaluable for test buzzers to absorb spark and make the sound of buzzer more steady. Is also used by every experimenter in connection with wireless where a fixed capacity is needed. Several of these condensers should be in every experimenter's laboratory.
No. 6 Condenser, ½ M.F.—shipping weight, 1 lb. Price..... **$0.50**

NO. 7 DOUBLE POLE BELL TELEPHONE RECEIVER—hard rubber casing with 4 ft. cord and tips. Standard 75 ohms—very powerful magnets. This receiver can be used in connection with any ordinary telephone work, and you will even find it sensitive enough for short distance wireless work.
No. 7 Bell Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.80**

NO. 8 STANDARD TELEPHONE RECEIVER with Metal Head. This receiver is made by Stromberg Carlson Co., with genuine hard rubber handle and ear cap. A very good fool-proof as well as sensitive receiver that cannot be put out of order if you try. Used for the same purpose as No. 7 Telephone Receiver.
No. 8 Standard Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.75**

No. 9 IMPEDANCE COIL (Close Core Transformer). This is a very fine little transformer and is used extensively in connection with telephone work. It is in reality an A.C. transformer for which you would pay $5.00 if you had it made to order. The primary has 0.15 ohms, secondary 2000 ohms. It can be used for a variety of purposes that will suggest themselves to every experimenter. Can be used successfully to boost wireless signals. Also in connection with audions, etc. An A-1 instrument. Size 3 x 3 inches.
No. 9 Impedance Coil—shipping weight, 2 lbs. Price..... **$0.65**



NO. 10 MICROPHONE AND BRACKET. An A-1 sensitive microphone of the carbon grain type. Has hard rubber mouthpiece and enamel steel bracket, the instrument being 10 inches long. This microphone, in connection with our No. 7 or 8 Receiver, will constitute a complete telephone outfit, good to speak 50 miles or more, at a remarkably low price.
No. 10 Microphone and Bracket—shipping weight, 5 lbs. Price..... **$1.00**

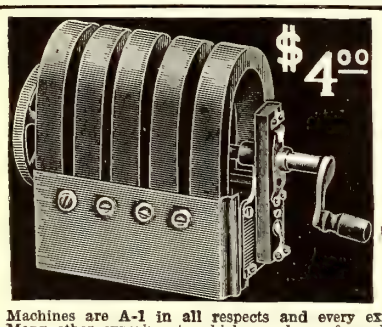
NO. 11 REPEATING COIL (Transformer). A standard repeating coil used for telephonic work. The coil windings are encased in an iron tube 2¼ inches in diameter. There are eight terminals for the four windings to connect to and the instrument is invaluable in connection with radio work to boost up signals, audion work, etc. Many interesting uses will be found for this coil. Resistances are: 100, 120, 145, 175 ohms.
No. 11 Repeating Coil—shipping weight, 8 lbs. Price..... **$2.00**

NO. 12 POLARIZED RINGER with Bells. The resistance of the two coils is 1250 ohms each. The armature is perfectly adjustable. Bell will work on any magneto. We also furnish blue print with ringer showing how *a first class polarized relay* can be made by anyone using only a few pieces of metal and screws.
No. 12 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.50**

NO. 13 POLARIZED RINGER with Bells. This is the same kind of ringer as the No. 12, except that it is not adjustable and that the resistance is less. First class in all respects. Blue print furnished with this to *make polarized relay* same as with No. 12. Solenoids on this ringer are worth more than the price we ask for the entire ringer, and do not forget a powerful magnet that goes with it.
No. 13 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.00**

NO. 14 HARMONIC RINGER. This ringer is also polarized and has a powerful magnet. It works on 66.6 cycles and any magneto will operate it if run at a certain speed. A very finely built instrument. Resistance of each coil being 200 ohms. Can be converted into a polarized relay by substituting a very fine leaf spring instead of the heavy one furnished. A most interesting instrument with which to experiment.
No. 14 Harmonic Ringer — shipping weight, 4 lbs. Price..... **$1.60**

NO. 15 RINGER without Bells—630 ohms. This also is a polarized ringer and has an adjustable armature. The adjustment is done by means of the top screw. A beautiful little instrument. With this instrument, too, we furnish a blue print showing how a *polarized relay can be built.* You should have several of these beautiful little instruments. They are worth their weight in gold; the powerful magnet alone being worth more than the price we ask for the entire instrument.
No. 15 Ringer—shipping weight, 2 lbs. Price..... **$0.80**



No. 55 5-bar magneto, 110 Volt A. C. Generator

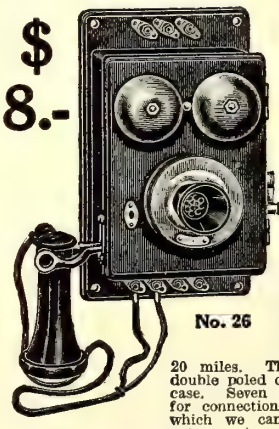
This is one of the most powerful magnetos ever built, when manufacturers could afford to put good stuff into them; equipt with transmission, make and break, etc. Transmission wheels are all brass, crank handle furnished. This magneto, as well as the other ones listed below, will light a 110-volt lamp merely by turning the crank handle slowly. While this magneto gives alternating current only, it can be rewound so it will light up a number of four, six and 10-volt lamps, all depending upon the thickness of the wire you wind on the armature. As we furnish these magnetos, they will give a powerful alternating current and you will not be able to stand the current when grasping hold of the terminals. This makes an ideal shocking machine. All our generators can be transformed into a direct current machine by equipping it with a home-made commutator. Machines are A-1 in all respects and every experimenter should have one of them in his shop. Many other experiments which can be performed with this machine will readily suggest themselves to any experimenter. The magnets furnished with these generators are very powerful, each one being able to lift one pound easily.

NO. 55 5-BAR MAGNETO GENERATOR as described—shipping weight, 25 lbs. Price..... **$4.00**

NO. 33 3-BAR GENERATOR, same as described above except that it has only 3 bars, and is somewhat smaller.
No. 33 3-bar Generator—shipping weight, 10 lbs. Price..... **$2.00**

NO. 44 4-BAR GENERATOR, same as No. 55 except that it has 4 bars, and is somewhat smaller.
No. 44 4-bar Generator—shipping weight, 15 lbs. Price..... **$3.00**

NO. 66 6-BAR GENERATOR, same as No. 55 except that it has one more magnet and the armature is somewhat larger and more powerful. This is the biggest type made and is extremely powerful.
No. 66 6-bar Generator—shipping weight, 30 lbs. Price..... **$4.50**



Complete Wall Set

This is a complete commercial telephone station. The cabinet is of polished oak, piano finish, within which is contained the powerful magneto, the 300 Ohm polarized ringer, and induction coil. The magneto is exceptionally efficient, being of the two bar type with brass gear transmission. The extra sensitive microphone, mouthpiece and two gongs are mounted on the front of the cabinet, giving the entire instrument that desirable appearance of compactness and efficiency. Guaranteed to work over 20 miles. The telephone receiver is a double poled one, and has a hard rubber case. Seven binding posts are provided for connections. The instrument is one which we can offer with pride to our patrons at a ridiculously low price. It is unobtainable anywhere else at less than $15.00 and is an instrument unequaled in value for the price we ask. Size over all 11" x 10" x 8". Shipping weight, 15 lbs.
No. 26 Long Distance Telephone Set..... $8.00

CARBON GRAIN TRANSMITTER



A special design of transmitter for long distance work. Is used on wireless telephone sets where a steady current of ¾ to 1 ampere is constantly required. Sizes over all 3¼ x 2½ inches. Shipping weight, 3 lbs. **No. 6080 Carbon Grain Transmitter as described..... $1.00**

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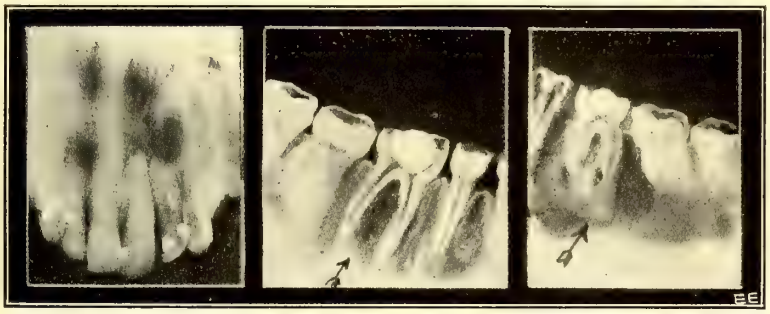
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Man's Greatest Curse--Infected Teeth

(*Continued from page* 345)

at the roots of infected teeth must have an outlet, especially if the tooth has been crowned and all means of drainage from the upper part of the tooth is thereby cut off. *Then the bacteria filter thru the bone in which the teeth are embedded, which bone is microscopically porous, and from the organisms or bacteria gain access to the lymphatic system and migrate to other organs and set up a secondary focus of infection.* When this condition occurs, it is easy to understand that the mere extraction of the offending tooth will not clear up the condition but the infection must then be eradicated from this new focus.

"We have various methods of locating these secondary *foci* of infection. If the tonsils are infected as a result of infected teeth, *the teeth should first be extracted and then the tonsils removed.* If the stomach is infected, an examination of the contents will show the presence of this infection and it can be treated by means of vaccines, but always *after* the infected teeth are extracted. In the more serious conditions the *intestinal tract* may be the seat of the *secondary infection* and, by means of the X-ray certain things relating to the function of the intestines may be found and intelligent surgical aid may have to be invoked.



Three X-Ray Views of Infected Teeth. The Two Right-hand Radiographs Show Abscesses Indicated by Arrows: The Dark Patches In the Left-hand Radiograph Indicate Abscesses. This Photo Was Taken Down Thru the Top of the Mouth, the Patient Holding the Plate in the Mouth Between the Teeth.

"There can be no doubt that many unexplained diseases have their origin in infected teeth. Thus Barker, at the Johns Hopkins Hospital, has shown that many cases of *pernicious anemia* have recovered when the infected teeth are extracted. It has also been shown that *serious heart conditions, diseases of the kidneys*—commonly known as 'Bright's Disease'—*diseases of the gall bladder* and many other diseases may be the result, directly or indirectly, *of a focus of infection originating in the teeth.*

Nervous and Mental Diseases Due to Infection

"Finally, the most serious result of infected teeth is to be found in the relation of this infection to *nervous and mental conditions.* We have been for years groping in the dark, trying to find a cause for these unexplainable conditions. We have considered mental diseases as something apart from general diseases where such things as worry, grief, fear, overwork, and many other elements are usually given as the cause of disease of the mind. Since we have found at the State Hospital at Trenton *that many of the patients suffering from mental disease had also very serious chronic infections of the teeth, tonsils, and gastro-intestinal tract,* and that by **eliminating these infections our patients recovered,** we are justified in concluding *that these chronic infections play a very important role in the causation of the mental condition.* Of course, other factors, such as we have mentioned, have a profound effect in lowering the vitality and allowing a latent infection to become active.

"By recognizing the fact that mental diseases may be the result of infection and the toxemia or poisoning due to this infection, we have been able to restore many patients, who with our former methods of treatment, became chronic patients and remained in the hospital until the time of their death. *Thus we have been able to discharge 87 per cent. of the patients admitted to the hospital in the last nine months, whereas for a period of ten years, the proportion of discharges to admissions was only 43 per cent.* In other words, we have *doubled* the number of patients who leave the hospital as a direct result of our researches.

"As a prevention of mental diseases, then, it would seem that the proper care of the teeth is of the utmost importance, and we would emphasize the fact that the proper care is entirely different from what the usual dental examination reveals, *and that only by refusing to have devitalized teeth* (teeth in which the nerve has been destroyed), *crowned, or otherwise preserved, and insisting upon having these teeth extracted, can we hope for better teeth and prevent infection, which later will have serious consequences.* This is a matter which can be controlled by the individual and it is the public in general who can bring about a better state of affairs by insisting upon good dentistry, in the sense we have explained, and by not allowing the kind of dental work which preserves the teeth to the detriment of the patient's health. Such results as we are trying to obtain can only be brought about by educating the public in these matters, as well as the medical and dental profession. For this reason we believe that the widest publicity should be given to these facts and their importance emphasized both from the standpoint of prevention and cure.

CONCLUSIONS.

"We feel justified in summing up the results of modern scientific medical and dental investigations as follows:

1. That bad or infected teeth are extremely prevalent and because they cause no symptoms to the patient are often unrecognized.

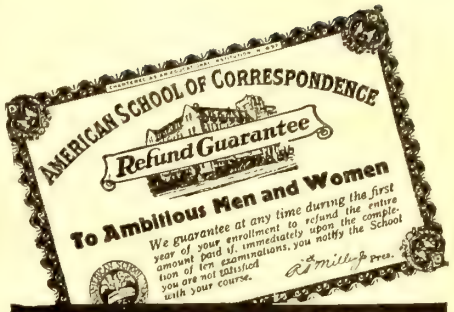
2. That these same infected teeth may be the source of many serious and often fatal diseases, including nervous and mental diseases.

3. That the only known prevention of the effects of this infection is to have all devitalized teeth removed as well as the teeth known to be infected.

4. That one should not allow devitalized teeth to be capt or crowned nor pivot teeth to be placed on old roots but insist that these teeth be extracted.

5. That all persons should keep in mind the danger of transmitting this infection to other members of their families, especially children, and thus prevent serious trouble in after years.

6. That while the infection may originate in the teeth, in the course of years this infection will travel thru the lymphatic system and invade other organs, and eventually set up secondary foci of infection, which become more dangerous than the original focus in the teeth."



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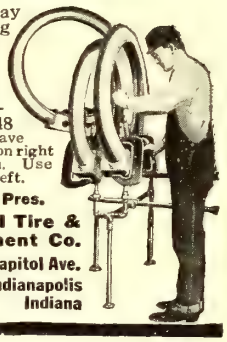
If we told you all the truth you wouldn't believe it. You would say, "it is too good to be true." But you can see what a great field there is for **Haywood Tire Surgery Stations**—for this better way.

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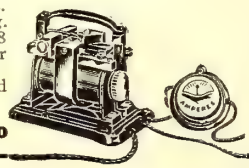
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The "Torpedoplane" and "Sub" Spotter

By George Holmes

(*Continued from page* 306)

called because of its weakness for laying eggs in other people's nests—is one further testimony to British engineering ability and the resourcefulness of our navy.

Rear Admiral Bradley A. Fiske, U. S. N., conceived the idea of a torpedo-carrying airplane in the winter of 1910-1911 as a means of defending the Philippine Islands, and discust the idea with the General Board of the Navy. In April, 1912, he applied for patent on the torpedoplane, which was granted in July, 1912, by the U. S. Patent Office.

The Italians were the first to make experiments in dropping weights from an airplane, with a view to evolving a method of launching torpedoes. Captain Alessandro Guidoni, Royal Italian Navy, using a 1910 Farman biplane equipt with floats, made a number of experiments at an Italian naval base in 1912-1915.

Captain M. F. Sueter, who was then director of the air department of the British Admiralty, appreciated the value of the idea and in conformity with the practise of the British Navy, which provides that the name of the commanding officer shall appear on a patent application with the name of the author of the invention, a patent application was made in the joint names of Captain Sueter and Lieutenant Hyde Thomson, in March, 1914.

The sinking of a Turkish troopship while at anchor in the Sea of Marmora, in 1915, by a British torpedoplane, created a little more interest in the experiment, but no greater support was given to the work and the experiments were superficial in nature and dragged on slowly, due to lack of official interest.

In May, 1917, those who believed in the potentiality of the torpedoplane and hoped that the Allies would put this device into effect against the German Navy before Germany could build torpedoplanes, were made heartsick by the report that the British steamship *Gena* had been torpedoed by a *German torpedoplane.*

In connection with the above, it is stated by the Admiralty that this method of attack was first practised successfully in August, 1915, by R. N. A. S. pilots, who sank several ships in the Dardanelles by torpedoes from seaplanes.

How the Torpedoes Are Carried.

A sketch of one of the German seaplanes that participated in the attack against the *Gena,* showing the pontoon arrangement for holding the torpedo in the German seaplane, is exactly like the arrangement on Admiral Fiske's torpedoplane. The torpedo is held between the two pontoons of the seaplane with a bracing to keep the torpedo from moving while the seaplane is flying.

Some years ago I had occasion to discuss, first with Admiral Fiske and then with Allied officers, the advisability of using *automatic brakes* to check the velocity or fall of the torpedo. This discussion led to considering a number of methods, such as lowering the torpedo by means of a cable. But it was realized that while it would be feasible to lower the torpedo several hundred feet by means of a cable, and its direction could be maintained by means of vanes, and the possible swerving of the torpedo might also be checked by means of vanes, which would hold the torpedo steady excepting in case of sudden turns, the advantages to be gained were not readily apparent. The giant naval seaplane NC-4, which crost the Atlantic, could easily carry two full-size torpedoes.

One Hundred Miles an Hour Torpedo Boat!

Some of the transatlantic planes being designed at present are capable of covering 3,000 miles without stopping. These machines can be converted into torpedoplanes by merely attaching the torpedoes under their planes or at some other convenient place. And then they become flying torpedo boats, capable of cruising at a speed of 100 to 125 miles an hour or more. A crew of half a dozen men will be sufficient to operate such a torpedoplane. Imagine this marvellous combination of speed, potentiality and mobility! What better weapon can we find for the defense of our coasts and island possessions? An enemy fleet bent on attack or carrying an invading force would have to contend with large torpedoplanes before it could come within 1,000 miles of our shores and with smaller torpedoplanes launched from aerodrome ships, such as are recommended by Admiral Rodman.

Admiral Fiske's "Sub" Spotter.

A patent was recently issued to Admiral Fiske on a clever submarine localizer.

As the illustration shows the aircraft, plane or dirigible tows a super-sensitive sub-sea microphone thru the water by means of a float or else an armed boat, which may serve to give battle to the enemy, should he arise to the surface. Suspended from the boat is a sound-detecting microphone connected by circuit wires carried by a cable to a battery and telephone receiver in the car of the airship.

The operation is as follows: When a submarine is under water, power is supplied from her storage battery to an electric motor, whereby the submarine is driven. The continuous whirring sound made by the motor while in operation transmitted thru the water affects the microphone so that this sound is heard and recognized in the telephone receiver by an observer in the airship car, listening thereat.

Being thus apprised of the location of the submarine, the observer may transmit that information to a station ashore, or to a vessel afloat, by any known means—as, for example, by visible signals or by radiotelegraphy.

In order to enable the observer to convey information as to the speed and direction of the submarine, the sea area to be protected may be mapt in divisions of predetermined area, as 1, 2, 3, etc., of the detail drawing reproduced herewith. The observer knowing, for example, that he is over division 7 and hearing the submarine noise in his telephone, signals that fact to an observer at some central station. Afterward, being over division 5, *if he still hears the sound*, he communicates that further fact. The central station observer thus becomes informed that the position of the submarine is first in division 7, for example, and that its course is to a second position as in division 5, and, therefore, northeasterly, while the time elapsing between the signals will show approximately the speed of the submarine in going from the first to the second position.

The boat may be simply a float in boat shape, or it may be an armed motor-boat with crew on board. In the latter case, as soon as the observer in the airship signals the crew of the detection of a submarine sound, the cable may be detached from the boat, leaving the microphone suspended from the cable, and the boat free to watch for and attack the submarine, or to give warning to other vessels in the vicinity. Any suitable means of release may be provided.

By noting where the sounds in the telephone become louder or fainter, and by steering in such a direction that the sounds become louder or remain in the same intensity, the observer in the airship can move in a direction and at a speed approximately that of the submarine.

The Worst Crime of Civilization



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AMONG all our laws for the protection of women and children there is not one to prevent a weak, sickly, anemic man—a creature who is a man in name only—from marrying some pure, wholesome girl and making her the mother of children destined before their birth to be a source of grief and anguish to her as long as she lives.

Men of America, what are you going to do about it? How are you going to protect your sisters and your daughters? How are YOU, who read this, going to protect your future wife and *do your part* to breed a race of strong, sturdy children that will be a credit to America, instead of poor, sickly, watery-blooded little creatures who have no chance in life, and who, when they grow up, will inevitably help to fill our insane asylums and our jails?

Men of America, Wake Up!

It's up to YOU, to every individual one of you, to make YOURSELF fit, first of all. It's a living condition that confronts you, not an academic theory. It's a condition based on the immutable laws of heredity, which have operated ever since the world began. It's a condition recognized by every breeder of live stock, and taken advantage of to improve the qualities of the cattle, horses or dogs he raises. It's the great inexorable Law of Nature that Like Breeds Like; that the progeny will inherit the qualities of the sire in an *intensified degree.*

Read those last two words again, and think—think *hard.* What will YOUR children be? If YOU are weak and sickly; poisoned by constipation, green with biliousness, tortured by indigeston, wrecked by nervous headaches, with vitality barely sufficient to carry you through your daily work—*what kind of children can you beget?*

Fit Yourself to Be a Father

You don't want to deceive the girl who loves and trusts you and wreck her life by making her the mother of children who will cause her to curse the day she married you. You want her to bear happy, healthy, laughing children, who will grow up into strong, virile men and women, a source of joy and comfort to you both in your old age.

FIT YOURSELF to beget such little ones, and at the same time to take the place among men in the world to which you are rightfully entitled. YOU CAN DO IT—there isn't any question about it—IF YOU MAKE UP YOUR MIND TO DO IT. You can get rid of the hampering ailments that are preventing you from being quick, efficient in your work and keeping you from getting a better job or higher position at bigger pay; you can break off any evil habits that are giving you a hang-dog feeling and making you ashamed to look your fellow men and women in the face; you can build up your flabby muscles, strengthen all your vital organs, make your blood rich and red and fill yourself with the punch and power of a REAL MAN, if you will stop "putting it off until tomorrow," *take hold of yourself and go about it the right way.*

Strongfortism Will Enable You to Do It

Strongfortism has lifted thousands of weak, ailing, impotent, discouraged men out of the bog of hopelessness and despair and placed them on the broad, straight road to health, happiness and prosperity. Strongfortism has restored the manhood they had destroyed and thought they had lost forever and given them renewed vitality, ambition and the power to DO THINGS in the world. Strongfortism has enabled them to beget children who will make Americans of whom both they and their country will be proud.

Strongfortism will do for YOU what it has done for them. It is simply Nature's way of living life; the way that has no drugs or medicines about it; the way that makes for health and power and potency; the way that gets the most enjoyment out of life. I KNOW whereof I speak. My lifetime has been spent in studying the human organism; in learning Nature's way of building up and strengthening the tissues of the muscles, the vital organs and the brain. I GUARANTEE results; I guarantee to improve you 100 per cent, physically and mentally, if you will follow my directions, and it makes no difference where you live, what your present condition is or whether your youthful follies brought you to it. You can follow out my course without interfering in any way with your present occupation, in the privacy of your own bedchamber if you like.

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..Thinness	..Biliousness	..Skin Disorders
..Rupture	..Torpid Liver	..Despondency
..Lumbago	..Indigestion	..Round Shoulders
..Neuritis	..Nervousness	..Lung Troubles
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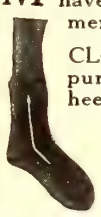
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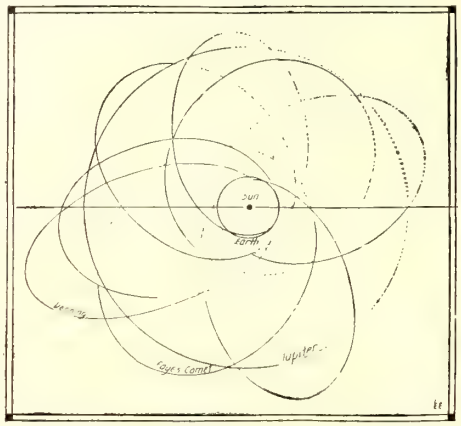
Popular Astronomy

THE NATURE OF COMETS

By Isabel M. Lewis

(Continued from page 313)

istic tail and peculiar cometary features are fully developed. As the comet again recedes from the sun after perihelion passage its speed slackens once more. It soon parts with all its spectacular features and fades rapidly away into oblivion.



This Diagram Shows How the Planet Jupiter Captures the Large Majority of the Comets. It Will Be Noted That Most of the Comets Are Grouped Around Jupiter's Orbit.

THE DISTINCTION BETWEEN STARS AND PLANETS.

THE chance enquirer into the mysteries of space usually is puzzled by the distinction that is to be drawn between stars and planets. All celestial objects except the sun, moon and a few chance comets he is apt to group together vaguely under the head of "stars" even to the "shooting stars."

The planets shine only by the *reflected light from the sun* around which they revolve, as does also the earth, which is one of the smaller planets. This light from the sun may be reflected from a rocky surface, as in the case of the moon, which is not a planet, to be sure, but a satellite *of* a planet, —the earth,—or it may be reflected by a cloudy atmosphere as in the case of Venus or from surface snow and clouds as in the case of Mars. The outer and larger planets Jupiter, Saturn, Uranus and Neptune, being chiefly in a gaseous condition, reflect sunlight from the gaseous vapors that envelope their central molten or gaseous cores.

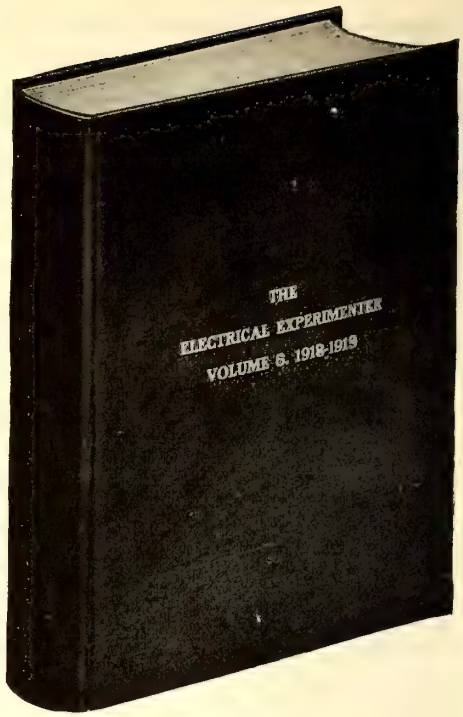
Stars, on the contrary, are *suns* composed of intensely hot incandescent vapors of many chemical elements *emitting light and heat of their own.* The heat of the stars is inappreciable to us simply because they are so far away.

In size, the planets are conspicuously inferior to the sun and to the average star tho it is now known that there are some dwarf stars in existence that are as small as planets. The sharp distinction remains, however, that planets revolve around a central body that supplies them with the light and heat that they do not possess themselves, while the stars, however small they chance to be, shine by their own light and move thru space as independent bodies.

Not only is the distinction between stars and planets one of physical condition and, generally speaking, size. It is also one of relative distances.

The planets are all comparatively close to the earth. All are companion satellites of the same sun. The nearest Venus comes at times within twenty-six million miles of us and the farthest Neptune within twenty-seven hundred million, but the very nearest

(Continued on page 357)



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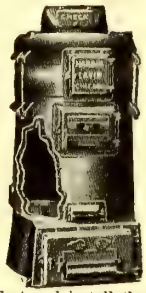
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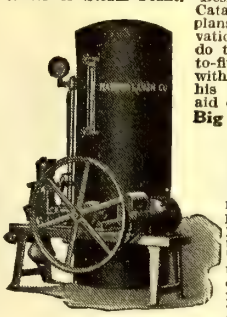


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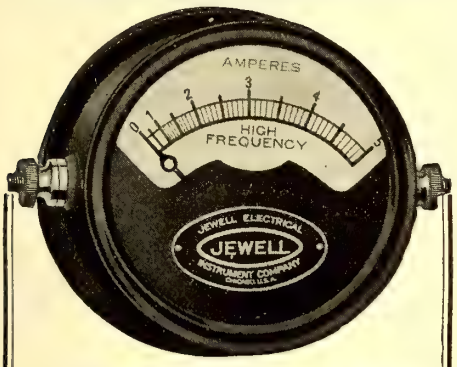
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READ THE CLASSIFIED ADS. ON PAGES 380—382

CARUSO CONCERTS TO AMATEURS BY WIRELESS 'PHONE.

Cleveland, Ohio, or that portion equipt with wireless receiving instruments, heard its first wireless telephone concert on the night of April 17th. And it is to become a permanent institution.

Every Thursday night between 8 and 10 o'clock the radio amateur or professional who "tunes" his instrument to receive wave lengths of 375 meters will be able to listen to strains from Caruso and Sousa's band interspersed with baseball scores and the latest news bulletins.

The concert will come from the plant of the Martin Company, air plant manufacturers and will be audible to wireless operators within 200 miles. It is estimated that 400 radio amateurs "listened in" on the first concert.

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Changing Nature's Face

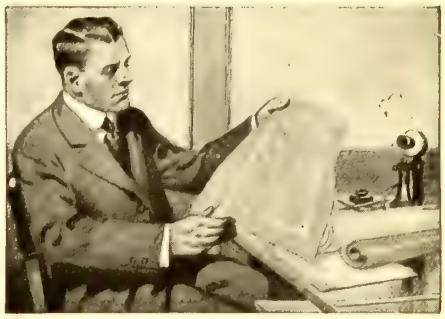
(Continued from page 300)

copper wires extend from the blasting machine to one or more of the detonators. The ends of the two insulated wires inside the cap of the detonator are bridged by a very fine wire, which is soldered to the ends of the feed wires, and it is the heating of this fine bridge wire in the midst of the explosive charge, due to the passage thru it of the electric current transmitted from the dynamo, which ignites the cap explosive and in turn the main dynamite blasting charge. Electric blasting caps are made practically air-tight and water-tight, and are therefore safer to handle than the ordinary open-end blasting cap. It requires about 1½ to 2 amperes to melt the fine platinum bridge wire in the cap.

Connecting Wires

Owing to the small amount of current required, about 2 amperes, to melt the fuses in the electric detonators, and as these are invariably connected in series, a fairly small wire can be used to carry the current from its source to the location of the blast, as well as between the various charges, as shown in the accompanying diagram. No. 20 insulated copper wire is usually employed for connection between the dynamite charges in the holes. For the feed wires between the charges and the dynamo, a larger wire, such as No. 14 rubber covered copper conductor, is used. Several ways of connecting the charges in a group, as for instance in blasting a "ditch" or "brook," are illustrated in the accompanying diagrams, *A, B, C, D.* As will be seen, the various charges are connected in series. However, under some conditions the charges are connected in parallel. The series connection here shown is invariably used when a hand-operated *blasting machine* is employed to explode the charges. Parallel or series-parallel arrangements are used with dry or storage cells, or else an electric generator driven by a gasoline engine is used as the source of electricity for firing the blast. The standard blasting machines, fitted with magneto generators are designed in different sizes to fire from 1 to 200 charges, depending upon the type and size. The amount of current produced is about 3 amperes with this machine, while

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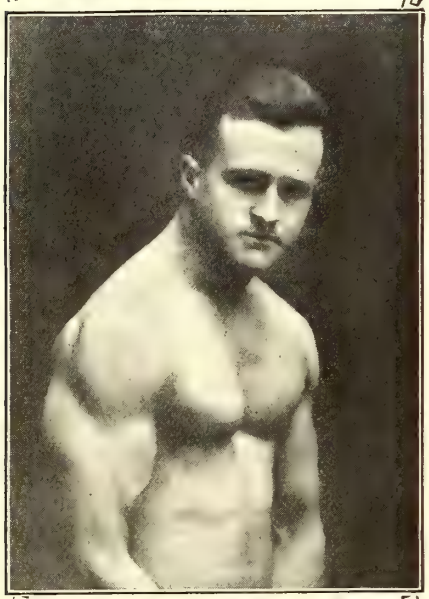
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How to Prepare the Blasting Charge.

The preparation of the load is accomplisht in several different ways and depends upon natural conditions where the blasting is to take place. Where ordinary wet ground such as in meadows or near a brook is to be blasted, in order to form another ditch or stream, it frequently happens that the necessary blasting holes may be drilled with a crow-bar. After the dynamite cartridge has been placed in the bottom of this hole with the electric detonating wires attached, the hole will in most cases fill with water, and this provides a satisfactory substitute for *tamping,* and will give very high efficiency when the blast takes place. It is interesting to mention in this particular instance, that in actual coal mining operations the drill hole is commonly filled with water instead of being tamped with coal dust, etc. Water being practically incompressible and possessing considerable inertia under the sudden bursting pressure of the charge, results in very high efficiency of the blast. Where a hole has been drilled in rock, or wherever it has been tamped or filled up with loam, the following proceeding is to be noted: To guard against danger of a prematurely detonating charge, the first five to eight inches of tamping over the dynamite cartridge should be *gently packed* by means of a tamping stick. When this amount of lightly tamped material has been placed, the rest of the tamping should be made as hard as possible, using a *wooden* tamping stick for the purpose. Moist clay free from gravel and clods makes good tamping material. Free running sand or moist loam is also effective. As pointed out in instruction books on the handling of explosives, it is not necessary to use any loam to tamp the drill holes, where the blasting is done in *watery ground,* or wherever the water will fill the hole to a depth of a foot or more. It is good practise, especially where heavy charges are used, to place two inches of paper or dried leaves immediately over the priming charge, so that they can be used as a safety marker, if the tamping has to be removed for any cause.

Purposes of Blasting.

The accompanying illustration shows three distinct purposes for the blasting operations carried on by agriculturists, and those desirous of cleaning up stump-strewn and rock-covered property. The method of using one, two or three lines of holes for blasting various widths of ditches is shown in the left-hand illustration. It is indeed surprising to learn that these ditches, in actual tests carried on before Government experts, have been blasted out with dynamite in the manner here shown. The bottom level of the ditch, when finished, was so nearly perfect *that not a shovel had to be touched to it.* In some cases, where specially deep ditches are desired, it sometimes becomes necessary to place another row of holes along the bottom of the first ditch blasted out, and then to blast this out.

The experts in charge of the blasting

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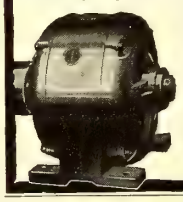
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usually drill a few holes and try several trial shots to ascertain the best depth and spacing for the holes. For ditches of three or three and one-half feet width, the depth of the holes will usually be 24 to 30 inches, and the spacing between the holes from 18 to 24 inches, altho it may be necessary to increase the depth and decrease the spacing in some cases. The test is usually begun with holes two feet deep and 18 inches apart. These are placed in lines and about 10 of them loaded with one dynamite cartridge each.

This loading, say the experts, should lift the soil at least 200 feet into the air and scatter it over the adjoining swamp for a distance of 150 feet, *leaving a clean ditch.* If such is not the case, then a different loading layout should be tried.

Blasting Stumps.

One of the principal uses of dynamite as utilized by agriculturists and by engineers in clearing up large areas containing obstructions is that of blasting out stumps. The lower illustration in the accompanying view shows how a large lateral stump is drilled, and how the electric blasting caps and dynamite cartridges are placed. The terminals of the blasting caps are connected in series, and the two wires run to the blasting machine which should be situated 250 to 300 feet away from the stump at least.

A new innovation in drilling the holes for stump blasting is the use of a portable electric drill or auger. One or more of these electric drills, as may be required, can be operated from a portable gasoline engine and dynamo outfit, or else from electric feed wires supplied by the local light and power company. Comprest air drills have also been used to some extent for this work and have proved very satisfactory. In all stump blasting it should be noted that the depth of the holes should reach to the sub-soil, not close up to or in contact with the wood. The best tools for making the holes are the crow-bar and the sub-soil punch.

Breaking Boulders.

There are three general forms of blasting applied to rocks, particularly those of the *boulder* class. *Blockholing* requires the smallest amount of explosives, altho more labor is involved with the drilling of a hole or series of holes directly into the boulder, as shown at the top of the right-hand illustration herewith.

Mudcapping, as depicted at the bottom of the right-hand illustration, requires the smallest amount of labor, but a considerably larger amount of explosives, while *snakeholing* is intermediate with respect to both labor and amount of explosives required. Each method has its own particular and special use.

Blockholing consists of drilling a hole into the boulder and charging it with a small amount of dynamite. It is the best and simplest method for breaking very hard or very large boulders, especially those of the "niggerhead" type, which are very difficult to break by other methods.

Snakeholing consists of punching a hole underneath but immediately against the bottom of the boulder, and placing a charge of explosives in as compact shape as the size of the boulder will permit. A boulder which has been snakeholed out of its resting place is shown in the accompanying right-hand illustration. As will be seen, the explosive, being confined on the under side of the boulder by the earth, can exert a powerful blow on the boulder and will force it out of its position or roll it out. If a sufficient charge is used, the boulder will be broken into fragments. The boulders should always be either pried out or snakeholed out of their resting places to the top of the ground, before attempting to break them by blockholing or a shattering blast of the type described above.

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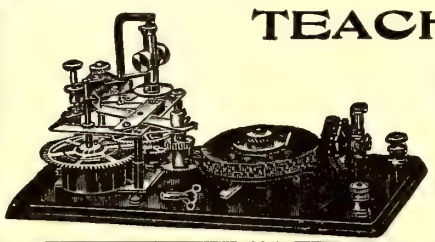
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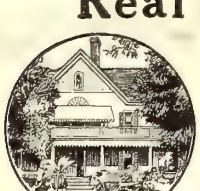
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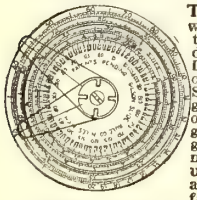
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The explosive should be placed on the boulder at the place where it would be struck with a hammer were it small enough to break in that way. This may be on the top or side. If the boulder is embedded in the ground, a snakehole shot to roll it out on the surface should first be made, *because the confining dirt makes it much harder to break with a mudcap shot.* The mudcovering should be as thick and heavy as it is convenient to make it, *not less than* 5 *or* 6 *inches,* and should be free from stones, *as the blast will throw them as tho they were bullets. Never lay a stone on top of the mud for the same reason.*

The explosives used are 40 per cent dynamite for easily broken rock and 50 per cent strength for hard "niggerhead" boulders.

Seam Blasting:—Frequently ledges and boulders have *seams* from which the mud or stone chips can be removed to a considerable depth. When such a seam is as much as one-half inch wide, successful blasts can be made by packing a reasonable amount of 40 per cent or stronger dynamite into the crack and tamping it securely with moist clay. This method will require about the same amount of dynamite as snakeholing, but is more satisfactory for badly-seamed boulders or ledges. The greatest care must be exercised in placing and tamping the charge *to prevent the expanding gases from escaping thru the cracks.*

Diameter of Boulder in Feet	No. of Cartridges Required: Mud-capping	Snake-holing	Block-holing
1½	2	1	¼
2	3	1	¼
3	4	1½	½
4	Don't attempt	4	¾
5	Don't attempt	6	1

This is based on the use of dynamite of 50 per cent strength. If 40 per cent dynamite is used, increase the amounts by half, and if Red Cross Farm Powder is used for snakeholing or blockholing, the amounts should be doubled.

Scrapping Old Machinery.

Breaking up old machinery, such as heavy castings or steam boilers, can be readily done with dynamite.

For scrapping a boiler use only 40 per cent or stronger explosives. Remove the dynamite from the shell and distribute in a continuous cord about half an inch in diameter all the way around the boiler, and secure it with a heavy mudcap. This can be placed along one of the seams more easily than on the smooth plates. When detonated such a charge will cut the plates almost as neatly as a shearing machine, and will reduce the cumbersome boiler to a size that can be handled.

For breaking heavy castings mudcapping is practised the same as on boulders. Sometimes a hole in the casting can be used for a block hole and loaded as described previously.

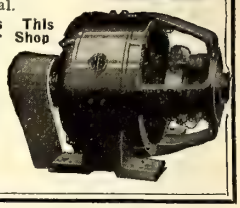
Large vessels and even boilers can be broken up *by first filling them with water, and, if possible, closing all openings.* The dynamite is primed and suspended in the water near the bottom or the thickest metal, *but must not be in actual contact with the metal.* The explosion of such a charge transmits a powerful blow to all sides and shatters them.

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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

Automatic Cut-Out Switch.

(334) Ben Waigand, Nampa, Idaho, states: "I am enclosing a print of a patent my brother and I took out some time ago. I would very much like to hear from you as to its worth in the electrical field. Also what we shall do with the patent.

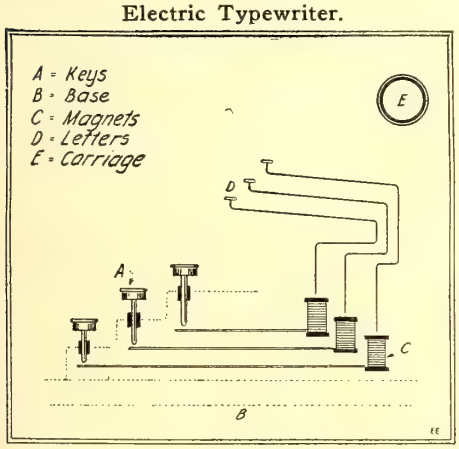
A. The invention relates to an automobile cut-out switch which is to produce a mechanically operated means, whereby, when a fuse in a three-phase circuit is blown, the switch connecting the circuits will be automatically thrown out of operation from the circuit. In three-phase circuits, one of the fuses may be blown, but this does not entirely break the circuit since it will continue to operate on a one-phase circuit, tending to overheat the motor or diminish the lights. By means of this invention, however, upon any of the fuses being blown, the switch is thrown open automatically. This seems to be a very good idea except for the fact that the fuse links which work this switch are exposed all around, which we believe is against the Fire Underwriter's ruling. Some device should be attachable whereby this objection is overcome. Otherwise, we think the patent is a good one. How successful it will be from a commercial standpoint we have no means of knowing. It all depends upon the owners of the patent who wish to exploit it.

Mechanical Converter.

(335) Herbert M. Hubs, Indianapolis, Ind., wishes to know if he could obtain a patent on a mechanical current converter which he designed. He claims that it will work with an efficiency of 80%.

A. It is impossible to say off-hand if a patent can be obtained on the idea as we do not know what it is about. We do not know the technical details; for that reason we cannot give any intelligent advice.

Electric Typewriter.



(336) Lucius M. Turner, Royston, Ga., writes as follows: "I have an idea which I think is entirely original concerning a typewriter that will work with electromagnets. My idea is as follows: Have each key used as a switch or, in other words, used like a telegraph key. As you are aware, each arm on which the letter is attached is shaped somewhat as shown in diagram. When the key is pressed the circuit of that particular magnet is closed. For instance, take the letter 'K.' Press the letter K and that closes the circuit of that certain magnet and the letter K is made. Magnets are located under each letter, as shown in illustration. IN THIS WAY ALL LETTERS WILL BE HIT WITH EQUAL FORCE. In reading letters and typewritten matter you often see some letters less plain or dimmer than others. This would be absolutely avoided. The magnets would be very small and therefore consume very little current. The current could be supplied with a few batteries located under the table or in the drawer, or in any other convenient place that is not needed. Please advise me as to whether it could be patented, and if it would be practicable. Also if it could be manufactured at a reasonable price (please give me some idea as to the price) and if I could find a ready market for same."

A. A very clever idea, and it seems it has the germ of a possible great future. Our present typewriters are operated on a very antiquated plan, and have not been improved since Remington built his first machine. What we refer to is the muscular energy it takes in operating a typewriter. It is rank foolishness in this age of invention and electricity to ask people to wear themselves out by pounding the keys. Electricity should be the mover. Mr. Turner in his invention has shown a very simple way of doing it. He uses the keys to establish the contact. Even the slightest touch will close the circuit. Then electricity, plus electromagnets, will do the rest. Each electromagnet will pull down its key. It thus should be possible to operate a typewriter with the very slightest touch, and each typewriter could be plugged into a light socket or otherwise, a battery or storage battery without any trouble whatever. Of course, the details will have to be worked out to make the device practical, but we certainly think that it is a coming thing. We believe also that such a typewriter could be marketed at a cost only slightly higher than the present-day machine.

We think a patent can be obtained on this invention without much trouble, and we would advise our correspondent to get in touch with a patent attorney at once.

Auto Tail Lamp.

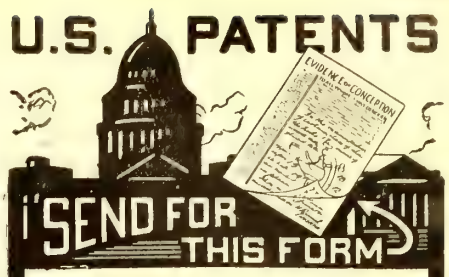
(337) G. R. Smathers, Charlotte, N. C., says: "I have invented a combination auto tail lamp. It is a combination affair of two lamps in one, one being red, the other white. Either red or white bulbs can be used, or instead use red or white lens. It is electrically operated and is provided with extra "push" for white light, which is to be used in backing out of garage or "turning around" at night, in order to avoid "backing" into obstacles such as fences, ditches, etc. The white light, which is larger and brighter than the red one, serves the same purpose as do the front headlights. This device is also provided with the well-known license-plate bracket. The red light throws a white light on plate from under side."

A. From the description and drawings which we have inspected, we do not see anything fundamentally new in the device, and we doubt very much that a patent can be obtained on the combination. There are many similar devices on the market now.

Adjustable Book-Mark.

(338) N. Alpert, Sedalia, Mo., submits description and model of a new article of manufacture. In part he says: "Please advise me whether I can obtain a patent on an adjustable book-mark. It is to

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be made of two strips of steel. The adjustable strip is so fastened that it is able to slide up and down or sideways. The stationary strip can move sideways in either direction. Near the end of this strip and on the underside, a clip is attached, by which the whole thing may be fastened to a page. I am sending a rough model with this letter. It will give you an idea of how the device will work.

A. This is a very clever idea, and we think there ought to be a market for it. It could possibly retail for five or ten cents, and for this reason five-and-ten-cent stores would probably be a good market to exploit the idea. We think a patent could be obtained.

Improved Fuse Plug.

(339) Thomas Sheehan, Duluth, Minn., wishes to have our opinion on an improved fuse-plug which works on the thermo-electric principle, similar to the *blinker contact* arrangements, that blink electric lights. This fuse is made similar to the regular fuse, except that in the interior it has a steel wire, which has a tendency to contract when a certain number of volts and amperes pass thru it. Naturally the wire must be of the gage that will not contract unless the voltage is over 110 volts. Our advice is asked on this invention.

A. While this is a very clever idea, and while no doubt it works and perhaps a patent can be obtained upon it, we doubt very much whether it would prove a success from a practical standpoint. We think the Fire Underwriters would not allow such a fuse plug to be put in use, for the reason that there probably would be bad arcing at times, and the heating effect therefrom would endanger fixtures, etc.

A gold palladium alloy which makes an acceptable substitute for the more expensive platinum iridium alloy used in chemists' utensils has been developed by metallurgists in California.

CREDIT CORRECTION NOTICE.

The story entitled "The Autograph of an Oyster," publisht in the July issue of the ELECTRICAL EXPERIMENTER, should have been credited to the courtesy of the *"New York Sunday American"* instead of the Star Company, who are the publishers.

How to Make Photo-Micrographs

(*Continued from page* 317)

will require a shorter exposure than dense objects or objects stained with carmine or picric acid. The experimenter should use his own judgment in regard to the length of exposure; some idea of the length of exposure may be obtained by examination of the photo-micrographs here shown.

No. 1. Scales from the wing of the moth of the grape-vine cut-worm, and are a good example of the scales which cover the wings of all moths and butterflies. This is the "dust" which comes off on the fingers when holding a butterfly or moth by the wings. Different shaped scales will be found on the same insect by taking scales from the various parts of it.

No. 2. Parenchyma of sunflower leaf; the specimen was obtained by stripping a small piece of the epidermis from the upper part of the leaf. The large pointed objects are hairs, the thin jagged lines mark the cell walls; the small objects shaped somewhat like coffee grains are the stomata by means of which the plant takes in CO_2, its principal food, from the air.

No. 3. Part of the surface of the under wing of the squash bug. The photo shows cells and the opening of glands which exude moisture, keeping the wing from becoming brittle. The dark line is part of a vein.

No. 4. Is a micro-photograph of the nitrogen fixing organisms from a nodule on the root of a pea. These micro-organisms have the property of fixing nitrogen from the air.

No. 5. Tip of antenna of May beetle; the short sharp bristles are the sensory organs, probably the sense of smell.

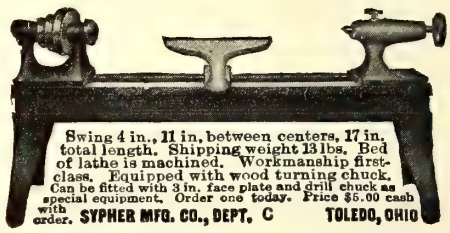
No. 6. Tip of the wing of the crane fly, showing covering of fine hairs.

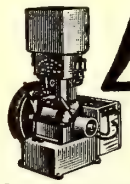
For the average experimenter a microscope having a magnification from 15 to 250 times is sufficient, and with it photographs of pollen, mould, mildew, et cetera, can readily be made.

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Popular Astronomy

By Isabel M. Lewis

(*Continued from page* 350)

of the stars is twenty-six trillion miles away. An inconceivable great abyss separates the sun and his planet family from the stars.

It is because they are so near that planets appear disk-like in the telescope, just as the sun and moon appear disk-like without the telescope. Even in the most powerful telescope in existence the stars appear as points of light simply because they are so distant.

Since the planets are so near, they appear to wander thru the sky from day to day and from year to year, the result of the earth's motion around the sun as well as their own motion. As a result of these two motions their apparent motion thru the sky is very complicated and the nearer the planet is to the earth the greater the rate at which it appears to move thru the sky from day to day. The stars, on the contrary, are apparently immovable for many hundreds of years, tho in reality they are in rapid motion thru space.

The continual change of position of the planets is confusing to the beginner who desires to learn to know the grouping of the stars into constellations. It is quite disconcerting to find an unknown bright star where none is indicated on the map. Perchance the observer may think he has discovered a brilliant *Nova*, but Novae, especially brilliant ones, are extremely rare. Gradually the fact is brought home that the unknown object is simply one of the five planets visible to the naked eye.

Uranus at the limit of visibility and Neptune far beyond it we need not consider.

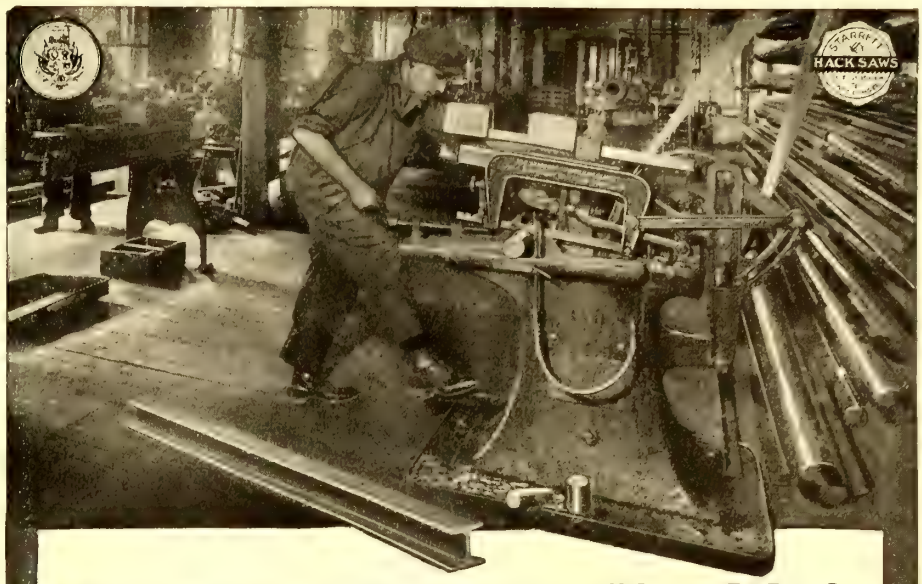
Venus and Jupiter one soon learns to recognize by their unusual brilliancy which far surpasses that of the brightest stars. They are distinguished from each other by their distinctive colors and relative brightness. Venus is always a clear sparkling white and considerably brighter than Jupiter who glows unflickeringly with a slightly yellowish tinge .

Mercury, "The Elusive One," as the ancients called him, is rarely seen as he is always so near the sun. When it is possible to catch a glimpse of him in spring or fall when the ecliptic rises most sharply from the horizon, one marvels at his beauty and brilliancy as he twinkles in the twilight with the splendor of a first magnitude star.

Mars, "The Ruddy One," always glows with a deep red tinge but changes very greatly in brightness. When far away from us Mars is very like Antares, the deep red star glowing in the heart of the Scorpion low in the southern, summer sky. When comparatively near to the earth, however, Mars is one of the most strikingly beautiful objects in the sky and surpasses all stars in brilliancy.

Saturn, never particularly interesting without the telescope, is dull leaden colored and, in brightness, resembles a number of first magnitude stars. It is, therefore, more easily mistaken for a star than any of the other planets. It is easy to keep track of this planet when it is once found, however, as it takes nearly thirty years to make one trip around the sun and therefore moves eastward among the stars about twelve degrees a year.

During July and August the splendor of Venus will attract the attention of even chance observers of the heavens. It will be "Evening Star" during these months, as it has been during the spring and early summer and will reach its greatest brilliancy on August seventh. After that date it will draw rapidly nearer the sun.

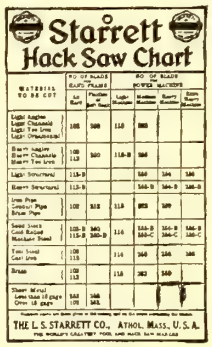


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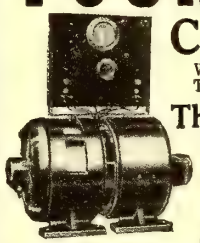
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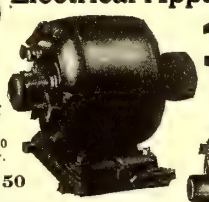


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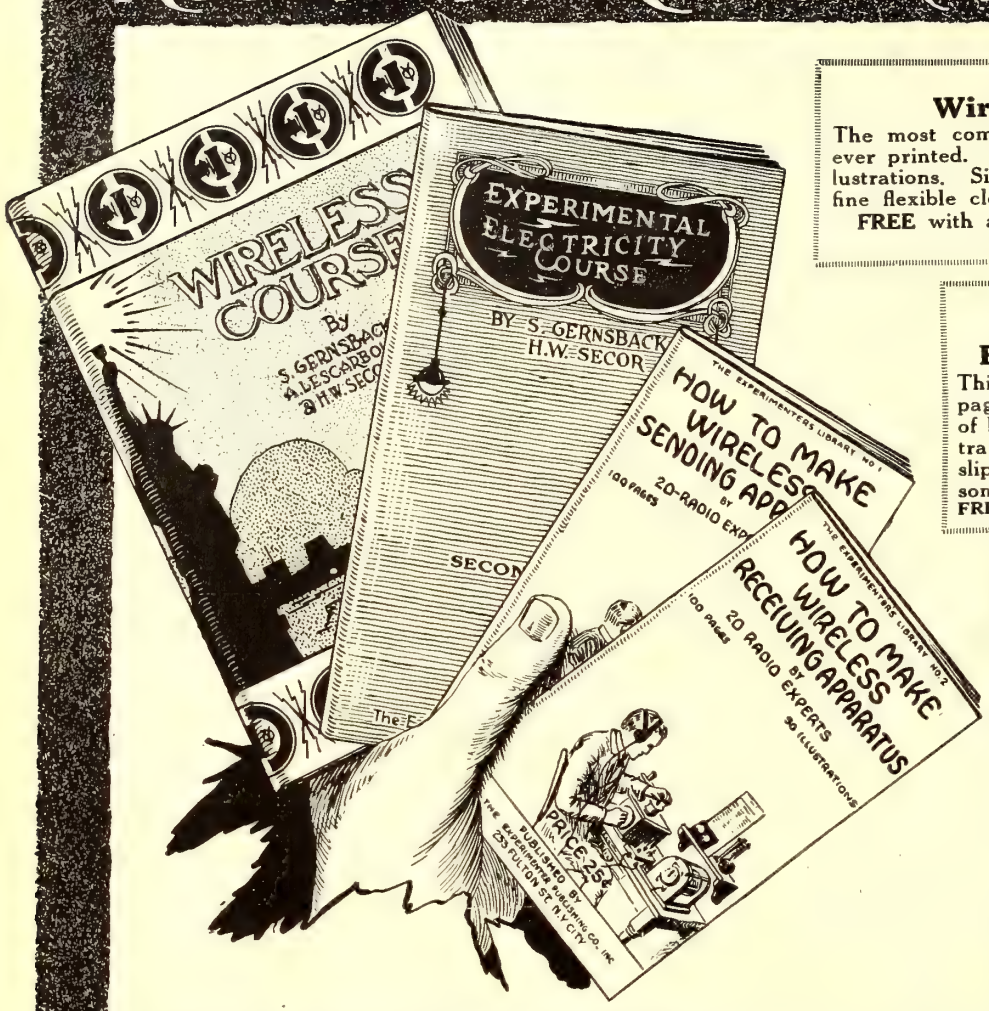
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Inside a U-Boat

(*Continued from page* 309)

captured enemy craft, the U-117, U-140, UB-148, UB-88 and the UC-97. The views here reproduced were taken on board the surrendered submarine U-105, and the machinery shown is typical of the other German craft of this type.

Under a U-boat's Deck.

The submarine UC-97 was a smaller craft than some of the others, but proved to be one of the most troublesome craft possest by the enemy during the war. This boat was designed to serve as a mine layer, as well as being fitted for carrying torpedoes, and provided with a 4.1 inch deck gun. She was propelled by oil-burning Diesel engines, each rated at 300 h.p. for travel on the surface. Propulsion when submerged was accomplisht by means of four compound-wound interpole generator-motors, mounted in pairs on the same shaft and coupled to the engine by means of a clutch. Each generator-motor unit developed 100 kilowatts capacity, or 130 h.p., when running as a motor at full load. These machines were artificially cooled. When these units are driven by the Diesel engines, while cruising on the surface, they operate as dynamos and charge the storage batteries. When submerged the engine clutches are thrown over, and the generators are now operated as motors by the electric current supplied from the storage batteries. A motor-driven air compressor supplied the necessary comprest air for discharging the torpedoes, emptying submerging tanks, et cetera. The electrical control and switchboard rooms on the UC-97 are situated forward of the engine room, from which all electrical apparatus is controlled. The hull is divided off into water-tight compartments which can be sealed off individually by close-fitting doors. The control room is directly below the conning tower. In this control room we find apparatus for steering the vessel, firing the torpedoes, planting the mines, also for filling or emptying the submerging tanks. Much of this part of the control equipment is installed in duplicate, so that if one set is disarranged the other set may be instantly put into service. The U-boat is steered by electric motors, provided in duplicate. One motor is placed aft and one forward, thus reducing the chances of becoming totally disabled to a minimum. It is possible to maintain the U-boat within two feet of any specified depth below the surface by discharging from or letting in water to the submerging tanks. There are provided elaborate and carefully calibrated depth gages on all submarines which indicate at any instant the exact depth at which the submarine is submerged. One of the accompanying photographs shows these depth gages.

Collapsible Motor-Operated Periscope.

The periscope is a collapsible affair which can be quickly elevated, thanks to the ubiquitous electric motor, for the purpose of taking a "sighting" and then quickly lowered. Two periscopes are invariably provided, in the event that one should become fouled or shot away. The periscope measures approximately four inches at the base and two inches at the top, thus reducing the visible portion and its accompanying "wake" to the smallest possible dimensions. This is highly important as the "wake", if very broad, can be easily seen by a sharp enemy look-out. Aiming at the head of this wake, the eagle-eyed gunner can make things highly unpleasant for the submersible.

In the forward part of the submersible are located the officers' quarters and the radio operating room, as well as the sub-sea telephone apparatus, by means of which the sounds of the propellers and engines of ships can be heard several miles away.

The Under-water "Ears" of the U-boat.

No wonder the surreptitious U-boats popt up in the least suspected places, for they could detect an enemy merchantman one to two hours' sail away. By carefully listening to the sounds picked up by the microphones mounted in the shell of the vessel, a steamer or warship could be trailed or maneuvered around for miles. U-boats have been known to dodge the Allied destroyers for periods of three and four hours; "blind-man's buff" you might call it, but he who laughs last laughs best, for the destroyers carried a better under-water sound detector than the "Heinies" and every move along his tortuous course was closely checked up. Periodically, depth charges were "let go" and many times, more than the Germans care to admit, the final crunching sound of a vanquished U-boat, as the depth bomb spelled its doom, came to the ears of the destroyers' officers via the sensitive hydrophone. The U-boats could be trailed just as accurately finally, as if they had been maneuvering on the surface of the sea.

Life on these craft was not to be craved for, especially when a U-boat got cornered and had to lay on the bed of some sound or harbor, for 10 to 15 hours. Electric cooking utensils were supplied, the same as on all of the Allied submarines.

The larger U-boats measured 300 feet and more in length, and had a capacity of 20 or more torpedoes and 45 mines. Craft of this type are propelled by two powerful Diesel engines, developing 1,200 h.p. each, for cruising awash, charging the storage batteries, etc., and when submerged propulsion is effected by a set of four 500 h.p. electric motors. The motors are operated as generators while awash, when it becomes necessary to charge the batteries. These large sub-sea craft often had a cruising range as great as 7,000 miles. The speed of this type of craft on the surface is about 19 knots and submerged about 10 knots. They carry two disappearing deck guns of 4 to 6 inch caliber. The torpedo tubes are four in number at the bow, while two are provided at the stern. At the bow of the U-boat the Germans mounted a cleverly contrived saw for cutting thru sub-aqueous nets. Even so, the nets placed in the waters about the English coasts enmeshed many of them, from which they endeavored to struggle loose in vain, as the official Admiralty reports prove. It may be said in closing that, contrary to the usual expectations, inspection showed the workmanship on the machinery of these U-boats to be very plain and ordinary.

Go to Church by Telephone

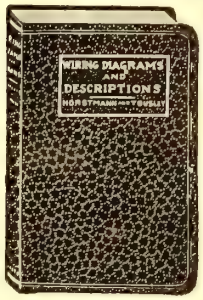
Holding church services by telephone was one result of the influenza epidemic. This was done by one church in Muncie, Ind., which arranged that at 10:30 o'clock, thru the coöperation of the local telephone company management, the telephones of all subscribers who wished should be connected with the telephone in the church, to which a special microphone was attached. The church organist also played a few numbers, which were thoroly enjoyed by the listeners.

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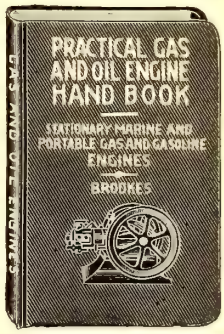


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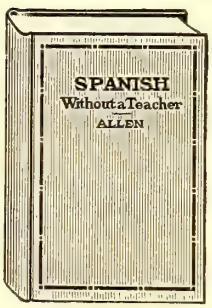
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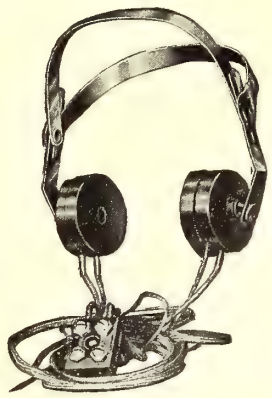
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How I Invented the Crystal Detector

By Dr. G. W. PICKARD

(*Continued from page* 325)

great improvement over the coherer, I soon found that it, also, had defects. Severe static or nearby sending would usually cause a partial or complete paralysis of the contact, curable only by the hit-or-miss process of repeatedly jarring the detector so that new contact points were formed, or the old ones unwelded. Even in the absence of severe electrical disturbances, the contacts gradually became, as it were, fatigued, and the signals weakened toward inaudibility, unless periodically restored by jars. Then, also, the microphone detector lived up to its name by acting as a microphone, picking up any slight sound or vibration in a most annoying way. Finally, even if the detector was screened from sounds and jars, it was prone to develop a hissing or frying sound, which overlaid faint signals to their obliteration.

The Contact Detector Is Invented.

In the first part of the year 1902, the American Wireless Telegraph and Telephone Company erected stations at Atlantic City and Cape May, N. J., about 40 miles apart, and also equipt the schooner *Pleiades* as a floating experimental station. On May 29, 1902, I was in the Cape May station, experimenting with a new system of tuning, and receiving signals from the *Pleiades*, then about two miles off Cape May. The detector I was using consisted of several fine sewing needles, laid lightly across a pair of carbon blocks, and in series with three cells of dry battery and a telephone receiver. Becoming annoyed at the microphonic "fry" of my detector, I attempted to check this by, as I thought, cutting out of circuit two of the three dry cells. The frying ceased, and the signals, tho much weakened, became materially clearer thru being freed of their former background of microphonic noise. Glancing over the circuit, I discovered to my great surprise that instead of cutting out two of the three cells, **I had cut out all three,** so, therefore, the telephone diafram was being operated **solely by the energy of the receiver signals.** A contact detector, operating without local battery, seemed to me so extraordinary, so contrary to all my previous experience, that altho I did not then know the reasons for its operation, I appreciated its possible great value to the art, and resolved at once to thoroly investigate the phenomenon at the earliest possible moment. This entirely accidental discovery was the foundation of my invention of the crystal detector.

Silicon and Other Detectors Invented.

During the summer of 1902, I was concerned with the development of a system of radio-telephony, conducting this work in the Boston laboratory of the American (Bell) Telephone and Telegraph Company. As one of the essential elements of this system was a detector which would respond quantitatively to telephonically modulated electrical waves, I at once began a series of tests, first with the form of the carbon-steel microphone I had used at Cape May, and then with other contact materials. Discovering that such detectors responded quantitatively to musical spark signals up to at least 2000 sparks per second, and were therefore capable of receiving speech, I devoted my energies for the time to the transmitting end of the system, finally discovering, in the fall of 1902, an effective means of telephonically modulating a stream of electrical waves. Returning to the detector development, I found that the Telephone Company had in their laboratory a large quantity of magnetite ($FeO.Fe_2O_3$) crystals, which had been procured as a possible material for loading coil cores. I broke one of these crystals apart, exposing a fresh fracture face, made a small area contact thereon with a brass point, and found that this crystal, like the carbon steel detector, operated well without local battery, but, unlike the carbon-steel contact, did not require a light or microphonic contact for best operation. In the period 1902 to 1906, I tested many different minerals and combinations, including magnetite, pyrite, galena, molybdenite, silicon and zincite. Much development was also required on holders for these minerals. Perhaps one of the greatest early stumbling blocks in such development was the old coherer idea that extremely light pressure contacts were necessary. With the carbon-steel microphone, this was still true, but I can remember my surprise when I found that many of the minerals worked best with quite high pressure contacts.

31,250 Crystal Detectors Invented.

A list of the several thousand materials I have tested would make dry reading. *Suffice it to say that I have found some two hundred and fifty minerals and furnace products which make operative detectors, either against metallic contacts, or in combination with other minerals. The possible combinations of these two hundred and fifty substances, amounting to some* 31,250 *pairs, have all been tested by me, or by my assistants, and many hundred useful pairs have been found.*

Oscillating Crystal Detectors.

The last word on crystal detectors and their uses has yet to be written. **For example, it may be of interest to know that they can be made to OSCILLATE, under proper circuit conditions, and I have found it possible to receive intelligible signals from UNDAMPED wave stations across the Atlantic, on a simple contact between a fragment of galena and a fine wire.**

MOTHER SHIPTON TOLD OF AVIATION IN 1488.

The following, which is known as "Mother Shipton's Prophecy," was first published in 1488, republished in 1641 and again in 1875. It will be noticed that all the events predicted in it except the last two lines have come to pass:

Carriages without horses shall go;
And accidents fill the world with woe.
Around the world thoughts shall fly,
In the twinkling of an eye;
Water shall yet more wonders do;
How strange, yet shall be true.
The world upside down shall be,
And gold be found at root of tree.
Through hills men shall ride,
And no horse or ass be at his side.
Under water men shall walk,
Shall ride, shall sleep, shall talk.
In the air men shall be seen,
In white, in black, in green.
Iron in water shall float
As easy as a wooden boat.
Gold shall be found, and shown
In a land that is not known.
Fire and water shall wonders do,
England shall at last admit a Jew.
The world to an end shall come
In eighteen hundred and eighty-one.

(*It is curious to note that only the last two lines—WHICH DO NOT RHYME—have failed to come true. All the others that do rhyme did come about as prophesied!—Editor.*)

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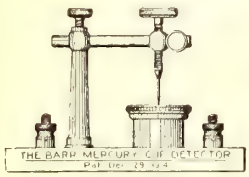
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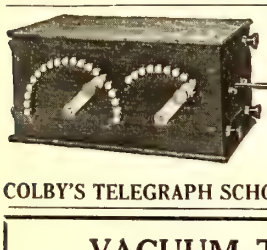
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E. F. W. Alexanderson Wins "I. R. E." Gold Medal

At the May meeting of the Institute of Radio Engineers held in New York City, May 7th, E. F. W. Alexanderson, consulting engineer of the General Electric Company, was awarded the gold medal of the institute in recognition of his original research and inventions in the radio field.

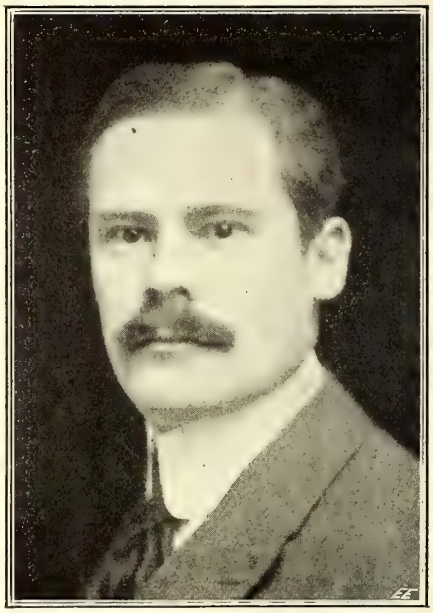
In accepting the gold medal, Mr. Alexanderson said:

Such great strides have been made in all fields of science and engineering during the emergency of our late war that I feel it a specially high honor to receive the Radio institute medal at this time.

"The radio art has drawn its talents from almost every profession. Broadly speaking, radio men may be classified as radio physicists, radio engineers and radio amateurs. In a sense we are all amateurs and we shall never know who was the first amateur. We do know, however, that the first radio physicist was Hertz who discovered and determined in his laboratory the laws of electromagnetic radiation. We also know that the first radio engineer was Marconi, who made the first use of electromagnetic waves for practical communication and developed the wonderful system which for the last 20 years has made the high seas safe for navigation.

"Fessenden conceived the possibility of bringing radio engineering within the realm of power engineering, and it was my privilege, due to connection with the General Electric Company, to develop the first radio frequency alternator. Indeed it was thru the work which this Company was requested to do for Fessenden that my interest in radio communication was first excited, and this has resulted in the contributions which I have had the opportunity to make to the radio communication of today.

"Radio telephony is a by-product of the development of sustained radio waves as a method of alternating current power transmission. With the previous system of spark telegraphy it was no more possible to transmit the modulation of the human voice than it would in land telegraphy to reproduce speech from the dots and dashes of the Morse code. But with the sustained energy of the continuous wave, it has become possible to put a dynamo electric machine behind the wave and vary the flow of power in correspondence with the modulations of the human voice, thus making long distance radio telephony possible.



E. F. W. Alexanderson, Well-known Radio and Electrical Engineer, Awarded the "I. R. E." Gold Medal.

"Mr. President and members of the institute, it has been a privilege to be connected with the great development in radio in the last years and I wish to express my deeply felt appreciation of the recognition represented by this beautiful medal. I thank you."

Concentrated or Loop Aërials

(*Continued from page 328*)

from B to D no sound, and then from D to C another rise and fall of intensity, the maximum in each case occurring when the plane of the loop is along 30-210° line but the signals in A B sector are about twice as loud as in C D sector; this gives the direction of signal in direction of arrow. If however the connections of Fig. 4, are used then the result will be as shown in Fig. 6. The signals will be much louder and will be heard only in the A B sector, thus making it strictly *undirectional.* If the loop be grounded on the grid side, then Fig. 7 shows the result, i. e., *loud signals but NO directional effect whatever.*

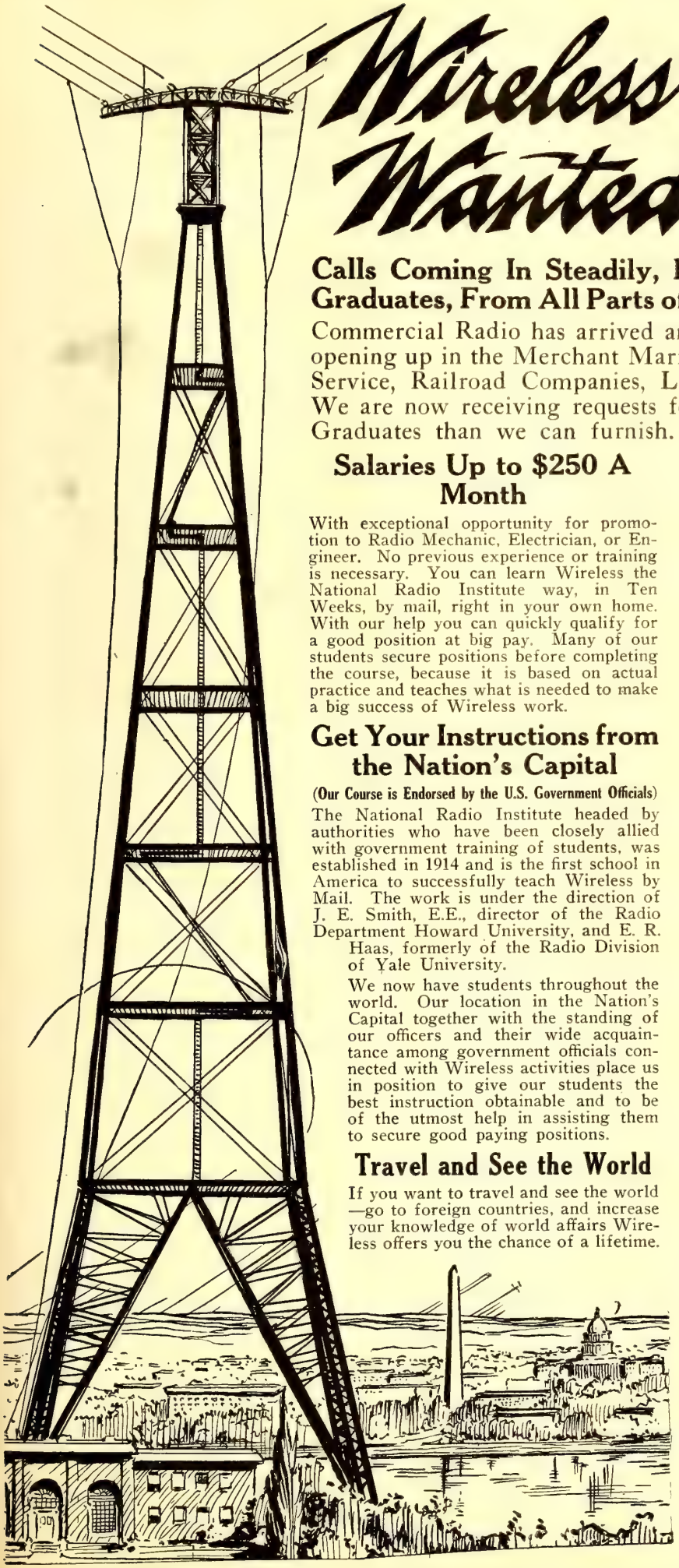
Fig. 3 shows the connections when it is desired to receive on other than the wave length of the loop. In practice it will be found to be simpler to have several loops of proper wave lengths rather than be bothered with a tuner.

As many navy and army operators know, the loop eliminates a lot of interference and also static. However, if it is desired to eliminate static more effectively, then it is necessary to take the loop and outfit into the cellar or under ground. Signals will be found to come in just as loud as tho an elevated aërial were used, but the static will be absent, *even in the midst of a thunder-storm* when an ordinary aërial "spits fire."

The loop shown in the photo and diagram Fig. 8, consists of 240 turns of No. 22 S. C. C. and with a 43 plate variable condenser has a range of from 2,000 to over 3,000 meters. Larger loops can be made if it is remembered that the same length of wire is required. The inductance is determined by the area turns, and hence a small loop will act about as well as a large one. If several loops are operated simultaneously from known points, but separated some distance, the exact location of the sending station can quickly be determined. And further if the circuit of Fig. 4, is used a very large amount of interference on the same wave length can be eliminated, since only such stations as lie in the region from 150° to 270° will be heard at all, while receiving from 210° and as the outfit tunes sharp much of this is cut out. By carefully adjusting the apparatus as good receiving can be done on the loop as with the ordinary aërial, and all other features will be additional. *Stations 200 miles away can be located to a pin point on the map.* Thus the Radio Amateur has opened to him a wide field that will make possible better work with less bother.

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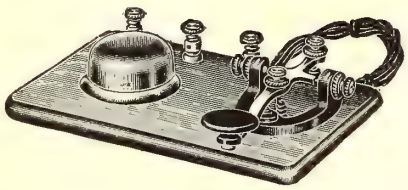
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Wireless Receiving Ban Raised

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The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

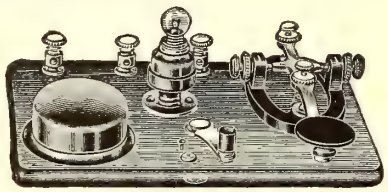
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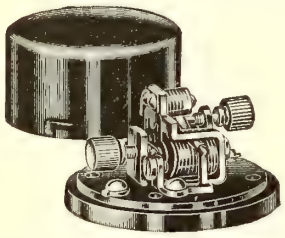
This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.



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This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

It consists of practically a closed circuit field of low reluctance, having a steel armature to which is riveted a strap supporting a movable contact. The armature tension is adjustable by means of a screw with a milled head large enough to be easily and permanently adjusted with the fingers. The stationary contact is adjusted by means of a similar screw. The magnet coils are connected in series with a total D. C. resistance of 3.9 ohms. Shunted across these coils is a resistance having a D. C. value of 3 ohms. This shunt eliminates all sparking such as occurs at the break on ordinary radio buzzers and the energy saved thereby is transferred into any oscillating circuit connected to it, the result being that this buzzer as constructed radiates five times more energy than any other existing type. All connecting wires liable to be broken are eliminated. Contacts are of genuine platinum, which is essential in order to maintain a constant note. The parts are mounted on a Condensate base to insure constancy in operation.

Diameter 2 in., height 1¼ in. The cap is attached to the base by a bayonet joint.

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55 Mesco Radio Buzzer $2.05

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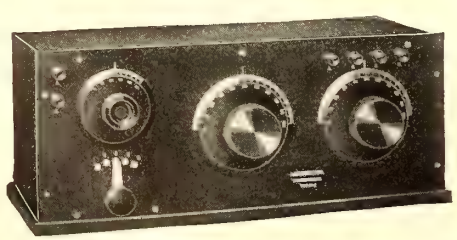
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Various models designed to operate on wave length ranges from 170 *to* 20,000 *meters are described in our bulletin sent free upon request.*

A. H. GREBE & CO., Richmond Hill, New York

Radio-Planes Watch Forests and Ranches

(*Continued from page* 295)

stations erected about the ranch. The installation and maintenance cost of these stations is relatively small in any case. They have also been so greatly simplified during the war that practically anyone can be instructed in handling the talking and receiving apparatus in a short time. Some of these sets work as simply as the ordinary telephone.

Airplanes and Radio Serve to Protect Nation's Forests.

Recently the use of *airplanes* to patrol the forests and watch for incipient forest fires was extended by the Government and now the *wireless telephone* has been installed for an experimental trial. If found to be practicable the wireless will be extended to cover the great woods with an invisible net of communication.

The wireless is expected to be an improvement upon wires or cables for one very important reason. In the past great difficulty has been experienced in maintaining wire communication in the forests because of the interruption to the service caused by falling timber, especially in the stormy season. Snowslides have been another source of destruction to the wires. The use of wireless, of course, obviates all such difficulties.

For the purposes of the present experiment the Signal Corps of the Army has lent to the Forest Service four combination sets of transmitting and receiving apparatus. One set of the equipment is to be installed on Mount Hood at an elevation of about 13,000 feet, and another at the nearest forest ranger station, about twelve miles away. Two other sets are to be placed in the Clearwater Forest region of Idaho, which is a very heavy wilderness country.

All of the wireless stations will be establisht at *look-out points,* where watch is kept for forest fires, and will supplement the regular service, which not so long ago was augmented by the addition of airplanes for patrol. Now two additional airplane routes for that purpose have been mapt out, both operated from Mather Field, near Sacramento, Cal. The other two routes of the airplane service are operated from March Field, near Riverside, Cal.

The first route from Mather Field will cover the northern parts of the Eldorado and Tahoe forests on the valley side of the Sierras. The planes will start from Mather Field each morning and proceed to Oroville by way of Placerville, Colfax, Nevada City and Strawberry Valley. A landing will be made at Oroville, where a suitable field has been provided. The return trip will be made in the afternoon.

The second route from Mather Field will cover the southern parts of the Eldorado and Stanislaus forests. Starting from Mather Field, the route runs to Placerville, Grizzly Flat, Big Trees, and to a landing near Sonora or Tuolumne. In this case also the return trip will be made in the afternoon. Each of the Mather Field routes has a round-trip length of about 150 miles.

Forest Service reports tell of a successful trial patrol undertaken recently under test conditions. No difficulty was experienced in detecting fires in heavy timber at elevations of from 6,000 to 10,000 feet.

Peculiar interest attaches to the movement for conservation as affecting North Carolina, Tennessee and Kentucky because of the potentialities involved.

NEW SUBSTITUTE FOR PLATINUM.

The question of substitutes for platinum has received almost world-wide attention, many nations having been obliged to devise something. Most of the platinum came from Russia before the war. Germany was no exception. Some of the recent substitutes are enumerated in a German paper. The most important seems to be that suggested by Gotthold Fuchs, of Berlin, consisting of a wolfram-gold-nickel alloy which can be cast, forged and rolled, is of light color and polishes brightly, which platinum does not. Another substitute is an alloy of silver, wolfram and nickel. Both these alloys are stated to be acid resisting. A nickel-iron alloy, known as platinit, is said to be serviceable as a substitute for platinum in glow lamps, its coefficient of extension being similar to that of glass. For laboratory purposes an alloy of nickel and chromium affords a platinum substitute for wire and sheets, but cobalt alloys, such as cobalt-iron and cobalt-chromium are as serviceable, especially for acid-resisting purposes.

Peacetime Uses for War Inventions

By H. Winfield Secor

(*Continued from page* 298)

The illustration in Fig. 7 shows two applications out of many for the once busy *U-boats*. America and the other Allied countries can make use of all the superfluous U-boats without a doubt. For exploring the *flora* and *fauna* of the undersea regions they are ideal. They can be fitted with powerful electric projectors, observations lenses and windows, when not only can visual observations of the deep sea life be studied, but even motion pictures can be taken. And for pleasure trips at the seaside resorts—I would hate to have the job of figuring up how many five dollar bills one could rake in, in a single Saturday afternoon, with one of these pleasure submarines at Coney Island, not to mention the Beach at Coronado, Calif., and who would not like to explore the secrets of the Great Lakes? We have heard of the chap who endeavored to dash over Niagara Falls in a rowboat, and no doubt we shall soon hear of the enterprising fun-promoter, who will, for a consideration of $25.00 or so, invite you for a trip over Niagara in one of the former Kaiser's plush upholstered U-boats. Plush upholstered is right, and we would like to have it about nine feet thick.

In order to attract the sea and lake fishes for the edification of the passengers aboard, we can imagine that some genius will roll up his sleeves and get busy developing a "food gun" which can be attached to the torpedo tube. Presto! Push the button and out flies a perfect barrage of fishsome dainties for our piscatorial neighbors, when they will come bounding forward in great flocks, much to the delight of the submarine's guests, snapping their teeth gladly and otherwise showing how delighted they are.

The *Submarine Detector*, which is shown in Fig. 8, and which was wonderfully perfected during the World War, should find many peacetime applications, particularly on all ocean-going and inland lake vessels for the purpose of locating other vessels in a fog or at night, and also for accurately locating the presence of icebergs and reefs. The submarine detector, of which several different types were developt during the war, operates on one general principle, that of *sound wave transmission thru the water*. The sound produced by the propeller and driving motors or en-

(*Continued on page* 378)

BRANDES WIRELESS HEADSETS



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"Superior" Set $6.

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We achieve this by perfectly matching the tone of both receivers in each set. This eliminates all confusion to the ear due to unmatched harmonics.

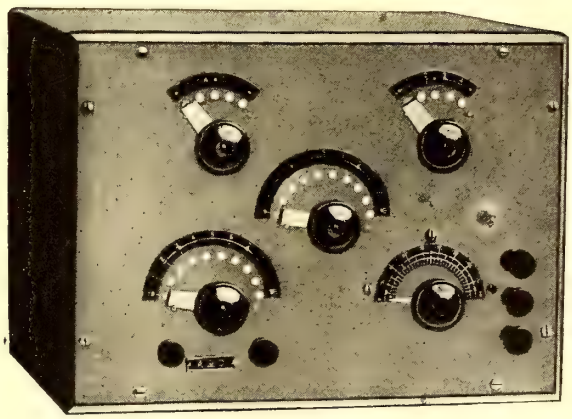
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It is the policy of this company never to consider a sale completed until the customer is thoroughly satisfied. Incidentally our instruments seldom fail to satisfy, because they are scientifically designed and built on honor. If you are interested in radio apparatus of the highest grade at fair prices, enclose a 2-cent stamp for our catalogue.

Type UL-5 Receiver.

This is a complete receiver for undamped waves up to 17,000 meters. No external coils, couplers or condensers are needed, since it is entirely self-contained. Sizes 8" x 12" x 7" approximately.

We control the patent rights for the Mignon System and can supply these instruments.

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Is it because of its consistent performance, excellent workmanship, materials, low prices?

These would account for it partly. The real reason must lie in the fact that we have always been in the van. Design and system employed have been so far in advance of others as to overshadow our rivals.

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We do not aim to sell the most radio apparatus—only the best. Quantity is a secondary consideration.

We were the first to produce the audion amplifier and the oscillion undamped wave transmitter, and its popularity is attested by its wide use.

Our latest productions, the Honey Comb Coils, Unit Set, Coil Mountings, Two Step Amplifier and Audion Control Box have been greeted with enthusiastic demand far exceeding our expectations.

The Unit Receiver fills the demand for a really efficient receiver for any and all wave lengths of any preferred circuit and design without the usual costly cabinet and expensive assembly.

We have been literally swamped with orders, so do not feel surprised when your dealer tells you it will be necessary to wait a few weeks before you can get delivery.

By placing your order now you will avoid the greater congestion in our factory when the purchasers of this meritorious apparatus of novel design begin enthusiastically recommending it to their friends.

DE FOREST RADIO TEL. & TEL. CO., 1415 Sedgwick Ave., New York City

Faradic Currents—How To Apply Them

(*Continued from page* 318)

eight minutes or at the outside fifteen minutes is long enough for a treatment. The exceptions to this rule are in the treatment of some chronic diseases, as chronic articular rheumatism, etc., and in general electrizations, where a little longer time might be allowed.

No definite rule holds as to the frequency of sitting, as much depends upon the nature of the disease, the sex, age and habits of the patient. Some acute cases require daily sittings, seldom more than that. In chronic cases from two to four times a week may be enough.

Constipation

Connect the rectum electrode to the *negative* pole of the battery and place it in the anus. At the same time the *positive* over the stomach, liver and bowels. Use the *secondary* current. A small internal dose of cascara sagrada will sometimes prove beneficial. However, the use of cathartics, as a rule, is not advisable, and the above treatment is much better without them. Eat good plain digestible food. A dish of oatmeal and milk eaten in the morning will help to regulate the bowels.

Corns.

Place the foot upon the foot plate, it being attached to the *negative* pole of the battery and apply the *positive* pole directly to the corn, using a small piece of sponge fastened to the ear electrode. Treatment should last about ten minutes daily. Use the *primary* current.

Canker.

This is caused by indigestion. Let the patient live upon a light milk diet for a few days. Thoroly wash the mouth and throat frequently with borax or boracic acid diluted with water. Electrical treatment: Place the *positive* at the nape of the neck on the spine and apply the *negative* to the stomach. This treatment should last about ten minutes. Use *secondary* current. Another treatment is to place the tongue electrode in the mouth having previously attached it to the *positive* pole of the battery and apply the *negative* to the neck and throat. Use *primary* current. A general tonic treatment two or three times a week will be beneficial.

Diabetes.

Diabetes seems to be a nervous disease, and for that reason we recommend what is called *Central Faradization.* The object is to bring the whole central nervous system under the influence of the primary current. Place the *negative* pole at the pit of the stomach and pass the *positive* over the head and forehead, down the back of the neck and along the whole length of the spine. Use a very light current about the head and increase gradually. Do not apply the current to the head more than one or two minutes at a time. The spine will stand a much stronger current than the head. The back may be treated about five or six minutes. After this give tonic or general treatment for ten minutes, with the *secondary* current.

Death—Apparent.

People who have to all appearances been dead, have been restored to life by electricity. The test is as follows: Place the sponge electrode (*positive* pole) to the back of the neck, and apply the *negative* to the body over the lungs and heart. A mild *secondary* current is first used, gradually increasing it until the patient shows signs of life. Keep this treatment up for about five minutes, also apply the *negative* electrode to the arms, wrists and hands. Now sponge the whole body with the *nega-*

(*Continued on page* 371)

DESTROYER FLOTILLA NAVIGATED 1,100 MILES BY DIRECTIONAL WIRELESS.

Seven links in the chain of naval destroyers stretched across the Atlantic by the United States Navy for its transoceanic flight reached their Newfoundland base after traveling from New York enveloped in fog from Fire Island to Trepassey Bay, thus navigating 1,100 miles entirely by directional wireless, with which the Transatlantic seaplanes were equipt. The trip was said by Captain Arthur Crenshaw, base commander, to have been one of the severest tests this means of navigation ever had. The destroyer Philip became separated from the flotilla in the fog, but she entered the harbor soon after her companions.

To War On An American Destroyer

By A. H. Whedon

(*Continued from page* 329)

Of course, a certain amount of roll and pitch is to be expected—but a destroyer of a very nervous disposition just can't be still at all!

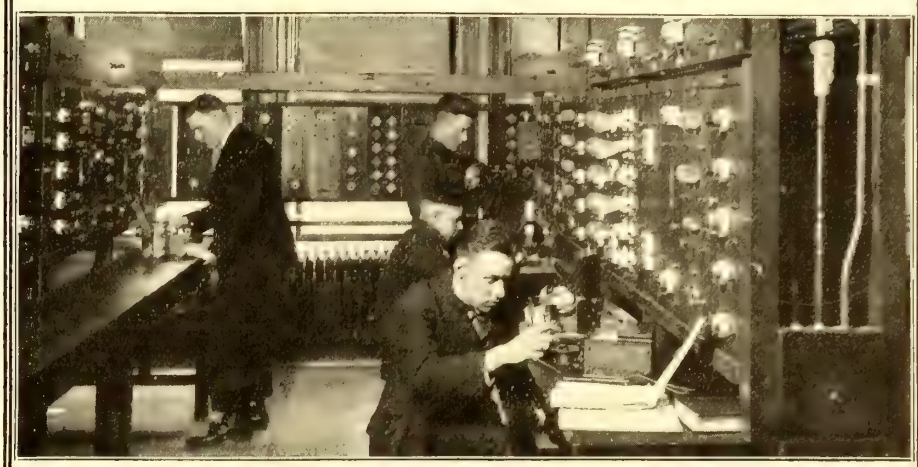
The largest roll that we made while I was on the *Conyngham* was seventy-two degrees to starboard and sixty-eight to port. That is in the ship's log, and signed by the Captain. And, friends and fellow citizens, I maintain that *that* was sure *some roll.* Try it once and see. A destroyer is always rolling at sea, and in a storm she is one great "dance artist."

The *radio shack* is mounted either way forward or way aft, in the place most calculated to get the benefit of the rolling and pitching. Of course, it is superfluous to mention the fact that everybody from the oldest salt down to the newest rookie gets sea-sick on the first trip to sea on a destroyer. The rookies come aboard expecting to be sick. But when a "gob" wise in the ways of ships (big ones) comes aboard, he proclaims for all to hear that he has been going to sea too long to get sea-sick. The day comes when we go to sea. The next day friend "gob" fails to rise for breakfast—not that he is sea-sick or anything like that, y' understand, but simply that last night's chow must have disagreed with him. By noon time he joins the rest of the gang at the lee rail, actively engaged in the sport technically known as "feeding the fishes." Yea, verily, 'tis a great life until you get used to it. And nine-tenths of the sailors get so that the more she rolls, the better they like it.

But now consider the case of the poor radio man, who is forced to sit for at least four hours before his set, never getting up from his chair and never taking his receivers off. Every time the ship takes a big roll he rolls with it, unless his chair is screwed to the deck—but they never are—and there is a wild scramble to hold on to pencils, pads, code books, and other loose articles that have a tendency to hide under power transformers, switchboards, or any other place where it is deuced hard to recover them.

At the first calm spot, the "op" nervously attempts to readjust his detector, and succeeds in making things worse. So he shifts over to the audion and thinks his troubles are over. So they are until he discovers that the filament battery is run down and needs recharging. Then follows a choice line of briny "cuss" words. About this time the boat decides to take another roll, and the show starts all over again.

In between times, the "op," if he is new on a destroyer, realizes that he really isn't feeling well. Then he begins to wonder why he ever joined the Navy anyway. Of course, he can't leave his post to join



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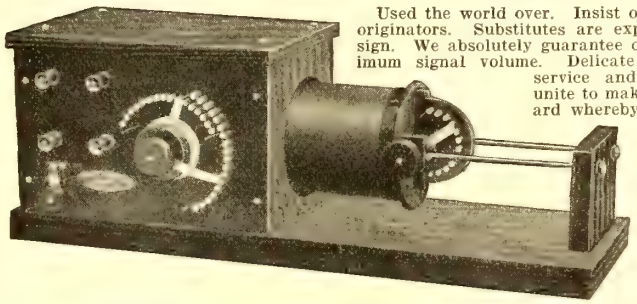
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AMPLIFY YOUR RADIO SIGNALS

With the new DETECTAGRAPH-TRANSMITTER, the amateur can amplify radio signals to such an intensity that he can hear the signals about his station without the need of the telephone head set.

By the addition of a loud talking telephone he is able to hear the messages many feet away from the instrument.

The super-sensitive DETECTAGRAPH-TRANSMITTER herewith shown is two and three-eighths inches in diameter, five-eighths of an inch thick and weighs less than three ounces. It is the most sensitive sound detecting device ever brought before the public.

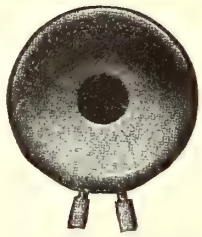
The manner in which the amplifying process is attained is by attaching with tape the DETECTAGRAPH-TRANSMITTER to the regular wireless receiver.

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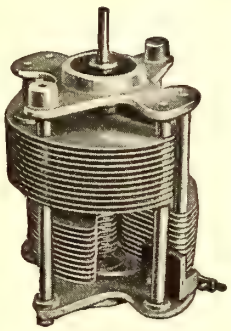
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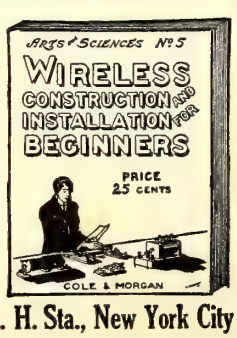
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his friends at the lee rail, but he must do something—quickly!! Ah—he grabs somebody's tin pail that is lying around, which is used to wash in. But friend "op" is not standing on ceremony, he wants action, and quick action—and he gets it!

The radio shack on the *Conyngham* was an inside room, and had no port-holes or other openings on deck. In order to provide for good ventilation, a small air vent was installed in the overhead of the radio room, leading out on deck. It was put in hastily, and was far from being watertight. When we hit a storm and the waves broke over the deck, lo! much "moisture" used to descend into the radio shack. In vain I pleaded with the ship's carpenter, and with tears in my eyes I begged him to fix that "gadget." But he was always doing something else. So I tried to see what I could do to it. When I got thru, it didn't leak, it poured! I had completely broken it. But I was triumphant. Now it would *have* to be fixt.

But we put to sea with the blame thing still busticated. It was the middle of December, 1917, and, for a change, the sea was unusually calm. Everything was all ski for two days, till we met the U. S. S. *George Washington* and the U. S. S. *Huron* to be convoyed into Brest. (This was before the *George Washington* became the Presidential ferryboat. Then, suddenly, all the furies of the sea and heavens turned loose. Everyone who was at sea in that part of the ocean will remember that storm to their dying day. For two days and nights we headed into it and gained but forty miles! Ordinarily the destroyers would have ridden it out with the storm instead of against it. But we had fifteen thousand U. S. soldiers to guard, and we stuck—! At last, even the troop-ships could stand it no longer, and we got a signal from the *George Washington* to "countermarch." That is, turn around and go with the storm. All that night we just drifted, taking things easy, and the next morning the storm had subsided enough for us to try to make port. There were times during those awful two days and nights when even the captain on the bridge remarked that we would never live thru it. And in the face of his belief, he refused to leave the troop-ships to the tender mercies of a stray submarine, for while no "sub" could work during the storm, there was bound to be a calm spell afterward when we would be needed. So we stuck—!

We finally reached port, but what a mess our division was! Of course, everything was absolutely swept clear of the decks. One destroyer even had a smoke-stack carried away, and another one had her main mast broken off. The *George Washington* had lost most of her life boats, and eight men had been washed overboard. The *Conyngham* escaped with very little damage. All our compartments were flooded, and of course there was nothing left on our deck in the way of sea chests, the carpenter's bench, etc. AND the radio shack! Just drift back a few lines to where I mentioned the broken ventilator and then on down further where I mentioned the storm. Two and two never made six—so you can imagine what our radio shack looked like. I had a young Atlantic Ocean in there—six inches of water rushing all over the deck and having a fine time playing with the power transformers and the Leyden jars, with *ye scribe* perched up on the desk, soaking wet and wondering who started this war.

And so it goes—as someone once remarked—"If we had some ham, we'd have some ham and eggs—if we had the eggs, ——etc." For those that like it the Navy is sure a fine playground, but personally I am better satisfied to sit here writing this short reminiscence in order to win a few extra pennies for a new pair of shoes for the baby!



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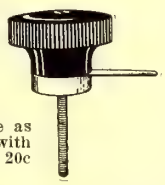
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A Review of Radio-Telephony

(Continued from page 326)

from the Western Electric Company Engineering Organization to engage in this work. At this time plans were in the making for the tremendous aircraft program which was later undertaken by the Army, and it was clear to all that a successful means of communication between battle planes when flying in squadrons would be of inestimable value and would greatly increase the efficiency with which these squadrons could be maneuvered. The early work had shown such promise that there was justification for assuring the Signal Corps that this means of communication could be worked out successfully and applied to aircraft of various types. As a result of this conference, orders were issued by the Signal Corps for the Western Electric Company to undertake the development of a wireless telephone system for the purpose.

The problem now was to produce sets of minimum size and weight, physical structures which would withstand the extreme vibrations and jars encountered in flying, especially in landing, the most convenient disposition of control elements, suitable sources of power for both high and low voltage, and a form of antenna which would not interfere with the evolutions of a plane in squadron formation.

It was realized that the solution of the last mentioned problem would consume more time than was at our disposal, and while work was immediately started in the field on antenna measurements and study, the design of the sets proceeded on the basis of using a trailing wire antenna.

The working out of a practical helmet design proved to be more difficult than the success of the earlier experiments indicated. It was found that the degree of interference experienced changed very rapidly with slight imperfections in fit. The problem was also complicated by the necessity of providing means for using oxygen at high altitudes, and of providing for the comfort of the wearer over a period of several hours. It was found that a very slight amount of pressure on certain portions of the ear caused excessive pains and headaches after a very short period, and the final design was a compromise between comfort and efficiency as to sound insulation.

The problem of power supply was an interesting one. It was required that the weight should be reduced to a minimum, which precluded the possibility of employing storage batteries. There are obvious objections, also, to attaching any form of generating device to the propelling engine. Consideration of all the factors led to the adoption of a wind-driven generator for the purpose. This generator of about 100 watts direct current output was required to produce a potential of 300 volts for the plate circuits of the vacuum tubes, and a potential of 25 volts for the filament circuits. It is necessary, to insure most efficient operation, that the filament current be kept constant, and the fact that the specifications called for operation with airplane speeds varying from 40 to 160 miles per hour made the problem of voltage regulation loom large. Ordinary forms of electro-mechanical regulating devices did not prove to be successful, and while it was probable that something of this type would eventually have been developed, the problem was solved by a very ingenious arrangement proposed by Mr. H. M. Stoller, in which the vacuum tube is the essential element. The voltage of the generator is held approximately constant by means of a vacuum tube regulator, which controls the field flux. Two field windings are pro-

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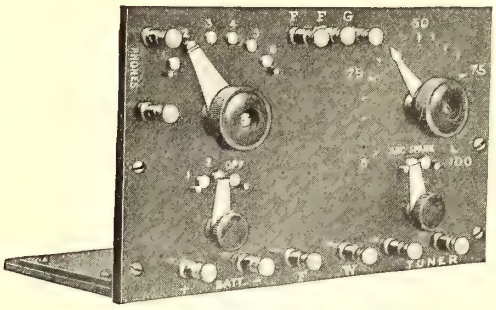
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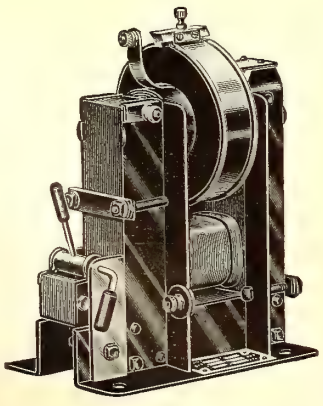
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vided, the main field, which is in series with the filament of the regulator tube, and a differential field which is in series with the plate circuit. At minimum speed the differential field is inactive and the generator behaves like an ordinary shunt machine, except that the main field has a small resistance in series due to the regulator tube filament. This filament is so designed that the main field current heats it to a temperature which gives a small electron current. This current flows thru the differential field and reduces the resultant flux. At minimum speed, the differential current is small, but as the speed increases, the main field current tends to rise (as in any shunt generator) and this increases the temperature of the regulator tube filament. The electron current is, therefore, considerably increased, which current, flowing thru the differential field, reduces the generator flux and thus restricts the rise in voltage. Due to the fact that the electron current of the regulator tube increases very rapidly with increase in filament current, the voltage is held practically constant between 4,000 and 12,000 revolutions per minute. The 1.5-ohm resistance units are provided so that the regulator may be set to give different voltages by cutting them in or out of the main field. The 100 ohms shunt resistance is used to prevent hunting.

Upon the completion of the next set of models, field tests were resumed and on August 20th the first two-way telephone conversation between two planes in the air was successfully accomplisht. After this first trial, Major Bartholf and Lieutenant Stevens, of the Signal Corps, held two-way conversation between planes with very satisfactory results.

Late in 1917, the type of airplane set shown in Figs. 4 and 5 was installed on our airplanes. The various parts are arranged so that they can be mounted in any available space in the machine. The switch box shown in the diagram is to provide for communication between pilot and observer by means of the same microphones and helmets used in radio-telegraphy. The transmitting and receiving set proper is shown in Fig. 4. This set is 17x10x7 inches and weighs but twenty-one pounds. The generator is of the wind-driven type, and is shown in Fig. 6 with the tail cover removed giving a view of the vacuum tube regulating device. The complete weight of the entire outfit is about fifty-eight pounds. Fig. 7 shows a simplified form of the circuits.

The last distinctive type of radio-telephone outfit is the short wave set installed on submarine chasers and destroyers during the war. These sets are shown in Figs. 9 and 10. The circuits of these sets are practically the same as for the airplane sets, except that the power for them is obtained from small dynamotors run on a 30-volt storage battery. The complete transmitter and receiver, together with the amplifier and extension set, are shown in Fig. 8 and the transmitter receiver itself is shown in Fig. 9.

The set is installed in the radio room with the amplifier for the loud-talker. An extension set consisting of a telephone transmitter and receiver, together with the loud speaker, is mounted in the pilot house. By means of a switch in the radio room, the operator can cut in the extension set while the conversation is being carried on by the captain. It is also possible to use either the head receivers or the loud-speaker for receiving.

This equipment has an effective range of from 5 to 10 miles and can be used in four wave lengths ranging from 250 to 600 meters.—*From a paper by E. B. Craft and E. H. Colpitts, entitled "Radio-Telephony," read before the American Institute of Electrical Engineers, Feb. 21, 1919. Photos courtesy Western Electric Co.*

Faradic Currents—How To Apply Them

(Continued from page 366)

tive while the *positive* electrode is at the base of the spine. The room should be well aired, and the patient's feet and hands should be kept warm with hot water and bags.

Headache.

The treatment of headaches depends upon the cause. If caused by disordered stomach or bowels, what is called a sick headache, place the *positive* electrode at the base of the brain and apply the *negative* over the stomach, liver and bowels, using a *mild secondary* current. General tonic treatment of the whole body with *secondary* current will cure or help some patients, while central faradization (as described in treatment of diabetes) will help others.

Indigestion.

Place the *positive* at the back of the neck and sponge the region of the stomach and bowels with the *negative*. Another method is to place the *positive* electrode on the tongue and the *negative* at the pit of the stomach. Use *secondary* current. If the patient is debilitated give general tonic treatment of the whole body.

Neuralgia.

If properly treated, neuralgia is one of the diseases that yield most readily to electrization. There is one difficulty in the treatment of neuralgia by electricity and that is the intensity of the pain. Often the first few treatments aggravate the pain, especially if the current is too strong or the treatment is continued too long. Not over one treatment a day should be given. Give a general tonic treatment of the whole body every other day. For local treatment, where there is no swelling, apply the *negative* to the painful parts, and the *positive* at the hands or feet. If there is swelling apply the *positive* to the disease, and the *negative* at the hands or feet, using a *secondary* current.

Rheumatism—Inflammatory and Acute.

Either of the above kinds of rheumatism may be treated with the *positive* electrode. If the trouble is about the head, neck, arms or shoulders, hold the *negative* in the hands and apply the *positive* to the painful parts. If the pain is below the arms, apply the *negative* electrode to the feet and the *positive* to the affected parts. Drink freely of lemonade. Avoid alcoholic liquors, meats and fatty food. A rigid diet for a few days is to be recommended.

Rheumatism—Chronic.

Chronic rheumatism is much more obstinate and resists a cure more than the acute kind. Very often the general tonic treatment will give relief. For local treatment, treat with the *negative* electrode instead of the *positive* as in the acute form. Also use the primary and secondary currents alternately. If the joints are enlarged treat with the *positive* electrode, using the primary current. Keep the body warm and the feet warm and dry. Do not allow the patient to expose himself to any dampness. The electric bath is to be recommended.

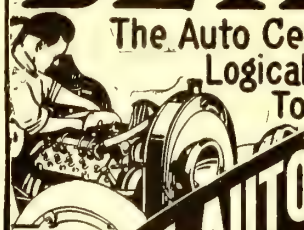
Sunstroke.

In most cases of sunstroke, electricity is a valuable agent in restoring persons who have been overcome with the heat. General tonic treatment should be given, also central galvanization as described in the treatment of diabetes. Local treatment to the head may be given and a *very light secondary* current should be used, *positive* electrode at the head and *negative* at the base of the spine. In all cases have the attention of a good physician.

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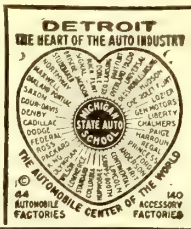
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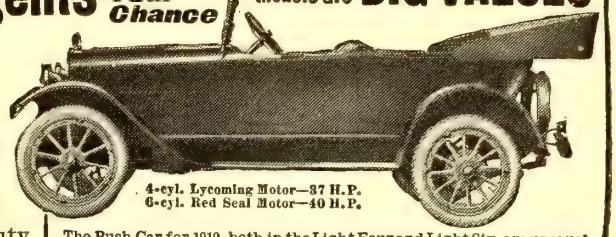
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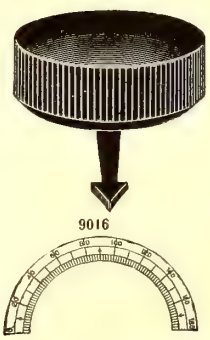
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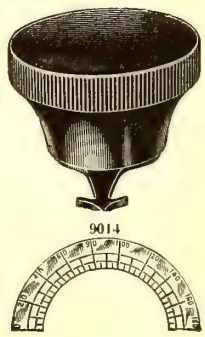
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Germany will be allowed to repair German submarine cables which have been cut, but are not being utilized by the allied powers, and also portions of cables which, after having been cut, have been removed, or are at any rate not being utilized by anyone of the allied and associated powers. In such cases the cables, or portions of cables, removed or utilized remain the property of the allied and associated powers, and accordingly fourteen cables, or parts of cables, are specified which will not be restored to Germany.

Air: The armed forces of Germany must not include any military or naval air forces except for not over 100 unarmed seaplanes to be retained till Oct. 1 to search for sumbarine mines. No dirigible shall be kept. The entire air personnel is to be demobilized within two months, except for 1,000 officers and men retained till October. No aviation grounds or dirigible sheds are to be allowed within 150 kilometers of the Rhine, or the eastern or southern frontiers, existing installations within these limits to be destroyed. The manufacture of aircraft and parts of aircraft is forbidden for six months. All military and naval aeronautical material under a most exhaustive definition must be surrendered within three months, except for the 100 seaplanes already specified.

POCKET WIRELESS SOON, PREDICTS MARCONI OFFICIAL.

Godfrey Issacs says the English Marconi company, of which he is managing director, expects to have a commercial service of wireless telephones in operation in New York and London early next year.

The company hopes to make arrangements with New York and London telephone companies so that eventually the British and American wireless 'phone subscribers will be able to sit at their desks and "Hello, London" or "Hello, New York."

Isaacs foresees the day, not far distant, when pocket wireless telephones will be in wide use. A business man's secretary, walking along the street, Isaacs says, will hear a bell ring in his pocket, will put a receiver to his ear and hear "his master's voice" give him instructions, probably from an airplane hundreds of miles away.

The Daily Mail says that the British government probably will compel all commercial airplanes and airships to carry wireless telephone or telegraph equipment. Larger machines of both types may be compelled to carry both.

BULLARD ONCE AGAIN RADIO DIRECTOR.

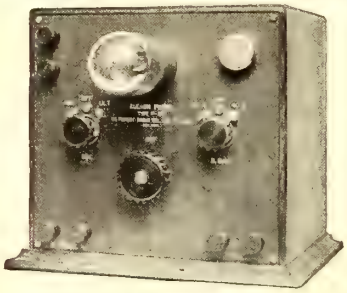
Navy orders were issued April 9th, reappointing Rear Admiral William H. G. Bullard as Director of Naval Communications, a position he held at the time the United States entered the world war, but from which he was detached for service overseas.

Rear Admiral Bullard is an honorary member in the Radio League of America, as our readers will remember.

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Heat Engines

By John J. Furia

(*Continued from page* 320)

utes at the beginning of the day and the steam pressure is controlled automatically. Kerosene is used as the fuel which is considerably less expensive than gasoline. No shifting of gears is necessary. A turn of the throttle will give enough steam to climb any hill or to slow down to a crawl. No fussing with carburetor or ignition systems. The spent steam is condensed and led back to the boiler so that a much smaller water supply tank is used. No cooling system is necessary. A pilot light using up a negligible amount of fuel keeps enough steam pressure all day, so that one can make an immediate start. All gages operating on the fuel and steam are automatic, thus eliminating all danger. Why is it then that we do not see many of these steam cars. Two reasons—it takes a long time to educate the public—steam cars cannot be kept in the present public garages, since the open flame of the pilot light is liable to ignite the gasoline vapors present in all garages and cause fire. No doubt the steam car has a great future (provided the oil companies do not boost the price of kerosene).

The Hot Air Engine.

The *hot air* engine uses neither gasoline nor steam but plain ordinary air and that is pretty cheap. Let us examine the principles of its operation. Figure 3 shows an ideal engine consisting of a cylinder, piston, connecting rod, and fly-wheel. Heat is applied to the lower end of the cylinder as in A, the cylinder being composed of non-conducting material, except the bottom which is a good conductor. The heat will cause the air in the cylinder under the piston to develop great pressure and *eventually to expand,* forcing the piston *upward.* If the heat is suddenly removed and replaced by cold, when the piston reaches the top of its upward motion, then the air under the piston will *contract* and the piston will move *downward,* due to two causes: (1) the suction under the piston and (2) the pressure from above the piston, since the air above the piston was comprest when the piston moved up. This then would constitute the complete cycle and if repeated indefinitely our engine would continue to run. Let us look at Fig. 2 again. If the inlet were connected to a tank of air and the air heated, the air would expand, enter the cylinder and move the piston; if then new air were admitted and heated, this on expanding and entering the cylinder from the other side, because of the action of the slide valve, would cause the piston to move back again, giving us a motion similar to that of the steam engine.

The ideal hot air engine described above and this steam engine operated as a hot air engine, illustrate the two types of hot air engines in existence. The first typifies the *closed cycle* engine which operates continuously with the same mass of air (a fresh charge being occasionally admited to compensate for leakage). The second typifies the *open cycle* in which a new charge of air is admitted and exhausted at each stroke. The closed cycle engine is analogous to the new type of steam engine employing a condenser for the spent steam, while the open cycle is analogous to the old type non-condensing steam engine. Therefore it is readily seen that the closed cycle engine is more efficient than the open cycle, none of the fuel being wasted on the exhausted air. In all types of *hot air* engines, the power is secured by the pressure of the air produced by heat transferred by a separating metal wall. The air is admitted to the cylinder at a high temperature and pressure, it is allowed to do mechanical work on the piston as a result of which the pressure and temperature fall off.

There are two heating systems employed in hot air engines—the *regenerative* and the *non-regenerative.* A regenerative system is one which uses a device for absorbing the heat from the air as it passes in one direction and supplying it again on passing in the opposite direction. A non-regenerative system does not employ such a device. One of the best of the hot air engines is the Stirling engine which has been actually used commercially, tho without much success. It is of the closed cycle type working with a constant volume of air, and requires about 2 lbs. of coal per hour horsepower (i. e., more efficient than the steam engine). Its chief objection was that the heating plate, which takes the place of the boiler of the steam engine, burned out rapidly. Figure 4 is a sketch of the essential parts of the Stirling engine. C is the brick foundation of the engine, B the fire box, A the draft, H is the working cylinder, E the displacer acting in opposition to the working piston, D the air-box, F metal gauze, and G coils of pipe thru which cold water flows. The total volume of the air contained in the air-box, the working cylinder and the connecting pipe *remains constant.* The lower end of D is a plate pierced with holes, thru which the air flows when the displacer E moves downward. The upper part of D, thru which the coils G pass, is known as the *refrigerator.* The fire heats the air in the air box D. As the engine is started the displacer E moves downward, forcing the hot air thru the regenerator gauze F. Heat is absorbed by F and the air cooled. It is further cooled by the refrigerating pipes G. The pressure in H is therefore diminished and the piston moves downward. This forces the air back thru F into D, gaining heat from F and forcing the displacer upward. The heat gained from F, in addition to that gained from the fire, causes the air to *expand,* raising the piston in H. This completes the cycle. The inertia of the fly-wheel causes the fly-wheel to push down the displacer E and the cycle is repeated.

Steinmetz's Own Shorthand

(*Continued from page* 314)

"It is my opinion that every college student should learn some good accurate system of shorthand, so that he can follow the lectures and make notes without effort."

The system of shorthand that Dr. Steinmetz has evolved as the best adapted for writing on electrical subjects is based upon the "Arends" system of stenography as taught in Europe. Words are written as they are pronounced without regard to their spelling; that is, they are written phonetically. The word "height" is written h-i-t, but in this case the long "I" is used.

One of the most interesting features in connection with this system of shorthand is the fact that French and even Latin and Greek words and names can be perfectly written and read without the slightest hesitation.

With his own hand, Dr. Steinmetz has written down the rules, or it might be said, the "code" of his system, so as to assist those persons with whom he is working in a translation of his reports and various articles.

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Developments in wireless Telephony. By Dr. F. B. Jewett.
An efficient hot wire meter. By L. M. Lafave.
New "B" Battery for vacuum tubes.
100 Radio Prize Contest.
Radio Digest.
Latest Radio Patents.
Junior Section.

X-Ray Experiments

(*Continued from page* 319)

zation. This statement is not altogether accurate. Barkla has observed that when a pencil of rays enter an object which scatters them, the scattering is more marked in a direction parallel to the stream of cathode particles. The greatest objection has been advanced by Bragg. He reasons as follows: If a stream of cathode rays striking a target set up some sort of rays which it has been found instigate new cathode particles when they enter some body, it is reasonable to suppose that these rays merely serve as a means of transferring energy from one electron to another. He suggested that they might consist of neutral doublets made up of a *positive* and *negative* charge, which is broken up when the rays strike some object. This theory might explain why only a few and not all of the molecules in a gas are ionized, for as the doublet moved thru the gas only a few of the molecules would come into contact with it and be charged. Later, however, this theory was disproved.

The most important property of the rays is their power of making objects transparent and affecting a photographic plate. Procure about a 5 x 7 plate and carefully wrap it in black paper. Care should be taken that the *film side is placed upward* as the *glass* cuts off a good deal of the radiations. The bulb should be placed about six inches above the plate and the objects to be photographed laid directly upon it. The arrangement is clearly shown in one of the accompanying illustrations, Fig. 4. The bulb may be procured from several leading supply houses. The one shown is not provided with a third electrode. The coil is connected direct to the bulb, no condenser or spark gap being used. When the connections are properly made *the lower half of the bulb will glow a bright green.* If the polarity of the current is wrong, only a *ring of light* will show. The polarity may be corrected by a pole-changer in the primary circuit of the coil.

Radiographs, while once a comparative novelty, are now fairly common—especially since the war. Many interesting skiagrams have been returned from the front showing the invaluable work X-rays have accomplisht. The Customs House has made a novel use of their penetrating power. In order to see if anything such as bombs were concealed in bales of cotton or other apparently innocent objects, the bale would be placed before a powerful X-ray bulb and a man standing on the other side would examine it with a fluoroscope. Of course a small bulb operating on about a 2-inch coil does not possess very great penetrating power, but the reader should experience no difficulty in seeing thru the thick part of the arm. An X-ray picture taken with such apparatus is reproduced herewith. See figure. As was said above, the amount of penetration is proportional to the density, decreasing as the density increases. Use has been made of this fact in determining the atomic weight of unknown elements by measuring their transparency to X-rays. Benoist determined the atomic weight of indium by this process.

Another important property, and the one which gives us the readiest means of measuring their intensity, is their *ionizing* power. This may be easily illustrated by hanging a grounded plate above an electroscope of the ordinary flask type. The arrangement is shown in Fig. 2. *If the intervening air is exposed to x-rays the electroscope will be discharged.*

Another interesting experiment is to take an ordinary hydrometer and remove the float. Fill the bulb and about a third of the tube with water. Put your finger over the end to prevent the air from escaping and squeeze the bulb. It will be noticed that a cloud is formed. This is due to the moisture condensing around the dust particles in the air. After this has been repeated several times all the dust particles will be drawn down into the water and *no cloud will form.* Now, if when this condition has been reached, the apparatus is exposed to X-rays, a dense cloud will be formed. *This is caused by the moisture condensing around the ions, due to the X-rays.* This phenomenon forms the basis of the rain-making apparatus described in the February, 1919, issue of this journal as developed and patented by the Australian inventor and engineer, Balsillie.

Röntgen rays also possess the remarkable property of exciting *secondary rays* in substances which they strike. As this is a rather complicated phenomenon and as there are no experiments in connection with it which the average reader may repeat, it will not be discust here, except to mention that the secondary rays resemble the original cathode rays, only they travel at a slightly slower speed, which is dependent on the hardness of the primary rays. Recently X-rays have found a new application in the analysis of *crystal structure.* It was found that X-rays might be defracted by the cleavage surface of crystals. Using X-rays, it has not only been possible to determine the exact shapes of crystals, but also to actually show the arrangement of the atoms as well as the distance between them.

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Thunderstorm Electricity

By Rogers D. Rusk, M. A.

(*Continued from page* 307)

ly called *thunder-caps,* or *thunder-heads,* and often the clouds will grow so thickly together that to an observer on the earth they appear as a huge dark rolling-cloud extending across the sky, the tops being obscured except to aërial observers several thousand feet in the air. It is while such clouds as these are forming that the electrical forces are at work which build up enormous charges in a manner which will now be described.

How Rain-Drops Form.

Experiments show that *ions* are nearly always present in the air. Sometimes these are *charged dust particles,* sometimes they are *charged atoms of the gases* of which the air is composed. Experiment further shows that rain-drops condense about *negative ions* much more quickly and easily than about *positive ions.* The earth itself is a very highly charged *negative* body, its charge being estimated at 600,000,000 volts, but the rain that falls is *positively* charged almost as often as it is *negatively,* which may be accounted for by the fact that the *positive* drops, forming more slowly, are larger and heavier and are not retarded so much at times by upward currents of air. It is these upward currents of air in the clouds themselves that produce the charges within the clouds. The *negatively* charged drops being smaller and lighter are carried to the top of the cloud, very often forming a heavy *negative* charge. In a similar manner the heavier *positively* charged drops will fall to the bottom of the cloud forming a strong *positive* charge. In addition the wind may break up the drops into smaller droplets and when this is the case, it is found that the smaller droplets are nearly always *negatively* charged. By these processes of division and formation of charged drops and their separation in the cloud, enormous charges are generated, and the thunder-cloud is seen to be really a huge electrical generator as shown in Fig. 3. And when the charges become sufficiently great the lightning discharge results. This may take place from top to base of cloud which is usually a distance of about a mile, or it frequently takes place between the base of the cloud and the earth which is often a much shorter distance. From cloud to cloud the lightning may flash a distance of *ten or twenty miles,* and at such a time the discharge exercises a powerful *inductive* effect on all nearby clouds, which may cause flashes to occur in rapid succession.

When a *negatively* charged cloud approaches the earth, the *inductive* effect of the earth's charge may cause it to suddenly reverse its charge to *positive,* and the potential become so great that a discharge to the earth follows. Sixty per cent of these discharges to the earth carry *negative* electricity to the earth, while the remaining forty per cent carry *positive* electricity. This shows that sixty per cent of the discharges were from clouds which had built up a higher *negative* charge than the earth itself.

The phenomena of thunder-storm electricity cannot be said to be the product of any one particular cause, or of always exactly the same combination of causes. One thing, however, is certain. All of the above mentioned factors act together and atmospheric conditions are so variable and in such a continual state of change that a definite formula for their operation would be beyond the limits of possibility. The theories of thirty years ago which tried to explain lightning by means of atmospheric friction and other such causes have sunk into oblivion.

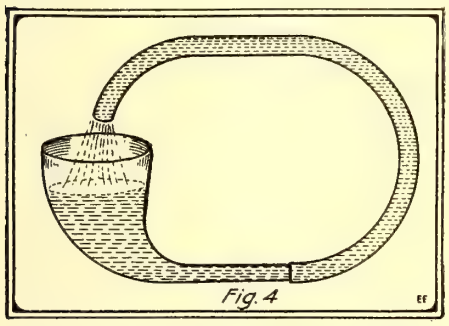
Experiments in Physics

PERPETUAL MOTION

By John J. Furia

(*Continued from page* 315)

See Fig. 6. In Electrostatics we learn that the sharper the point of a conductor, the greater the density of the charge present. Because of the great density, the charge leaves the conductor at the sharp points. If by some means we continually charge a conductor having a shape like that in Fig. 1, then the reaction will cause it to move as indicated by the arrows. The source of the charging can be a static machine (Whimshurst or other type). Why not belt the conductor so as to run our static machine; and sidetrack some of the electricity from the machine to be used for other purposes? One has but to look at the small weight of the conductor and the slow speed



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at which it runs and compare it with the large heavy static machine and the large force required to cause it to give a spark, in order to perceive at once the folly of such an absurd scheme.

Another idea along somewhat similar lines is the following: A screw fits tightly in a cylinder at the top of which is an ordinary rotary lawn sprinkler. As the screw is turned the right way, the water rises in the cylinder. When the water reaches the level of the sprinkler, it comes out from the nozzles and the reaction causes the sprinkler to turn. Once this machine is started it should operate forever, for as it turns, water rises to the sprinkler—while as the sprinkler operates, it turns and causes water to rise in the cylinder. It takes considerable force to cause the sprinkler to rotate due to the reaction; it would require still more force if the sprinkler had to in addition do the work of lifting the water up the cylinder. The reaction due to the water coming out from the level of the sprinkler *with no force behind it* is very small, and not ever sufficient to cause the sprinkler to budge. See Fig. 2.

Fig. 3 represents the cross-section of a cylinder containing grooved curved spokes. Marbles or lead balls rest in the grooves. It will be seen that the marbles at the left are further from the center than those at the right. Consequently because the rotational moment on the left is greater than that on the right (the marble being of the same size and weight) not only will the machine move perpetually and do work, but it will even start itself? By putting a belt around the cylinder, machinery can be driven continually, perhaps?!X! It is true that the moment on the left is greater than that on the right and therefore there is *apparently* a tendency to cause rotation opposite to the rotation of the hands of a clock, but if rotation is to take place the top marbles near the center vertical axis will have to be raised over the bend in the spoke, and the machine having no means of doing this, the scheme fails miserably.

The following is a good example of perpetual motion proposed by one ignorant of the simplest fundamentals of hydrostatics. If a pipe having a very large bowl is connected to a piece of tubing of small diameter, and curled in the shape shown in Fig. 4, when water is placed in the bowl, it should come out from the end of the tubing, thus filling the pipe bowl again and the passage of water from the pipe bowl out thru the stem and tubing back to the pipe again *will be continuous?* This will operate as long as the amount of water in the bowl is large compared with that in the stem and tubing, for then the weight in the bowl will be greater than that in the stem and tubing, and the weight in the bowl will force the water thru the stem and tubing, said early philosophers. This explanation, of course, ignores the fact that it is the pressure in the liquid that counts and not its weight, and since both ends (the bowl and the tubing) are exposed to the atmosphere, they are at atmospheric pressure and hence the liquid will stay at the same level in both.

(NEXT ARTICLE—STAGE TRICKS AND ILLUSIONS)

Jeweled Portal Welcomes N. Y. Fighters

(*Continued from page* 311)

altar on the farther side, making a total width of 110 feet. The bejeweled obelisks rise to a height of eighty feet and are surrounded by great jeweled forms in the shape of sunbursts which are each twelve feet wide and twenty feet in length.

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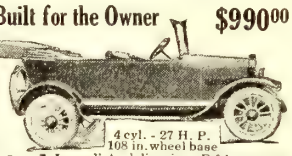
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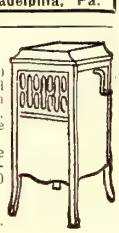
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Peacetime Uses for War Inventions

By H. Winfield Secor

(Continued from page 365)

gines of the distant vessel is picked up by a sound-sensitive electrical instrument, known as a *microphone*. By turning the microphone in different directions, and noting carefully the position where the maximum sound is heard in the receivers, the spot from which the sound originally emanated can readily be determined even to within a fraction of a degree, it is claimed. For locating icebergs or other obstructions, which of course do not produce any sound themselves, there is required a *sound producer* such as an under-water electric bell or siren. The sound waves radiate from this device, mounted between two microphones on a rotatable arm secured to the vessel, as the illustration shows, travel outward until they impinge against the iceberg or other impediment, when they are *reflected* as the arrows show. These reflections, or the "echoes," are listened for by the aid of microphones and sensitive telephone receivers connected with them. By swinging the bar supporting the microphones and siren in different directions, the position of the obstruction is at once determined. Its distance can also be ascertained with some of the more highly developed apparatus of this class, by direct reading instruments, or else by the relative strength of the sound heard in the receivers.

The *Radio Compass*, as it is called, has come greatly to the fore in the past three years. Prior to the World War it existed mostly in the laboratorial stage. But at the close of the war radio compass stations were to be found not only in the principal coastal regions in the vicinity of shipping activities, but they were also to be found on the great battlefields of Europe, where they were used for the purpose of accurately locating "enemy" radio stations. The radio compass should, we might almost say, find even a greater field of useful application in peacetime than it did during the war. It promises to become one of the most important scientific developments in wireless telegraphy, particularly for the navigation of aircraft. We were recently informed by a naval radio expert that the English Navy had the radio compass scheme worked out to wonderful perfection, and that during the war they were actually able to steer vessels up the entrance to the Liverpool Harbor, one of the most treacherous harbor entrances in the world, on the darkest and most foggy nights, without ever having a collision. See Fig. 9. To do this, a series of radio compass stations were situated on either shore at short intervals, and these stations sent out predetermined radio signals at successive intervals. This expert also mentioned that it was very easy for any Allied war vessel to instantly obtain her location and bearings if she was anywhere about the coast of England or Ireland, utilizing the service of the radio compass stations which dot these coasts. If the vessel wished to know her location, the radio code signal for interrogative "L" was sent out twenty times. This was the official notice to nearby radio compass stations that the ship calling wished to know her location. At least two land compass stations then took readings of her signals, and by triangulation and by means of wire or wireless communication between the two stations which had a fixt base line, the triangle was solved in a few minutes, and the exact location of the ship was transmitted to her radio officer from one of the land stations. The ship received her location figures in latitude and longitude about five minutes after sending out the call letter aforementioned.



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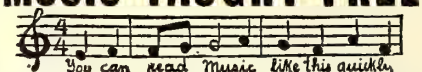
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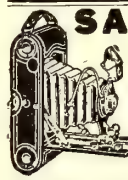
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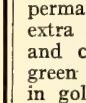
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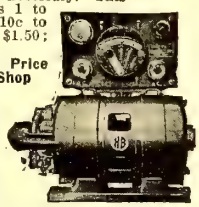
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Airplane Photography was pre-eminently one of the most highly developed sciences brought out by conditions imposed by the World War. Complete sections of the battlefront often had to be photographed in a single day's time, and by means of camera guns, and other extremely rapid photographic devices, thousands of pictures could be taken within a few hours in such a manner that when the films were developt and prints made, which took a short time with the perfected apparatus used by the Army in the field, these prints could be matched up by map experts so as to give a true composite photograph of an entire region. The work done by the Photographic Department of the Army in this respect was nothing short of miraculous. At a recent exhibit of this Department's work, one of the composite aërial photographs showed the entire city of Washington, D. C., and environs. The airplane flew over Washington in a certain prescribed course and took all of the photographs which composed the composite view in a little over *two hours!* The individual prints making up the composite view usually measured about three inches square. Imagine how easy it now becomes to obtain actual physical maps of such regions as the Rocky Mountains and other inaccessible and treacherous localities so that our geographies of tomorrow may indeed prove a marvelous revelation to the school students of today. Airplane photography in its modern aspect and with the high speed available should lend itself well to the requirements of mapping real estate, large farms, railroad sites and hundreds of other localities for many kindred purposes. See Fig. 10.

Gas Masks, as well as *Gas Detectors,* find many uses in our everyday life. The gas masks are useful to firemen and rescue squads and prove particularly efficacious for use in entering gas-filled mines and other subterranean passages. Gas detectors are not so well known to the general public, as these proved one of the extremely valuable keys to the success of the Allied soldiers. One ingenious form of electrical gas detector is illustrated in Fig. 11. This detector, which also permits of the measurement of the amount and strength of the gas present, comprises a pair of sensitive detecting wires, also a pair of resistance coils and a galvanometer, forming a Wheatstone bridge system, as the diagram shows. At the bottom of the apparatus is shown a metal block in which there are two cavities, each containing a gas detecting wire, and the gas reaches one of these wires thru a series of perforations placed in the external wall of the block. This clever patent has been granted to Gilbert A. Shakespear of Birmingham, England (U. S. patent number 1,304,208).

Depth Bombs apparently seem to be one of those peculiar inventions which follow the old adage—"killing two birds with one stone." Not only did they prove the undoing of the career of many U-boats, but they likewise show great promise of performing many useful peacetime tricks as well. Among other things, the depth bomb should prove uniquely successful in blasting ice jams in river gorges, etc. And as one of our naval officer friends recently told us, thousands of fish are stunned and killed every time a depth bomb is detonated on the water. See Fig. 12. Therefore, why fish with nets in the ocean, when by means of a few depth bombs detonated thirty to forty feet below the water you can stun or kill thousands of fish? Then by a simple suction arrangement pull them into the fishing smack so fast that it would take seventeen bookkeepers and three adding machines to keep account of the catch. Another practical use for depth bombs is the clearing away of derelicts or other obstructions in harbors, lakes or on the ocean.

BOYS



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Employers everywhere are looking for skilled draftsmen. They are offering good salaries to start with splendid chances for advancement.

Drafting offers exceptional opportunities to a young man because drafting itself not only commands good pay, but it is the first step toward success in Mechanical or Structural Engineering or Architecture. And drafting is just the kind of work a boy likes to do. There is an easy delightful way in which you can learn right at home in spare time. For 28 years the International Correspondence Schools have been giving boys just the training they need for success in Drafting and more than 200 other subjects. Thousands of boys have stepped into good positions through I. C. S. help, but never were opportunities so great as now.

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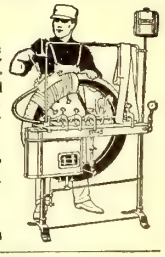
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YOU will find many remarkable opportunities and real bargains in these columns. It will pay you to read and investigate the offerings made every month by reliable firms, dealers and amateurs from all over the country. No matter what you may be seeking, whether supplies, automobile accessories, the opportunity to make money, or anything else, you will find listed here the best and most attractive specials of the month.

Advertisements in this section seven cents a word for each insertion. No advertisement for less than 50c accepted. Name and address must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency.

Ten per cent discount for 6 issues, 20 per cent discount for 12 issues. Objectionable or misleading advertisements not accepted. Advertisements for the September issue must reach us not later than July 22.

The Circulation of the Experimenter is over 115,000 and climbing every month

EXPERIMENTER PUBLISHING CO., INC., 233 Fulton Street, New York, N. Y.

Automobile Accessories.

Battery Charging Pays Big Profits. City current or gas engine operates. Easy terms. Hobart Brothers, Troy, Ohio.

Lubricant Carbon Remover. Cleans your engine and keeps it clean. Results guaranteed, $1. Circular. Lewis Gilbert, Skaneateles, N. Y.

Fords run 34 miles per gallon with our 1919 carburetors. Use cheapest gasoline or half kerosene. Start easy any weather. Increased power. Styles for all motors. Runs slow high gear. Attach yourself. Big profits for agents. Money back guarantee, 30 days' trial. Air-Friction Carburetor Co., 270 Madison St., Dayton, O.

Auto Motors and Supplies. Buick, Hupp, Franklin, Michigan, Everett, Hudson, Chalmers. Both water and air cooled motors, $40 each and up. Bosch Magnetos, $15 each and up. Presto Tanks, $5. Coils, Carburetors, Head Lamps, Horns, Air Compressors, Generators, Starters. Write for bargain bulletin second-hand auto accessories. Johnston, West End, Pittsburgh, Pa.

Power Increased; Carbon Eliminated; results guaranteed; write for booklet. No-Leak-O Piston Ring Co., Baltimore, Md.

Agents Wanted.

Beginners. Complete "Mail Order System." C, Box 1005, Atlantic City.

Agents Wanted to sell these rubless washing bars. Save soap and money. Agents making good. Le Hunt, 756 23rd St., Newport News, Va.

Big Money Made every day selling our automobile accessories. Every autoist a customer. Most remarkable inventions in the accessory line. Demonstration proves every claim. Particulars free. Exclusive territory if you act quick. The Embee Co., Wilkinsburg, Pa.

$10 Daily refinishing chandeliers, brass beds, automobiles by new method, without capital or experience. Free particulars and proofs. Write today. Gunmetal Co., Ave. D, Decatur, Ill.

Signs for store and office windows. $50 a week easily made. Chicago Sign System, G 326 River St., Chicago.

Wonderful Chance—Men's shirts and furnishings at wholesale rates, or make $10 daily starting real business. Goodell Co., Duratex Bldg., New York.

10 to $25 a day profit. Biggest summer seller. Concentrated fruit drinks. Just add water. Delicious drink in a jiffy. Six popular flavors. Bestever Products Co., 2426-SE-8 Polk St., Chicago.

Agents. Big returns, fast office sellers; particulars and samples free. One Dip Pen Co., 12 Daily Record Bldg., Baltimore, Md.

Insyde Tyres, inner armor for automobile tires, double mileage and prevent punctures and blow-out. Quickly applied. Costs little. Demand tremendous. Profits unlimited. Details free. American Automobile Accessories Co., Dept. 54, Cincinnati, O.

Help Wanted.

Auto Experts Wanted. $35 week. Learn easily while earning. Write immediately. Franklin Institute, Dept. H 806, Rochester, N. Y.

Detectives make big money. Travel; be your own boss. Either sex. We instruct, small cost. Write Johnson's Detective School, 232 Sheldon Ave., Grand Rapids, Mich., Dept. A.

U. S. Government wants Railway Mail Clerks. Hundreds needed. $1,100-$1,600 year. Examinations everywhere, Aug. 23. Sample questions free. Write immediately. Franklin Institute, Dept. H 26, Rochester, N. Y.

Agents 200% Profit. Wonderful little article. Something new; sells like wildfire. Carry right in pocket. Write at once for free sample. Albert Mills, Mgr., 1287 American Bldg., Cincinnati, Ohio.

Fishing.

Julian's Liquid Fishing Lure. Doubles your catch. By mail One Dollar. Circular for stamp. George Julian, Albany Bldg., Boston, Mass.

Postcards.

Five Prettiest Women Cards, hand colored, 25c. Chas. Durso, Dept. 41, 25 Mulberry St., New York City.

Stammering.

St-Stu-t-t-tering and Stammering cured at home. Instructive booklet free. Walter McDonnell, 105 Potomac Bank Bldg., Washington, D. C.

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233 Fulton St., New York City.

Dear Sirs:

Find inclosed a bill for 98c and also money for same. Kindly send receipt. Please pardon me for not sending it sooner.

It was the best ad I ever had and if I ever have any other instrument to dispose of I will advertise in your columns. I received 24 answers inside of 4 days.

Yours for success,

(Address) J. Rife Barbusser,

Exchange Ads.

For Sale—Electro Importing Co. Loose Coupler $6. Never used. James Walker, Pontiac, Mich.

Sacrifice: Large Camera, large Scientific book. Want: Wireless Apparatus. Stamp for list. Weniger, Brownsdale, Minn.

Exchange, Buy, Sell. Wireless, electrical goods, etc. Large list 6c. State what you have and want. Zehrbach, Box 600, Hiram, O.

Boys' Books for chemical or electrical apparatus. Stamp for list. Homer Votaw, Raymond, Wash.

For Sale—One new bicycle motor. Makes your bicycle a motorcycle. Walter Van Schaick, Lake Benton, Minn.

For Sale—One pair Murdock phones with cord, "Regular" Headband, two thousand ohms. Second-hand, but very sensitive. Twelve "Electrose" Ball insulators. New Six "Electrose" strain insulators. New one six hundred volt ground switch, 6 lbs., new. Thirty feet high tension cable 7/16 inch diameter, twenty thousand volts discharge. New six lbs. Copper Clad Wire, 510 feet. Best and latest Wire, new. Cash. Twenty Dollars, or make offer on part of equipment. H. K. Tryon, Berlin, New York.

$5 Electrical Water Purifier; want Film camera. Prints—or offers. Clarence Skinner, Topeka, Kansas.

For Sale—Wireless and electrical apparatus, also other articles. Cheap. List free. Write quick. Atley Maurek, Box 157, Austin, Minn.

Cheap—Twenty-three dollar Omnigraph. Arnold and Murdock Couplers. Load. Detectors. Meeker, 1632 University Ave., N. Y.

Exchange pair 1,500 receivers, headband, 100 Amp. switch, 9-4" insulators, fixed condenser, 2 lbs. aluminum wire No. 14, spark gap, 15 ft. ground wire; for folding camera like Kodak, value $10 (2¼x3¼). Maron, 390 Highland Ave., Malden, Mass.

For Sale—Complete unused analytical and industrial I. C. S. Chemistry Course. First $20 takes it. Nicholas Michel, 217 South 4th St., St. Charles, Mo.

5 H.P. 2 cycle single cylinder air cooled engine. Coil ignition. New piston rings and spark plug, good carburetor. Guaranteed A-1. $25. Money with letter. James E. Walker, Box 63, Marfa, Tex.

For Sale—"Ranger Arch-Frame" bicycle; 22-inch, three-speed, clincher tires, nearly new, $43. Stamp for answer. Gerald Willard, Heron Lake, Minn.

Exchange Ads—Cont'd

For Sale—2 K.W., D.C. 110 V. Dynamo. Marble slab with 0-150 V. Meter field rheostat and switch attached. Price $100. Or part in wireless receiving apparatus. S. R. McClure, Helm, Ky.

Wanted—Everything. Motor-wheels, cyclecars, anything. R. Place, Sprague, Fall River, Mass.

Attention, Experimenter—Brand new books, "Radio Telephony," by Alfred Goldsmith, $1.25 (sells for $2.00). "Practical Wireless Telegraphy," by E. E. Bucher, $1.25. Arthur E. Reider, 348 E. 15th St., N. Y. C.

Your Opportunity to Save Money. I have Printing Outfit; cost $150; is almost new; will sell for $100 cash. Have lots of Electrical Wiring Supplies; will sell at my cost (wholesale prices). Paid $80 for Smith Motor Wheel; very good condition; will sell for $45 cash. Above statements and your complete satisfaction fully guaranteed. Privilege to return within 10 days. H. L. Baer, Van Wert, Ohio.

Bargain—1,200-mile Receiving set, includes loose coupler, loading coil, condenser, silicon detector, buzzer code. Mounted; for $7. Money Order. Merle Doan, Vera, Oklahoma.

For Sale or Exchange: Six copies of Hawkin's Guides, $3.90; 1 400-day clock in first class condition, $5; 1 1 K.W. Thordarson Transformer, $18.90; 1 ¼" Spark Coil, $1; 1 1-K.W. Tesla Coil, $15; 1 Crystaloi Detector, Type AA, $5; 1 E. I. Co. loose coupler, $2; 1 Navy Type loose coupler, $4. All in first class condition. Address Walter Franseen, Woodhull, Ill.

For Sale—$40 Cabinet Set. Receives any 1 K.W. set in States. Uses bulb detector. Two loading coils free. $20. $35 Rotospeed Duplicator and equipment, $20. No. 3 Box Brownie, $2. Any article C. O. D. upon 25% payment. No trades. J. C. Gilliland, Munhall, Pa.

For Sale—½ K.W. Wireless Transformer complete with rotary motor gap and one battery charging outfit; will charge 3 six-volt batteries at once. Will sell all of above for $75. A good bargain for someone. E. L. Forslund, Madrid, Iowa.

Sell—3 1-qt. size Wet batteries, 75c each; 2-plunge batteries, 75c; telegraph outfit, $1.00; Selenium cell outfit, $1.00; loose coupler, $3.00; 6 bar magneto 110 volt generator, $4.00; telephone set, $3.00; Structo Auto Builder, $4.50. Raymond Fiedler, 70 Sargent Street, Lawrence, Mass.

Sale—1" coil, $2.50; O. K. motor, $1.00; step-down Thordarson, $3.50; ¼ K.W. transformer, $5.00. Also wire, silicon steel, etc. R. P. Hanger, Sherwood Ave., Staunton, Va.

Motor Winders. See ad under "Blueprints." Charles Chittenden.

Motor Generator for Sale. 220 volt, 60 cycle, single phase motor, 30 ampere, 36 volt generator. Specially wound for battery charging; 1 to 24 batteries charged at one time. Used very short time; good as new. Price, including switchboard and 4 charging rheostats, $230. Earl Hotchkiss, Forestville, Conn.

For Sale—High grade regenerative receiver with phones. Will sell parts separately. Also have key, large oil condenser, half-inch coil, motor, etc. Write for prices and description. E. H. Hartnell, Salem, Wis.

For Sale—$8 Loose Coupler, $6; 2,000 Ohm receivers, $4; $4.50 Variable Condenser, $3.50; $3.50 Variable Condenser, $3; $1 Fixed Condenser, 60c; $4.50 Detector, $3; $2.25 Transformer Key, $1.50. All Murdock goods. 2" Spark Coil, $6; Gernsback Interrupter, $1.85; 2 ½-pt. Leyden Jars, $2; $5 Vacuum Bulb, $3; 6 Volts 6 Amp. Dynamo, $1. Guaranteed all new. Send money order. K. Jennings, 106 Blue Hill Ave., Mattapan, Mass.

For Sale—One I. C. S. Heavy Electric Fraction Course without bound volumes. Highest cash price takes. Elwood Little, Decatur, Ill.

Wanted—Wireless goods for 3¼x4¼ Premo Camera. G. Kostka, 2215 St. Louis Ave., Chicago.

Will trade I. C. S. Mechanical Engineering Course for Chemical Laboratory. Herbert Langlois, 2414 Cleveland Ave., Everett, Wash.

For Sale—Steel Radio Tower, 115 ft. high. A bargain. W. Turnor Lewis, Racine, Wis.

Sell. Set of Ford Spark Coils, $7.50. Extension Desk Phone, $6. 2000 ohm Receivers, $2. Phillip Stout, 1621 Riverside Drive, Knoxville, Tenn.

Business Opportunities.

Start a Profitable Business manufacturing "Puffed Crisp." Delicious confection. Whirlwind money-maker. Machine, Instructions complete $6.50. Samples 10c. Bestever Products Co., 2426-PE-8 Polk St., Chicago.

$30 a Week. Evenings I made it with a small Mail Order Business; continued my regular job daytime. Free Booklet Tells How, 2c postage. Albert W. Scott, Cohoes, N. Y.

Enter a New Business. Earn $3,000 to $6,000 yearly in professional fees making and fitting a foot specialty, openings everywhere with all the trade you can attend to; easily learned by anyone at home in a few weeks at small expense; no further capital required; no goods to buy; job hunting, soliciting or agency. Address Stephenson Laboratory, 18 Back Bay, Boston, Mass.

Anyone Interested in making $100.00 month in spare time at home? Send 25c. (coin). L. Stutz, Middletown, Md.

$1 Does It. Bank references furnished. Investigate us thoroughly, that's all we ask. Results count. Our plan $1 down, $2 monthly few months gives you Warranty Deed to land. May pay profits $200 or more monthly. Maps, reports, established facts free. Address Sourlake Texas Oil Co., 867 De Menil, St. Louis, Mo.

Build Up an Income in Oil. Others are doing it—Why not you? Today is the opportunity. Join our easy monthly payment plan now—it may mean hundreds in profits. Write for information. National Oil Drilling Co., Dept. K, Houston, Texas.

Dollars Yearly in Your Back Yard. No ginseng, mushroom dope. New ideas. Investigate. Particulars free. Metz, 313 East 89, New York.

Manufacturers of Electric Vibrators and Hairdryers are requested to send us price lists at once and conditions of payment and delivery. I. Calvete, Ltd., 46, Newman Street, Oxford Street, London, W. I. England.

We Write Ads. that pull. Send outline for advice. Sales Letter $2. Jacobus Advertising Service, 1073 Sanford Ave., Irvington, N. J.

Victory. Mechanical Toy Soldier window attraction. 30 inches high. Salutes, turns head, points with finger, etc., as set. Well made, nicely dressed officers, privates, Uncle Sam, etc. Electrically operated. Does some stunt every half minute or oftener as set and will salute soldier and pay no attention to other if desired. Representative wanted in each city and town. Write for prices. The John M. Biggs Co., Box 324, Chattanooga, Tenn.

We will start you in the cleaning and dyeing business; little capital needed; big profits. Write for booklet. The Ben-Vonde System, Dept. H, Charlotte, N. C.

Open for proposition. R. A. Holmes, 1934 Edmondson Avenue, Baltimore, Maryland.

Break Into the Newspaper Game as correspondent or city reporter. Our correspondence course indorsed by leading editors. We give instruction and actual experience in gathering and writing news. Write for details. American Institute of Journalism. "A Newspaper School Run by Newspapermen." Dept. E, 22 Hawley St., Boston.

Your Money Back within ten days if not satisfied. Only one dollar per share for undivided interest in Sinking Ship Saver Patent. Two full pages illustrated description on second and third pages, news section, in 1918 June issue Illustrated World and first full page July, 1918, Popular Mechanics Magazine. Send $10, $25, $50, $100, or $1000 for as many shares and copy of patent. Inspect them and if not satisfied return to me within ten days and get your money back. C. Stewart Henslee, Inventor and Patentee, Chattanooga, Tenn.

Money-Making Farms. 19 States. $10 to $100 acre. Stock, tools, crops, often included to settle quickly. Write for big illustrated catalog. E. A. Strout Farm Agency, 150 E C Nassau St., New York.

The Enricht Chemical Technical Laboratories at Farmingdale, N. Y., offer their services to Manufacturers in Research work to improve and cheapen their output. Terms moderate. Correspondence solicited. Results guaranteed or no charge.

"Quick-Action Advertising—How It Is Building Business for the Progressive Advertisers of America"; A little story of results told by the advertisers themselves—not the publishers. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 W. 39th St., New York.

Blue Prints

236 A. C. Motor Connections, 2 to 12 poles, contains 54 single, 42 two phase, 50 three phase Star, 40 Delta, 12 Star-Delta. Appendix 38, changes of voltage, phases, speed, cycles, etc. Particulars and sample free. Charles L. Chittenden, 811 West 18th Street, Kansas City, Missouri.

Motors, Engines & Dynamos.

Gas Engines. Marine, stationary and cycle motors for bicycle attachment, rebuilt and guaranteed. Don't fail to get our price list before buying. Prices 50% lower than others. Write. United Motor Repair & Supply Company, 305-309 Broadway, New York.

Small Motors and Generators from bankruptcy and receivers' sales. Motors for all phases of current. Immediate delivery. Less than one-half regular prices. See display ad on page 259. Johnston, West End, Pittsburgh, Pa.

Gasoline Engine, marine or stationary, ¾ horse. Castings, $8. Speed Lathe complete, $2.75. Send 12c for blueprints. M. & J. Specialty Co., 252 Parke St., Pontiac, Mich.

Miscellaneous

For Sale. Choice Silver Black breeding foxes. Reid Bros., Bothwell, Ont., Canada.

Wanted. Small gasoline and steam engines, small lathes, drill presses and other light machinery. Will pay high cash prices for good material. Johnston, West End, Pittsburgh, Pa.

Here, Boys! Jersey Skeeter, flies 100 feet; see our ad page 344. Nifty Novelty & Toy Co., Newark, N. J.

Mansfield's Automatic water and oil finder a proved success, silver medal awarded. Particulars from Edwin A. Mansfield & Co., 94 Victoria Road, New Brighton, England.

Let me send you a harmless and agreeable recipe to stop the odor and relieve your sore feet for one dollar. Guaranteed or money refunded. Louis Burchard, 119 East Vermijo St., Colorado Springs, Colo.

Breed Canaries. Profitable pastime. Particulars free. Bird Farm, Lynnhaven, Virginia.

Motion Pictures.

Electric Arc Generator halves expense. Your engine operates. Easy terms. Hobart Brothers, Troy, Ohio.

Photoplays Wanted. Big prices paid. You can write them. We show you how. Free particulars. Rex Publishers, Box 175, E14, Chicago.

News Correspondents.

Earn $25 Weekly, spare time, writing for newspapers, magazines. Experience unnecessary; details free. Press Syndicate, 566 St. Louis, Mo.

Song Poems Wanted.

Write the Words for a Song. We write music and guarantee publisher's acceptance. Submit poems on war, love or any subject. Chester Music Co., 920 So. Michigan Ave., Room 265, Chicago, Ill.

Write the Words for a Song. We revise poems, write music and guarantee to secure publication. Submit poems on any subject. Broadway Studios, 197C Fitzgerald Bldg., New York.

Stamps & Coins.

Stamps—12 different from warring nations, 10c; 10 different foreign coins, 15c; 10 Uruguay stamps, 10c. Lists free. Toledo Stamp Co., Toledo, O.

California Gold. Quarter size, 27c.; Half dollar size, 53c.; dollar size, $1.10; large cent, 1820, and catalogue, 10c. Norman Shultz, Kings City, Mo.

1844 cent, 10c. 727 McClellan Ave., Detroit, Mich.

Stamps—61 All Different Free. Postage, 3c. Mention paper. Quaker Stamp Co., Toledo, O.

100 Different Stamps 12c.; 200, 27c. Michaels, 5600 Prairie, Chicago.

Lusitania Medals. Exact duplicates of German medal celebrating murder of innocents. Everlasting proof of Hun's damnable duplicity. 50c each; three for $1.00; $3.00 per dozen. C. E. Mahood, Warren, Pa.

Best One Cent Approvals in America. F. P. Hand, 1117 So. 60th St., Philadelphia, Pa.

Rare Coin Over 100 Years Old, 12c. Bohn, Crafton, Pa.

Approval Applicants, 65 different stamps Free. Reference—5 cents. Harland Burgett, 419 Spring St., Lima, Ohio.

Old Money Wanted.

We Buy and Sell Old Coins. $2 to $500 each paid. Keep All Old Money; you may have valuable coins. Send 10c. for New Illustrated Coin Value Book, 4 x 6. Guaranteed prices. Get posted. Clarke Coin Co., Box 110, Le Roy, N. Y.

Telegraphy.

Telegraphy (both Morse and wireless) and Railway Accounting taught thoroughly and quickly. Big salaries now paid. Great opportunities. Oldest and Largest School—est. 45 years. Catalog free. Dodges Institute, 7th St., Valparaiso, Ind.

Cameras, Supplies—Photo Developing.

Clean, Neat, Perfect Kodak Finishing at the lowest prices. Work returned the same day received. Send film for sample print and copy of catalogue on developing, printing, enlarging and hand coloring, also copy of Photo Craft Magazine, which will help you make better pictures. Photo Craft Co., Box 69, Ann Arbor, Mich

For 15c we will develop and furnish prints from one, six or eight exposure film or enlargement 8x10, your favorite negative, 20c to show quality and service. Associated Photo Company, Sta. A 12, Cincinnati, Ohio.

Mail us 15c with any size film for development and six velvet prints. Or send six negatives, any size, and 15c for six prints. Or send 35c for one 8 x 10 mounted enlargement. Prompt, perfect service. Roanoke Photo Finishing Co., 255 Bell Ave., Roanoke, Va.

Health.

Cigarette, pipe or chewing habit conquered. Nature's method. Guaranteed. Write for free brochure. Edw. J. Woods, TA-300, Station F, New York.

Tobacco or Snuff Habit Cured or no pay; $1 if cured. Remedy sent on trial. Superba Co., SA, Baltimore, Md.

Tobacco, Cigarette Habit Quickly Overcome. Eniram Remedy Co., Anderson, Ind.

Pyorrhea. H. E. Kelty, D.D.S., M.D., pyorrhea specialist for 15 years, has developed a successful home treatemnt for pyorrhea. Purifying, healing, preventative. Full month's treatment and booklet $1. Circular free. Dr. H. E. Kelty, 106 Gladwin Ave., Leonia, N. J.

Chemicals.

Chemicals in Sets, $13.50 to $54.25. Apparatus in sets, $11.75 to $55. Write for particulars. Ziegler Experimental Laboratory, Rochester, N.Y.

Chemicals. Special, 35 different chemicals, one ounce of each, including mercury, acids, etc. Sent express prepaid $2.50. Jos. Simpson, 3880 Windsor Place, St. Louis, Mo.

Amateurs and Experimenters—We can supply you with any chemicals and apparatus at the lowest prices. Write for our price list. Jos. Simpson, 3880 Windsor Pl., St. Louis, Mo.

Chemists. Send 75c for a complete set of 150 labels for your chemicals. Reginald Pitts, 103 Third St., Hanover, Pa.

Standard Chemicals and laboratory apparatus, cheap and reliable. July list and 10 formulae 6c. Frane, Eureka, Ill.

Potassium Sulphocyanide C. P. at 50c per oz., postpaid. Ziegler Experimental Laboratory, Rochester, N. Y.

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Continued on page 382

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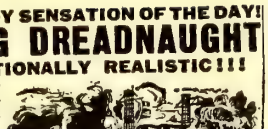
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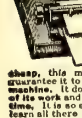


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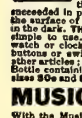
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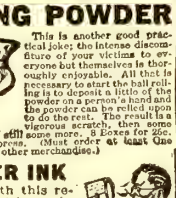
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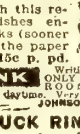
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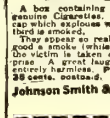
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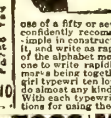
A box containing ten apparently genuine Cigarettes. They contain a tap which gets odorous when one-third is smoked.

They appear real, and afford as good a smoke (while they last) that the victim is taken entirely by surprise. A great laugh producer and entirely harmless. Price, box of ten, 25 cents, postpaid.

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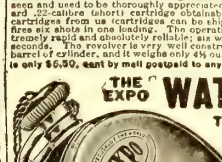
Measures but 4¼ inches long

Takes regular .22 calibre cartridges

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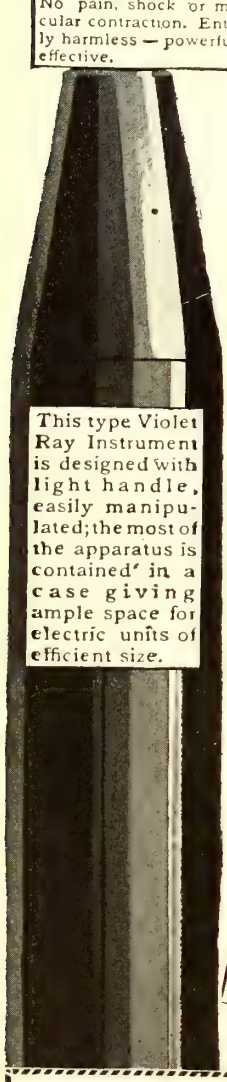
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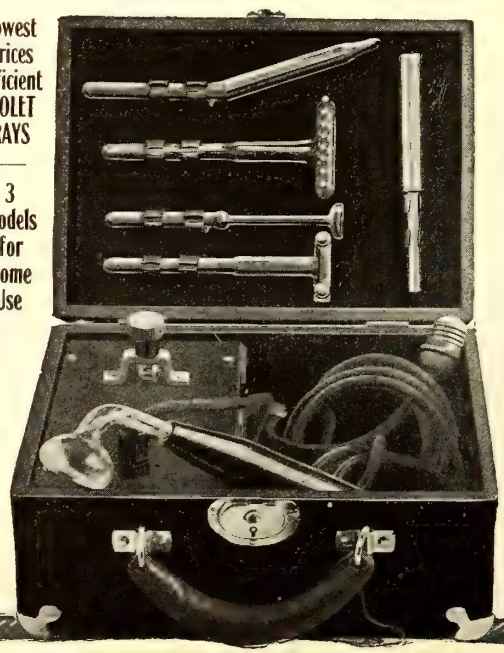
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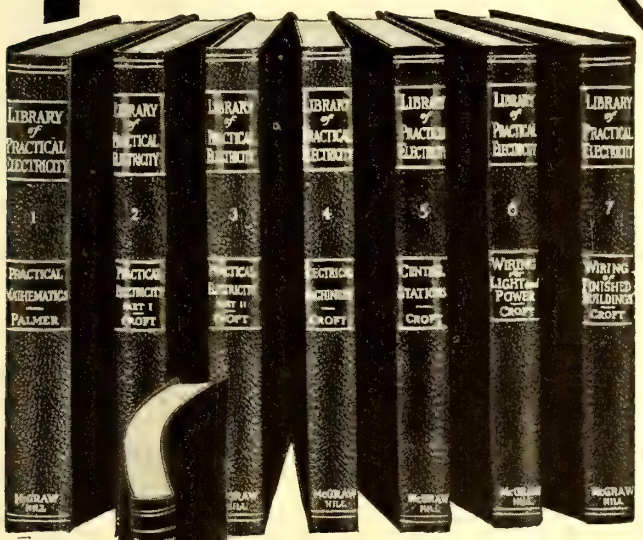
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EDITORIAL

HAIL

EVERY year millions of dollars' worth of crops and property are destroyed by hailstorms. Not infrequently human beings and cattle are killed, due to their inability to reach shelter in time. Of course such occurrences are not very frequent, which is explained by the fact that the average size of a hailstone is not much larger than a small hazelnut. But hailstones the size of a man's fist are by no means uncommon. Stones weighing two pounds have been observed, but these are very rare. But whatever their size or weight, hailstones are exceedingly destructive. Hurled from a great height, with a powerful wind accelerating their own speed, these frozen ice-pellets destroy vegetation at an appalling rate annually. Fruit on trees, crops and all vegetables are mowed down over great areas several times each year.

In the United States there is an average of over three hailstorms a year—Ohio leading with over ten such storms annually. Now the curious and outstanding fact about hailstorms is that nearly all of them occur during the summer, and practically none occur without thunder and lightning. There is nothing new contained in this statement—every child knows it. But here the writer would like to inject a new thought: namely, that the formation of hailstones is directly due to certain and as yet not clearly understood electrical processes. In other words, the formation of these round ice stones is the product of the electric current or static electricity.

This theory can be upheld by a few very simple arguments. In the first place, the height at which hail-clouds move is very low—never high enough to permit water to freeze. Proof: During all hailstorms rain always falls amid the hailstones, *and this rain is quite warm.* If the hail were formed by a sudden cold air wave, as our text-books want us to believe, where do the warm raindrops come from—or why does it not snow at least? However, it never does, particularly during the summer season.

But this is not all of the story. According to Jaentr, who investigated the subject thoroly, each hailstone is, as a rule, composed of a mass of mixed snow and ice in whose interstices there is held a gas—probably air or oxygen—powerfully comprest within the central cavity. If the hailstone is opened under water, the enclosed gas is seen to expand. According to Jaentr this gas is held under a pressure of as high as *fifty atmospheres!* We know that cold alone cannot produce such a result, but we do know that the electrical current under certain favorable circumstances can and does produce cold. However, we admit that our present knowledge is not sufficient to permit of a clear understanding of the complicated processes that take place in the formation of a hailstone. It should be a fruitful field for the investigator.

This brings us to a remedy for hailstorms. Many methods have been tried in the past to prevent these destructive storms—notably cannonading the clouds in France, Austria and Italy. No relief whatsoever was had.

But if we once admit the electrical nature of hailstorms and fully prove it, the remedy should be simple. Huge kites, larger than those built up to now and capable of carrying a thick, stranded copper cable, should be sent aloft immediately when storm clouds gather. At a ridiculously low cost a dozen such kites, spaced a mile apart, could draw the electrical charge to earth, thus emptying the clouds of their danger. It is worth a trial at least.

H. GERNSBACK.

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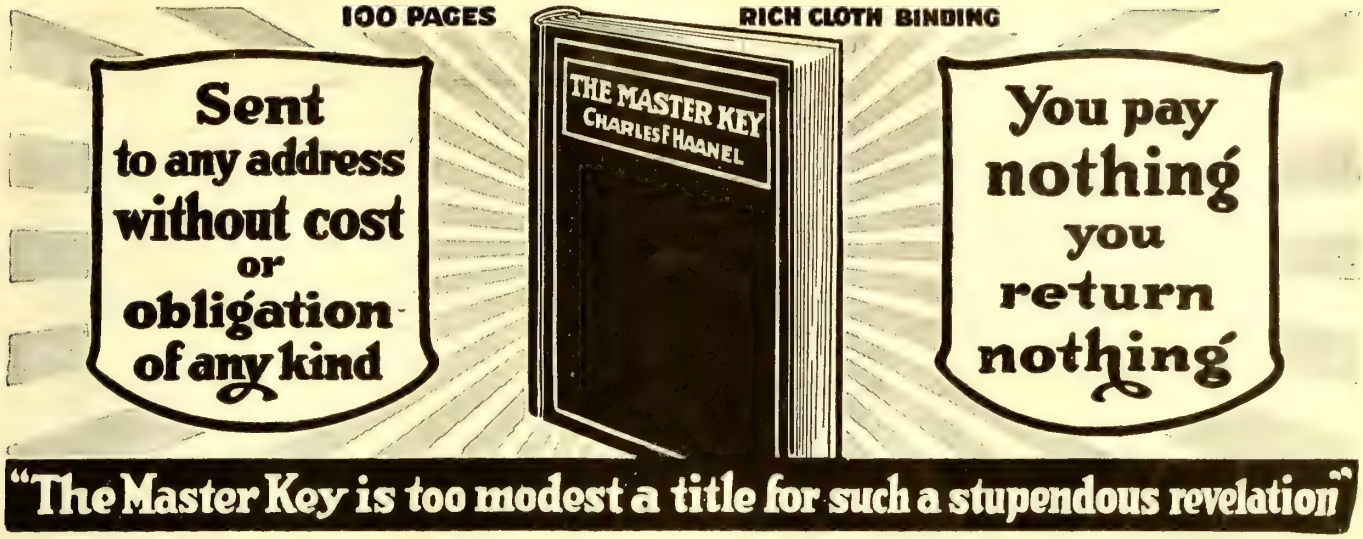
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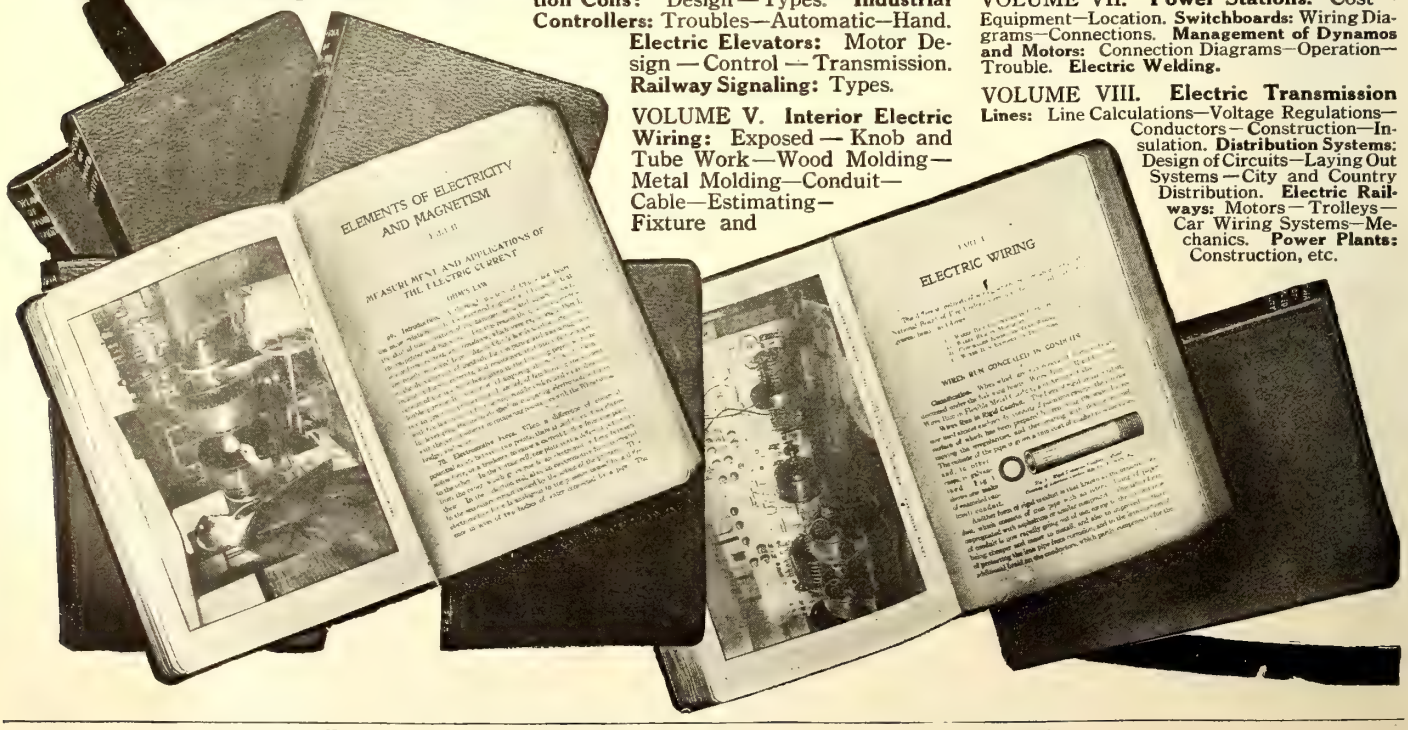
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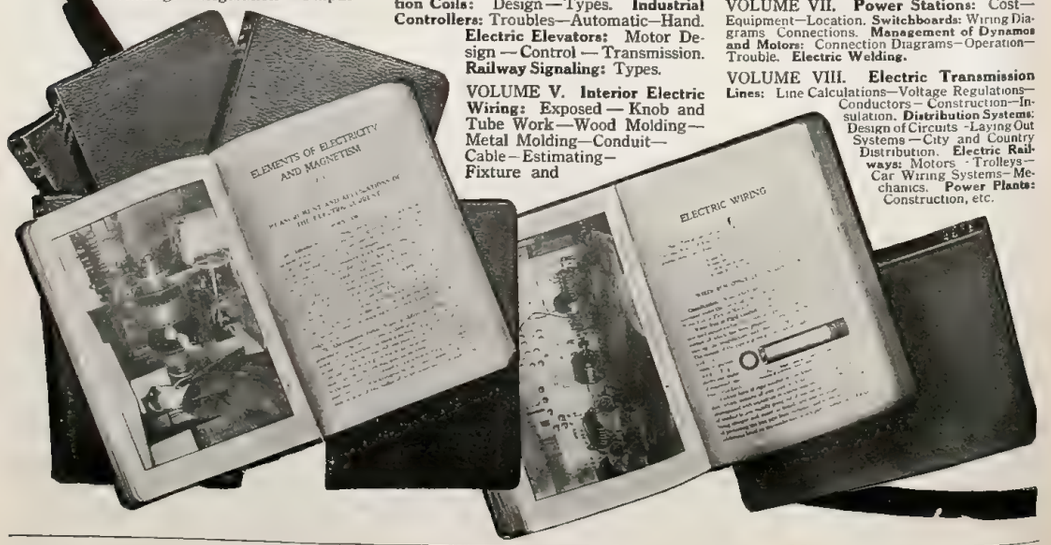
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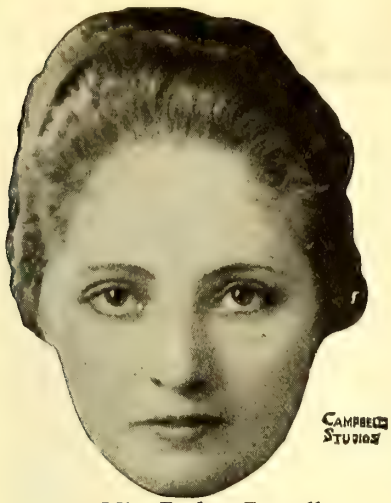
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Miss Evelyn Gosnell
in "Up in Mabel's Room"

Are You a Blond?

The Secret of Making People Like You



Wallace Reid
Star in "The Valley of the Giants"
A Paramount-Artcraft Picture

THE greatest asset any man can possibly have is the faculty for making people like him. It is even more important than ability.

The secret of making people like you lies in your ability to understand the emotional and mental characteristics of the people you meet.

Did you know that a blonde has an entirely different temperament than a brunet?—that to get along with a blond type you must act entirely different than you would to get along with a brunet?

When you really know the difference between blonds and brunets, the difference in their characters, temperaments, abilities and peculiar traits you will save yourself many a mistake—and you will incidently learn much you never knew before about yourself.

* * * * * * *

PAUL GRAHAM was a blond, and not until he learned that there was all the difference in the world between the characteristics of a blond and those of a brunet did he discover the secret of making people like him.

Paul had been keeping books for years for a large corporation which had branches all over the country. It was generally thought by his associates that he would never rise above that job. He had a tremendous ability with figures—could wind them around his little finger—but he did *not* have the ability to mix with big men; did *not* know how to make people like him.

Then one day the impossible happened. Paul Graham became popular.

Business men of importance who had formerly given him only a passing nod of acquaintance suddenly showed a desire for his friendship. People—even strangers—actually went out of their way to do things for him. Even *he* was astounded at his new power over men and women. Not only could he get them to do what he wanted them to do, but they actually anticipated his wishes and seemed eager to please him.

From the day the change took place he began to go up in business. Now he is the Head Auditor for his corporation at an immense increase in salary. And all this came to him simply because he learned the secret of making people like him.

You, too, can have the power of making people like you. For by the same method used by Paul Graham, you can, at a glance, tell the characteristics of any man, woman or child—tell instantly their likes and dislikes, and YOU CAN MAKE PEOPLE LIKE YOU: Here is how it is done.

Everyone you know can be placed in one of two general types—blond or brunet. There is as big a difference between the mental and emotional characteristics of a blond and those of a brunet as there is between night and day. You persuade a blond in one way—a brunet in another. Blonds enjoy one phase of life—brunets another. Blonds make good in one kind of a job—brunets in one entirely different.

To know these differences scientifically is the first step in judging men and women; in getting on well with them; in mastering their minds; in making them like you; in winning their respect, admiration, love and friendship.

And when you have learned these differences—when you can tell at a glance just what to do and say to make any man or woman like you, your success in life is assured.

For example, there's the case of a large manufacturing concern. Trouble sprang up at one of the factories. The men talked strike. Things looked ugly. Harry Winslow was sent to straighten it out. On the eve of a general walkout he pacified the men and headed off the strike. And not only this, but ever since then, that factory has led all the others for production. He was able to do this, because he knew how to make these men like him and do what he wanted them to do.

Another case, entirely different, is that of Henry Peters. Because of his ability to make people like him—his faculty for "getting under the skin" and making people think his way, he was given the position of Assistant to the President of a large firm. Two other men, both well-liked by their fellow employees, had each expected to get the job. So when the outside man, Peters, came in, he was looked upon by everyone as an interloper and was openly disliked by every other person in the office.

Peters was handicapped in every way. But in spite of that, in three weeks he had made fast friends of everyone in the house and had even won over the two men who had been most bitter against him. The whole secret is that he could tell in an instant how to appeal to any man and make him well-liked.

A certain woman who had this ability moved with her family to another town. As is often the case, it is a very difficult thing for any woman to break into the chill circle of society in this town, if she was not known. But her ability to make people like her soon won for her the close friendship of many of the "best families" in the town. Some people wonder how she did it. It was simply the secret at work—the secret of judging people's character and making them like you.

* * * * * * *

YOU realize, of course, that just knowing the difference between a blond and a brunet could not accomplish all these wonderful things. There are other things to be taken into account. But here is the whole secret.

You know that everyone does not think alike. What one likes another dislikes. What pleases one offends another. And what offends one pleases another. Well, there is your cue. You can make an instant "hit" with anyone, if you say the things they want you to say, and act the way they want you to act. Do this and they will surely like you and believe in you and will go miles out of their way to PLEASE YOU.

You can do this easily by knowing certain simple signs. In addition to the difference in complexion, every man, woman and child has written on them signs as distinct as though they were in letters a foot high, which show you from one quick glance exactly what to say and to do to please them—to get them to believe what you want them to believe—to think as you think—to do exactly what you want them to do.

Knowing these simple signs is the whole secret of getting what you want out of life—of making friends, of business and social advantage. Every great leader uses this method. That is why he IS a leader. Use it yourself and you will quickly become a leader—nothing can stop you.

You have heard of Dr. Blackford, the Master Character Analyst. Many concerns will not employ a man without first getting Dr. Blackford to pass on him. Concerns such as Westinghouse Electric and Manufacturing Company, Baker, Vawter Company, Scott Paper Company and many others pay Dr. Blackford large annual fees for advice on dealing with human nature.

So great was the demand for these services that Dr. Blackford could not even begin to fill all the engagements. So Dr. Blackford has explained the method in a simple, seven-lesson course, entitled, "Reading Character at Sight." Even a half hour's reading of this wonderful course will give you an insight into human nature and a power over people which will surprise you.

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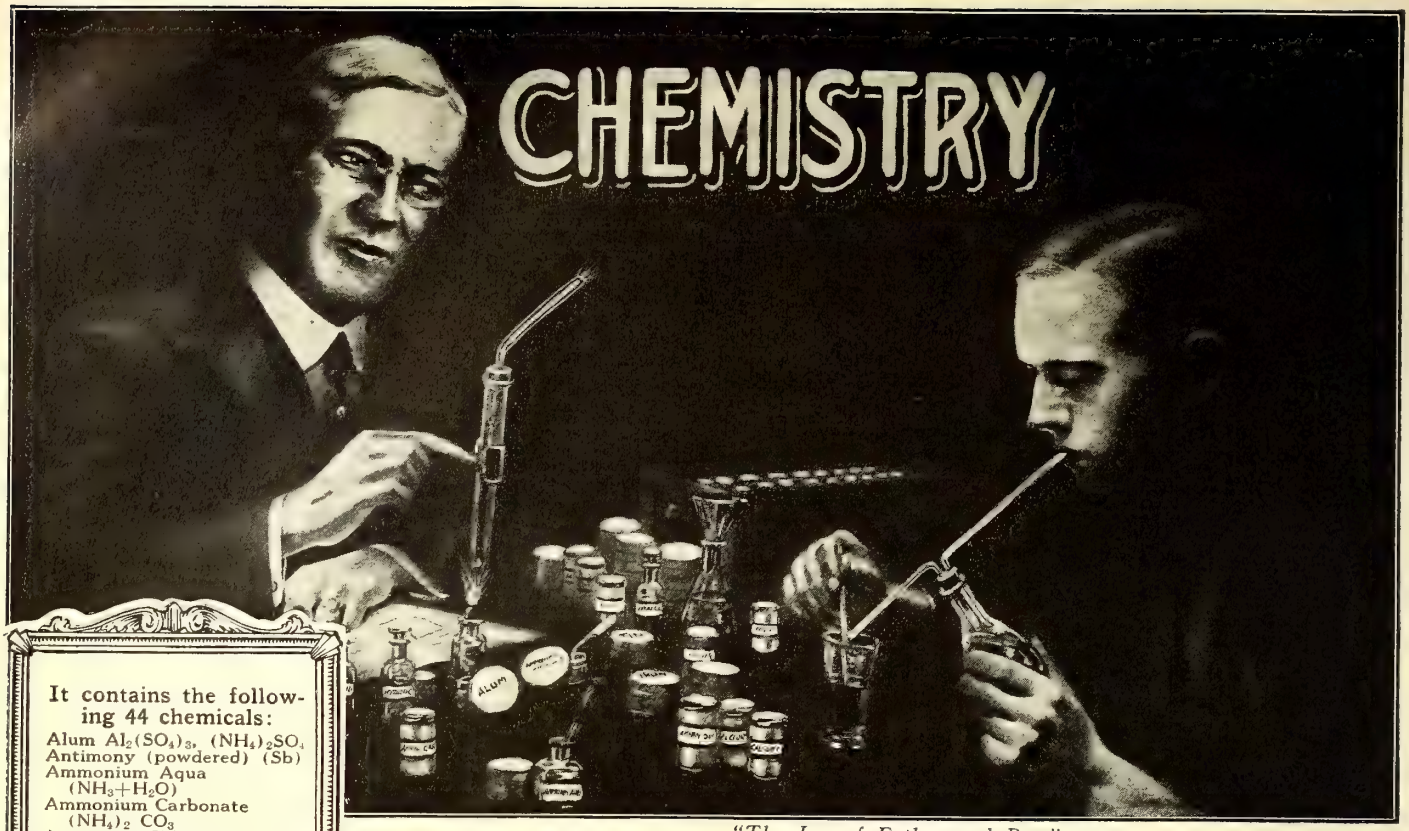
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The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

Among the **100 Experiments** are:

How to make chemical tricks; How to make invisible and magic inks; How to test flour; How to test soil; How to Make Chlorine Gas and smoke (German War Gas); How to bleach cloth and flowers. How to produce Oxygen and Hydrogen; How to make chemical colors; How to test Acids and Alkalies and hundreds of interesting hints and formulas.

It contains the following 44 chemicals:

Alum $Al_2(SO_4)_3$. $(NH_4)_2SO_4$
Antimony (powdered) (Sb)
Ammonium Aqua (NH_3+H_2O)
Ammonium Carbonate $(NH_4)_2\ CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride $(BaCl_2)$
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride $(CaCl_2)$
Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_4 2H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate $(MgCO_3)$
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
Sulphate of Nickel $(NiSO_4)$
Sulphate of Zinc $(ZnSO_4)$
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
Zinc Carbonate $(ZnCO_3)$

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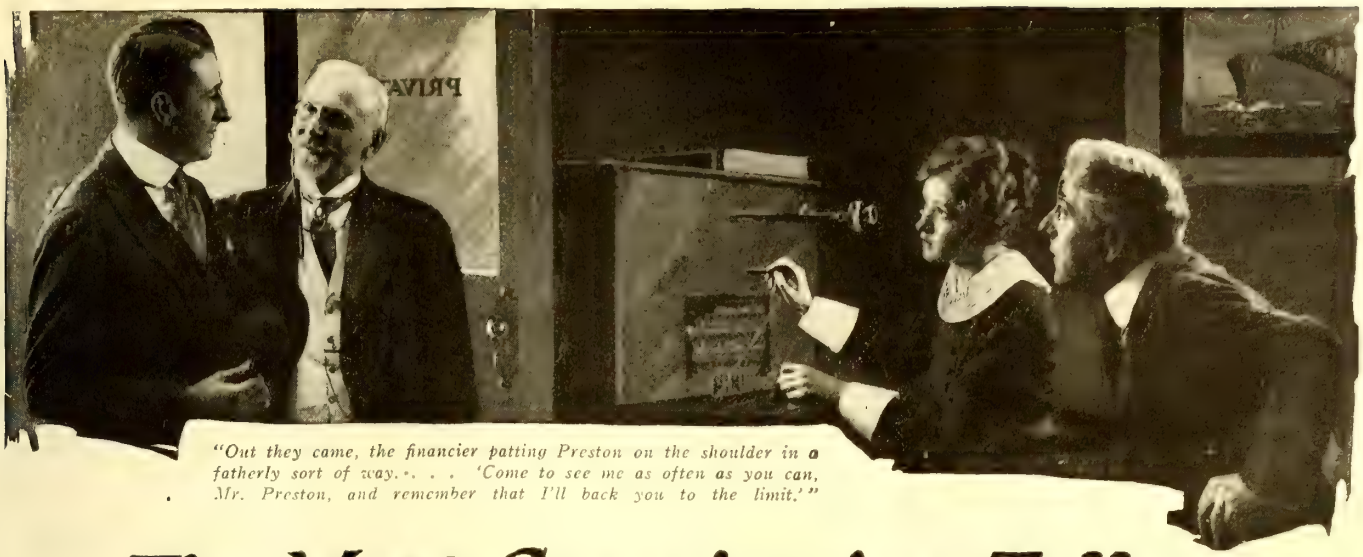
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"Out they came, the financier patting Preston on the shoulder in a fatherly sort of way. . . . 'Come to see me as often as you can, Mr. Preston, and remember that I'll back you to the limit.'"

The Most Convincing Talker I Ever Met

Everywhere this man goes, people shower him with favors and seek his friendship. Things which other people ask for and are refused, he gets instantly. How he does it is told in this amazing story.

LET me ask you this: There is a big business deal to be put through. It involves millions of dollars. Putting it through depends wholly on one thing—getting the backing of a great financier.

But this man is bitterly opposed to your idea and to your associates. Seven of the most able men and women in all America have tried to win over this financier. They failed dismally and completely.

Now, could you, a total stranger to this man, walk in on him unannounced, talk for less than an hour, and then have him take your arm as a token of friendship, and give you a signed letter agreeing to back you to the limit?

Could you?

ASTOUNDING? Yes! But it *WAS* done. And I'll tell you how. Here is the way it all came about. For a long time the directors of our company had felt the handicap of limited capital. We had business in sight running into a million dollars a month. But we couldn't finance this volume of sales. We simply had to get big backing, and that was all there was to it.

Because of trade affiliations, one man—a great financier in New York—controlled the situation. Win him over and the rest was easy. But how to win him?—that was the question. No less than five men and two women—all people of influence and reputation—had tried. They were all repulsed—turned down cold and flat.

You know how a thing of this sort grows on you and how bitter utter defeat is. Well, we were talking it over at a board meeting when one of our directors announced that he knew of only one man who could possibly put through the deal—a man by the name of Preston.

So it was agreed that Preston was to be sounded out at luncheon the following day. He proved to be a fine type of American. At 34 years of age he had become president and majority stockholder of a thriving manufacturing business rated at three-quarters of a million dollars.

Preston was deeply interested, as anyone would be over the prospect of closing such a big deal. The director in question said casually, "Why don't you run down to New York and take a shot at it, Preston?" Preston looked out of the window for a moment, and then quietly answered, "You're on."

I WENT along with Preston simply as a matter of form to represent our interests. Aboard the 10:25 train out of Chicago we headed for the smoker and got to talking with the crowd there.

Then I noticed something. Preston had dominated them all. Everyone was eagerly hanging on his words, and looking at him with open admiration. No sooner would he stop talking than one of the men would start him up again. And as the men dropped off at stations along the way they gave Preston their cards, with pressing invitations to look them up. No doubt about it, Preston was *THE* man aboard that car.

The colored porter, too, came under his sway. For that night, when the berths were being made up, the porter came unasked to Preston, told him that his berth was right over the car trucks, and insisted upon changing it to a more comfortable one.

And so it went all the way to New York. Everyone who met Preston took a great liking to him the instant he spoke. They seemed to be eager for his companionship—wanted to be with him every minute, openly admired him, and loaded him with favors.

Even the usual haughty room clerk at the hotel showed a great interest in Preston's welfare. He showered us with attention while a long line of people waited to register.

The next morning we called on the great financier—the man who was so bitterly against us and had flatly turned down seven of our shrewd influential representatives.

I waited in the reception room—nervous, restless, with pins and needles running up and down my spine. Surely Preston would meet the same humiliating fate?

But no! In less than an hour out they came, arm in arm, the financier patting Preston on the shoulder in a fatherly sort of way. And then I heard the surprising words, "Come to see me as often as you can, Mr. Preston, *and remember that I'll back you to the limit!*"

AT the hotel that night sleep wouldn't come. I couldn't get the amazing Preston out of my thoughts. What an irresistible power over men's minds he had. Didn't even have to ask for what he wanted! People actually competed for his attention, anticipated his wishes and eagerly met them. What a man! What power! . . . Then the tremendous possibilities of it all—think what could be done with such power!

What was the secret? For secret there must be. So the first thing next morning I hurried to Preston's room, told him my thoughts, and asked him the secret of his power.

Preston laughed good-naturedly. "Nothing to it—I—well—that—is—" he stalled. "I don't like to talk about myself, but I've simply mastered the knack of talking convincingly, that's all."

"But how did you get the knack?" I persisted.

Preston smiled, and said, "Well, there's an organization in New York that tells you exactly how to do it. *It's amazing!* There's really nothing to study. It's mostly a knack which they tell you. You can learn this knack in a few hours. And in less than a week it will produce definite results in your daily work.

"Write to this organization—The Independent Corporation—and get their method. They send it on free trial. I'll wager that in a few weeks from now you'll have a power over men which you never thought possible . . . but write and see for yourself." And that was all I could get out of the amazing Preston.

WHEN I returned home I sent for the method Preston told me about. It opened my eyes and astounded me. Just how he had won over the financier was now as clear as day to me. I began to apply the method to my daily work, and soon I was able to wield the same remarkable power over men and women that Preston had. I don't like to talk about my personal achievements any more than Preston does, but I'll say this:

When you have acquired the knack of talking convincingly, it's easy to get people to do anything you want them to do. That's how Preston impressed those people on the train—how he got special attention from the hotel clerk—how he won over the financier—simply by talking convincingly.

This knack of talking convincingly will do wonders for any man or woman. Most people are afraid to express their thoughts; they know the humiliation of talking to people and of being ignored with a casual nod or a "yes" or "no." But when you can talk convincingly, it's different. *When you talk people listen and listen eagerly.* You can get people to do almost anything you want them to do. And the beauty of it all is that they think they are doing it of their own free will.

In committee meetings, or in a crowd of any sort you can rivet the attention of all when you talk. You can force them to accept your ideas. It helps wonderfully in writing business letters — enables you to write sales letters that amaze everyone by the big orders they pull in.

Then again it helps in social life. Interesting and convincing talk is the basis of social success. At social affairs you'll always find that the convincing talker is the centre of attraction, and that people go out of their way to "make up" to him.

Talk convincingly and no man—no matter who he is—will ever treat you with cold, unresponsive indifference. Instead, you'll instantly get under his skin, make his heart glow and set fire to his enthusiasms. Talk convincingly and any man—even a stranger—will treat you like an old pal and will literally take the shirt off his back to please you.

You can get anything you want if you know how to talk convincingly. You've noticed that in business ability alone won't get you much. Many a man of real ability, who cannot express himself well, is often outdistanced by a man of mediocre ability who knows how to talk convincingly. There's no getting away from it, to get ahead—merely to hold your own—to get what your ability entitles you to, *you've got to know how to talk convincingly!*

THE method Preston told me about is Dr. Law's "Mastery of Speech," published by the Independent Corporation. Such confidence have the publishers in the ability of Dr. Law's method to make you a convincing talker that they will gladly send it to you wholly on approval.

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ELECTRICAL EXPERIMENTER

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Vol. VII. Whole No. 77 SEPTEMBER. 1919 No. 5

Silhouette Movies

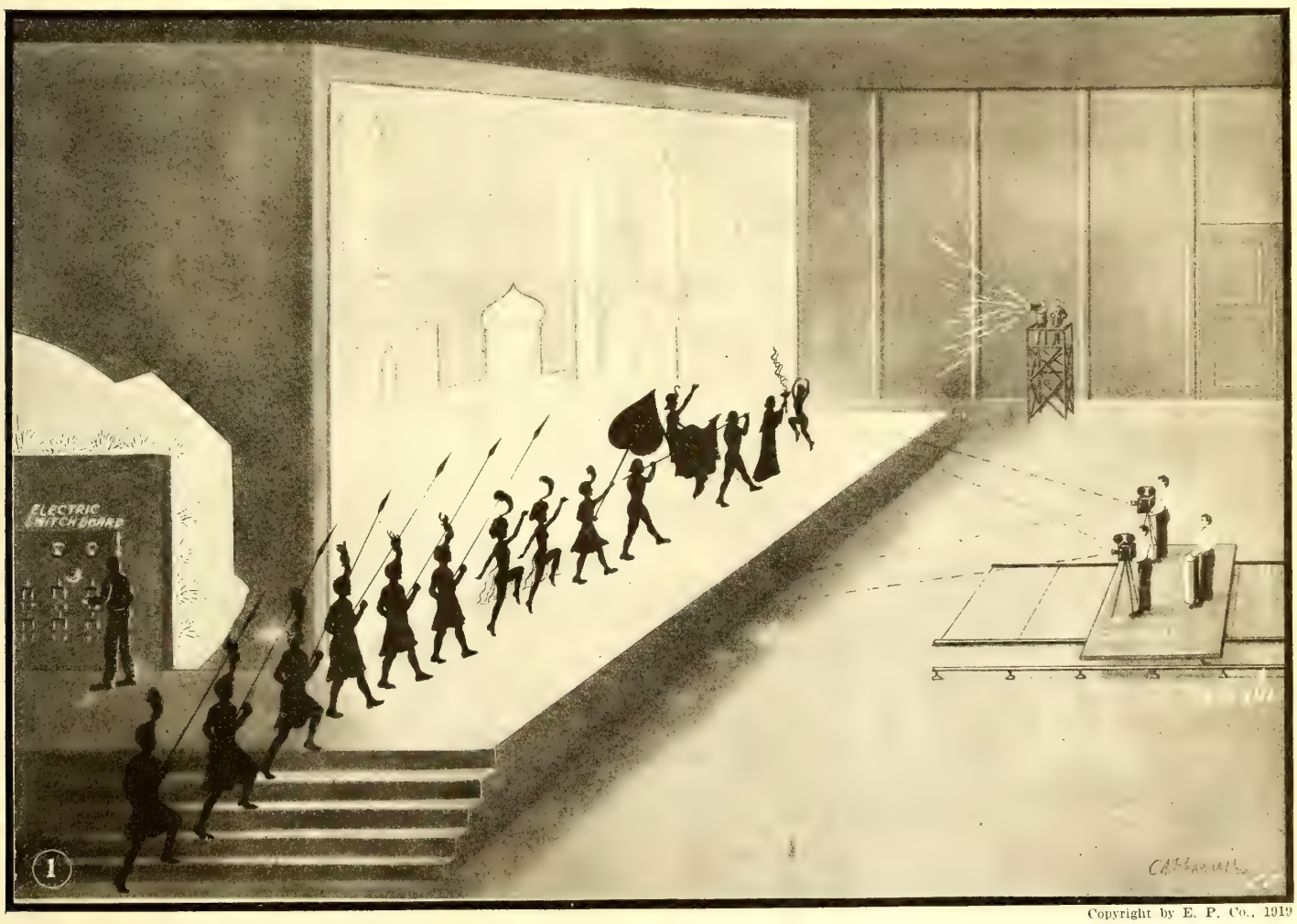
By H. GUMPEL

Mechanical Production of Moving Picture Films in "Silhouette"

PROGRESSIVENESS, combined with resourcefulness and inventive ingenuity, are counting for much to-day in the production of live motion-picture films. The public wants to be entertained during their leisure hours. Something radically new has to take the place of the old, constantly, to suit the "movie" fans and keep the theaters filled. The greatest attractions of to-day will lose their interest and novelty to-morrow. It is therefore self-evident that in this atmosphere of changeability there is a great field open for wide-awake inventors.

The latest novelty in the film world is the photographic production of *silhouette pictures* recently patented by C. A. Gilbert. Pictures of this kind until recently had to be drawn by hand. From fifteen to eighteen individual pictures illustrating the progress in action are needed per second. The individually drawn comic picture is therefore expensive in manufacture.

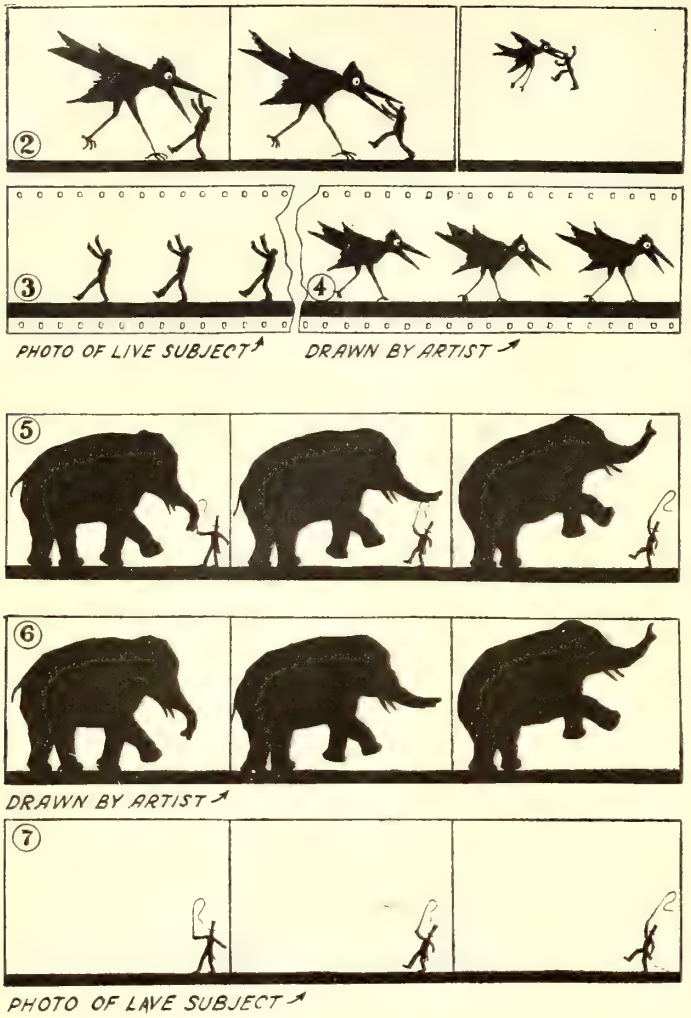
Gilbert is using silhouettes. Since these



Copyright by E. P. Co., 1919

The Latest in "Silhouette Movies." They Are Made from Life in the Manner Here Illustrated. The Stage Screen Is Highly Illuminated from the Rear and the Actors Appear Before It Drest in Black Clothes. The Camera Car Can Be Rapidly Moved Toward or Away from the Studio Stage by Means of an Electric Motor Attached to the Car Axle and Controlled by the Operators or a Third Man as Shown. Current Is Supplied the Motor Thru a Third Rail.

produce the weird and unusual effect of *black people* moving in a *black world*, they are most suitable for comic pictures.



A New Way to Make Silhouette Movies. The Man in the Pictures Shown Is Photographed as in Fig. 1 from Life, While the Giant Bird and the Elephant Are Drawn by an Artist in the Proper Scale and then Photographed. Figs. 2 and 5 Show the Combined Effects Clearly.

Silhouettes could be produced by shadows thrown on a light screen. Shadows, however, do not produce a sufficiently sharp image. Gilbert's method consists rather of directly photographing the actors. They present the appearance of silhouettes by having their movements performed in front of a powerfully illuminated screen. The method used is shown in figure 1. Here we have a stage upon which actors are moving before the transparent screen, behind which lights are arranged to give the necessary illumination, but without throwing direct light rays thru the screen.

The screen forms the front of a box or small chamber in which the light is produced, but projected from the white painted walls to the screen. The side wings of this box carry banks of powerful electric lights which brilliantly illuminate the rear side of the transparent screen. The arrangement is such as to prevent shadows from falling from actors upon the screen. Their position is indicated in figure 1. If the lights are of sufficient intensity, pictures taken by means of a motion-picture camera in front of the stage, as shown in figure 1, will be in silhouette. This method of producing the pictures presents the advantage of giving the actors entire freedom of movement, without reference to the illuminating arrangement.

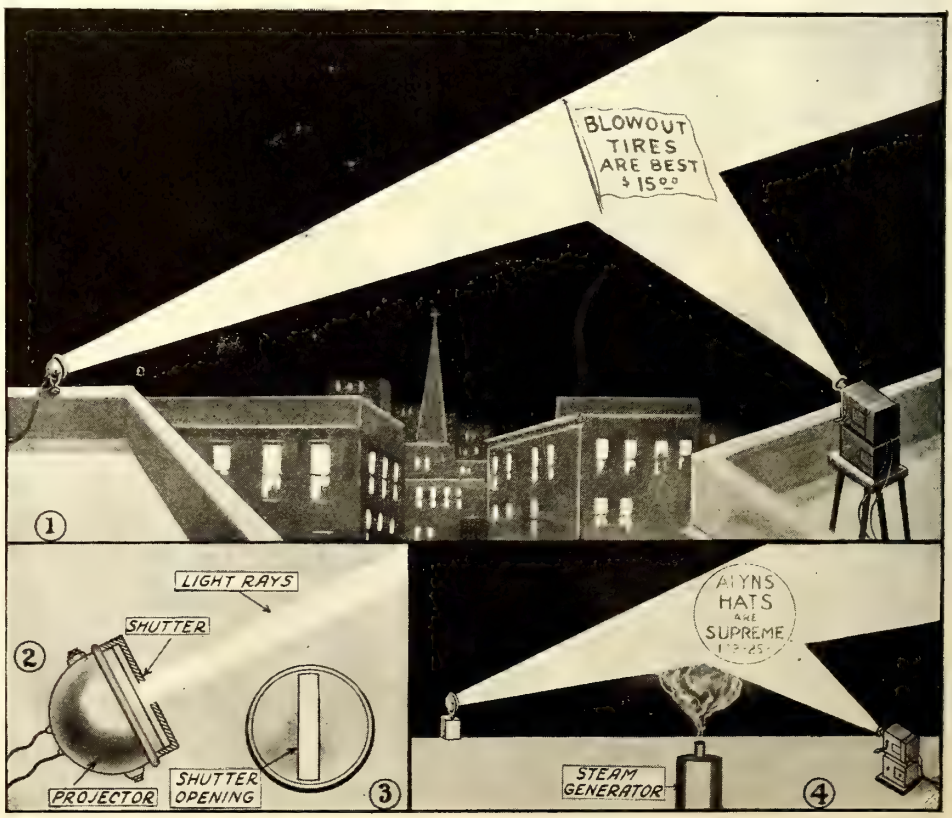
Gilbert's method admits of various interesting applications, by which novel effects can be produced. Figure 2, for instance, shows the picture of a tremendous bird eating a man. The actions of the man have been actually picturized (to use the language of the "movie" industry), as shown in figure 3, in a separate film. The bird, however, and his "cruel" actions have been produced by the pen of an artist according to figure 4. Then both films have been combined into the final working film, figure 2, with its weird impressions. In a similar way films, figure 5, of an elephant and his trainer have been composed by combining figures 6 and 7. The trainer has here been an actual man, but the elephant, no matter how natural he may look, has been originated by an artist. In this case it is decidedly more economical to arrive at the elephant's picture by employing the skill of an artist than by having an actual elephant on the stage.

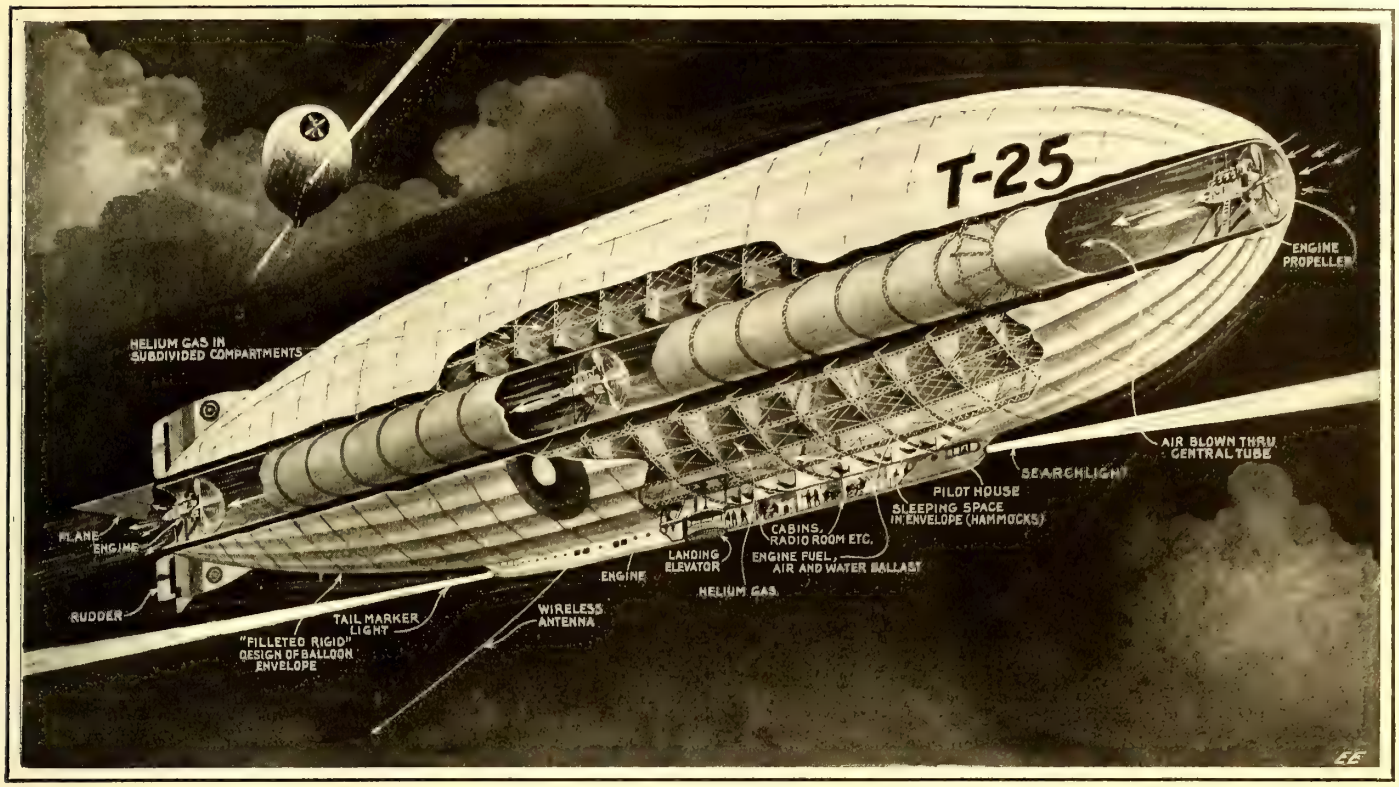
The background of the picture, consisting let us say of buildings, is frequently produced by having a permanent drawing painted on the screen before which the actors appear. A picture of this kind is illustrated in figure 1. In this case it is not necessary to combine two films into one, which naturally adds to the production expenses. It is often possible, however, to make the background a natural picture, such as a street scene, and this can then be combined with a comic silhouette picture produced by means of the Gilbert process.

An Electric Sign in Mid-Air

The accompanying illustration shows a recent invention of Mr. Frank H. Ellison, of New York City, who proposes an advertising scheme susceptible to many advertising adaptations whereby two powerful beams of electric light are flashed into space at right angles, causing thereby an image in the form of an advertisement, flag, etc., to be cast up at the juncture of the two beams. The main shaft of light may be thrown from a powerful electric searchlight projector, or other source of intense illumination, while the crosswise beam projector, carrying the image, may be in the form of a stereopticon, in which different slides can be placed and quickly changed, as desired. In the event that an atmosphere containing water vapor, as in the East, is not available it becomes possible to provide an artificial medium for the purpose, by employing a small steam generator or boiler under the spot where the image is desired. A single steampipe or two may be run a considerable distance above the roof of a high building in the vicinity, and when it is desired to throw the image or script in the air, the steam is turned on and thus forms a very good medium for the purpose.

The Accompanying Illustration Shows a New Invention, Which Is as Radical as It Is Novel in Its Conception. The Inventor Proposes to Throw an Image of a Flag or an Advertisement in Mid-Air at the Interception of Two Powerful Beams of Light, as Here Illustrated.





This Illustration Shows a Recent Development In Simplifying the Airship and at the Same Time Making for More Efficiency all Around. The Idea Is To Do Away Entirely With the Underslung Power Gondolas, Such as are Used on the English and German Airships of the Zeppelin Type. The Engines are Housed in a Wind Tunnel Running Thru the Center of the Airship as Shown. Propellers Which are from Fifteen to Twenty Feet in Diameter Create a Sort of Vacuum Within the Tube, and the Airship Therefore will Virtually Suck Its Way Thru the Air at an Increased Speed.

Speeding Up the Airship

By H. GERNSBACK

ON its historic cruise to the United States the R-34, while making a splendid achievement, disappointed many for the reason that it had been hoped that the dirigible would make a westerly passage much quicker than it actually did. Of course, the airship had to battle against head-winds nearly all the way over, which is best proven by the fact that on its return trip it accomplisht the eastward passage in 75 hours.

One reason, and the entire reason, that Brown and Alcock flew across the ocean in sixteen hours with an airplane, while the quickest trip of the airship took over four times as long, is explained in one word—friction. The airplane offers but little surface to the wind, due to the fact that its surfaces not only are comparatively small, but cutting like a knife, they do not offer much resistance to the air. The airship on the other hand, due to its large and cumbersome bulk, gives rise to enormous friction not only head on, but along its sides as well. In this capacity it stands on a par with the big ocean liner that sinks deep into the water, and consequently needs an enormous power to move it, whereas the little motorboat-hydroplane, when provided with suitable vanes, will actually skim above the water, hardly touching the latter, at a speed many times that of the ocean liner. Here we have the same comparison. It is simply a matter of reduced friction of the mechanical birds and their natural element, the air. We therefore find that if we can do away with all unnecessary friction on the huge airship, we will be able to propel it much faster. Take the case of the R-34 with its four gondolas; these take up quite a good deal of room and make for air resistance when the airship is in flight. While to the layman this appears trifling, it tends to retard the total speed of the airship very considerably, and if we can do away with these gondolas and their engines, we will increase the speed of the airship by just so much.

Also, if we can diminish the resistance created by the nose of the airship as it plows its way thru the air, we will again increase its speed. This, of course, is apparent, and the following experiment, which anyone may try himself, ought to prove it abundantly. Take a pail of water and try to drag it with the open side thru a stream of water. You will meet with an enormous resistance. Take the same pail and make a hole of about half the diameter in the bottom of the pail. You will now find that you can drag the pail with considerable ease, for the reason that the water flows right thru it. In the former experiment it was necessary to first fill the pail with water, and after this move (displace) a column of water represented by the diameter of the pail.

With these things in view, the writer offers a novel idea in which it is proposed to speed up dirigibles considerably. The idea is made clear in the accompanying illustration. It will be seen that this airship has no gondolas whatsoever, and the power plant is not hung underneath the airship, as is common in all Zeppelin types. Instead, the center of the airship is hollow, forming a wind tunnel extending clear thru the entire length of the airship. This air tube, of course, is not a small affair, but is anywhere from 15 to 25 feet in diameter, as will be noted. The three engines are stationed, the first at the nose, the second at the tail end, and the third in the center of the wind tunnel. The propellers must be of the same diameter as that of the tunnel, and the object is to have all three of them working at the same time in order to suck in the air at the nose of the ship and form a sort of vacuum. The air will then flow thru the tunnel, the same as the water flows thru the pail after we made a central opening in its bottom. From this it will be seen that the airship will *virtually suck its way thru the air,* and it should be possible for such a craft to make much greater speed than with the former methods. Moreover, as the engines are not exposed to the elements, it would also seem that not so much engine trouble should develop, as is the case with the under-slung type. Another very important consideration is that inasmuch as the air is rushing right back of the engines, the cooling of the latter is infinitely better than at present. And as every engine man knows, the better an engine is cooled the less likelihood there is of trouble developing.

In the aërial liner of the future, in order to do away with all unnecessary head resistance, the crew's quarters, etc., will probably be located at the bottom of the airship, and as will be noted in the illustration, the entire living quarters are fashioned with stream lines, to minimize all unnecessary air resistance.

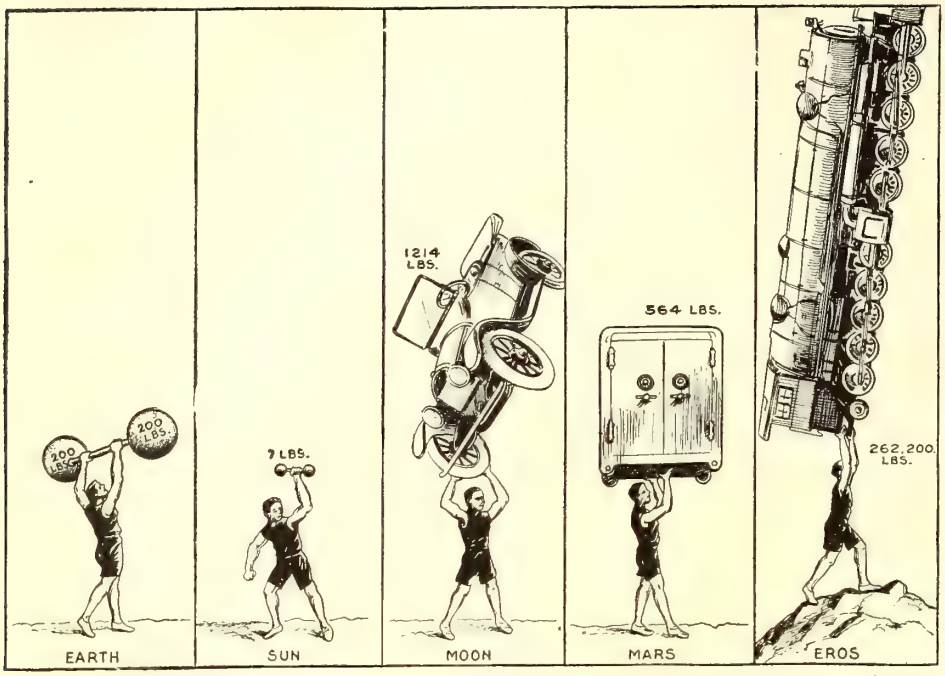
Hydrogen gas will probably not be used much longer, as already Zeppelin types in Germany demonstrated that these huge bags are not safe with the enormous quantities of inflammable gas stored within their metallic girders. Electric sparks set up by the electrical machinery of wireless apparatus are a constant danger to the explosive gas, and the same is true should lightning hit the dirigible. The airship of the future for this reason will use Helium gas in its subdivided compartments, or some other

(*Continued on page* 446)

Popular Astronomy

By ISABEL M. LEWIS
Of the U. S. Naval Observatory

Interesting Phenomena of Gravitation



This Shows Graphically How Much a Human Being Would Be Able to Lift on the Various Heavenly Bodies. This Illustrates That a Pound Does Not Weigh a Pound Everywhere in the Universe, But Changes According to the Mass and Density of the Heavenly Body upon Which It Is Placed.

THE earth is revolving around the sun in an orbit that is almost a perfect circle with a velocity of *eighteen and one-half miles per second.* If for any reason this orbital velocity should suddenly cease or be brought to *zero,* the earth would fall into the sun and the time of falling would be sixty-four and one-half days. If its orbital velocity should be brought *almost* to zero, that is if the earth still possest a slight motion at right angles to the line connecting it with the sun, it would describe an extremely narrow ellipse with the sun at the further focus (see diagram 1), and would return to the point where its velocity had changed after one hundred and twenty-nine days.

If the orbital velocity should be increased more and more, the ellipse would become wider and wider, and the period of the earth's revolution longer and longer. When the orbital velocity reached eighteen and one-half miles per second the earth would be revolving around the sun in a circular orbit in a period of 365¼ days (as it does now). If the orbital velocity should increase still more the earth's orbit would become elliptical again with the sun now at the nearer focus and the width of the ellipse would increase as the velocity increased.

THE EARTH COULD LEAVE SOLAR SYSTEM.

When the orbital velocity reached 26.2 miles per second (the velocity from infinity or parabolic velocity for the earth), the earth would escape the control of the sun and leave the solar system on the curve of a parabola never to return. If the orbital velocity should exceed 26.2 miles per second the earth would also escape from the solar system, but the curve would be hyperbolic instead of parabolic in form.

Now each planet in the solar system has its parabolic velocity or, as we might call it, velocity of escape from the solar system, and as this varies inversely as the square root of the planet's distance from the sun, it becomes less and less as the planet's distance from the sun increases.

For Neptune the parabolic velocity is only 4.7 miles per second. If its orbital velocity of three and one-third miles per second should be increased to this parabolic velocity Neptune would escape from the solar system.

If a body should fall from infinity or the distance of the stars toward the sun under the force of the sun's attraction *alone,* it would have acquired a velocity of 4.7 miles per second by the time it had reached the orbit of Neptune, 26.2 miles per second when it had arrived at the earth's orbit and 383 miles per second by the time it had reached the surface of the sun.

Let us consider now what velocity an object at the surface of the sun must possess in order to escape the sun's attraction and pass off into space. Evidently this would be the same as the parabolic velocity or velocity from infinity for the sun's surface, 383 *miles per second.* Any object at the solar surface endowed with a velocity in excess of this amount would leave the sun never to return.

THROWING A STONE INTO INFINITY.

Since it can be shown that this velocity of escape varies directly as the square root of the mass of the attracting body, it is possible to compute the velocity of escape for objects on all of the planets in the solar system as well as for objects on the sun. These values are given in Table I. Objects on any of the planets possessing these velocities or greater velocities escape from the control of their respective planets and either become satellites of the sun or leave the solar system entirely, depending on the excess of their velocities over the critical value. It will be noted from a glance at these critical velocities given in Table I that it would be easily possible to fire a cannon ball from Ceres, the largest asteroid, that would pass off into space, never touching the surface of the asteroid, while on Eros a stone could be thrown from the hand with sufficient velocity to enable it to escape the control of the asteroid.



How Would You Like to Clear in One Bound a Mountain Nearly One Mile in Height? This Is Exactly What You Could Do if You Were on Eros, the Small Asteroid. If You Could Jump Four Feet High on Earth, You Could Jump Over One Mile on Eros. Even on the Moon You Could Jump Over a House Without Much Trouble, with One Bound.

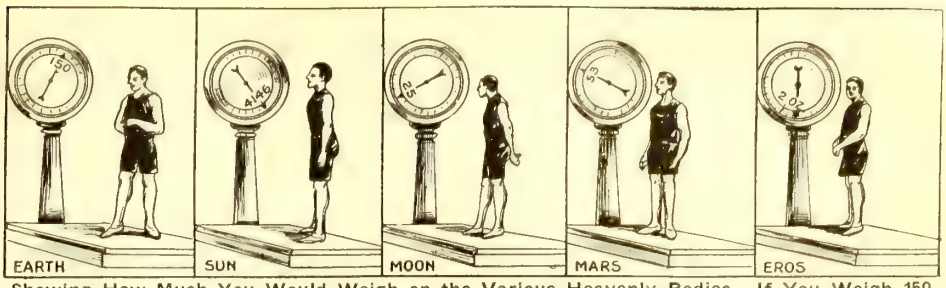
SHOOT A CANNON BALL FIVE MILES A SECOND AND YOU HAVE A NEW MOON.

In the last column in Table I is given the velocities for satellites grazing the surfaces of the various planets, the sun or moon, in circular orbits. It can be shown that these values are equal to the critical velocities or velocities of escape multiplied by the square root of one-half. It will be noted that for the sun this value is 271 *miles per second,* that is, an object hurled from the sun with a velocity of 271 miles per second would become a satellite of the sun, moving close to its surface in a circular orbit. An object hurled from the earth's surface with a velocity of 5 miles per second would likewise become a satellite of the earth, revolving around it in a circular orbit close to the surface.

It is interesting to consider in this connection what would be the course of projectiles hurled from the earth or other planets with varying velocities.

If an object should be thrown from a mountain or some other elevated position on the earth's surface *horizontally* (neglecting resistance of air) with a very slight initial velocity, it would fall almost straight downward, and if the earth were concentrated at a point at its center the object would move in a very narrow ellipse around the earth's center, returning to the point of departure again after 30 minutes. If the velocity is increased more and more the object falls further and further to one side, and if the earth were concentrated at its surface so the object would not encounter the surface; it would move in an elliptical path, always returning to the original point. The widths of the ellipse would increase with the velocity (see diagram II). Finally when the velocity with which the object is hurled reaches 5 miles per second it leaves the earth entirely and becomes a satellite of the earth, moving in a circular orbit with a period of 1 hour 25 minutes. If the velocity is increased beyond 5 miles per second the object continues to revolve around the earth in an elliptical orbit whose width increases with the velocity until a velocity of 7 miles per second is reached, when the object flies off on a parabolic curve, escaping the earth's attraction entirely and becoming a satellite of the sun. The same principle holds for all the other members of the solar system as well as for the earth, and a reference to table 1 will show the velocity of escape for each member of the solar system as well as the velocity with which an object must be thrown from the surface in order to make it a satellite of the planet in question.

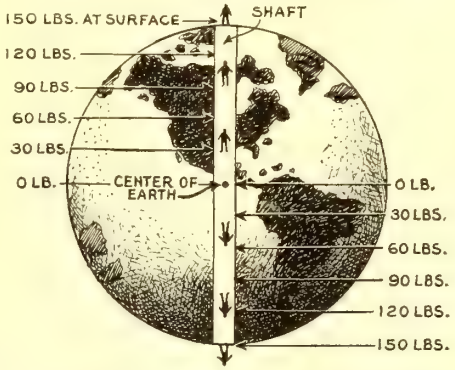
It is interesting to consider in this connection what would happen if the earth should suddenly explode. All particles that received an initial velocity *under seven miles per second,* the velocity of escape, would come back to the scene of the catastrophe *repeatedly* in elliptical orbits, and those that were ejected with *equal velocities* would come back *at the same time,* however different the directions of their ejection or the width of their orbits. If the velocity of ejection equaled or exceeded seven miles per second, they would not return.



Showing How Much You Would Weigh on the Various Heavenly Bodies. If You Weigh 150 Pounds on Earth, Your Weight Would Shrink to 2 Ounces on Eros. While on the Sun You Would Weigh over 2 Tons and You Would Not Have Sufficient Strength to Lift Your Own Body.

WEIGHT ON OTHER PLANETS.

Let us consider now some of the interesting phenomena arising from the fact that the surface gravity of a planet, or its attraction for objects at its surface, is proportional to its mass or the quantity of matter that it contains. This affects directly the weight of objects at the surfaces of the planets and the amount of work that can be performed against the attraction of gravity on the various planets.



Do You Know That if There Were a Shaft Drilled Right thru the Earth, and if You Were to Descend into Same, You Would Weigh Nothing When You Arrived at the Center? Our Illustration Shows How Much You Would Weigh at the Different Levels in the Shaft.

Taking the earth's attraction for objects at its surface as the unit, the relative surface gravity for all other planets, the sun, and the moon, has been computed (see Table I) by multiplying the density by the radius, both quantities relative to the corresponding values for the earth.

We then find what a man weighing 150 lbs. on the earth would weigh if it were possible for him to exist on the sun, moon or other planets, to what height he could jump against the attraction of gravity and what weights he could lift; also with what velocity an object must be endowed to enable it to escape from the planet and under what condition it would become a satellite of the planet revolving close to its surface in a circular orbit.

We note (Table I) that a man who weighs 150 lbs. on the earth would weigh 4,146 lbs., or over *two tons,* on the sun. If he could jump to a height of four feet on the earth he would find himself unable to raise his body even two inches by his own energy, against the sun's surface gravity. He would be, indeed, crushed by his own weight, lifting his arms and feet and moving about only with the greatest effort. He would have as much difficulty in lifting a weight of seven pounds on the sun as in lifting a weight of two hundred pounds on the earth.

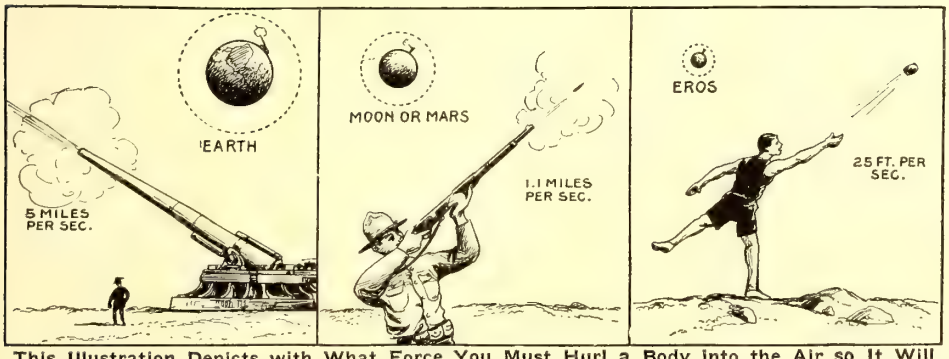
On the asteroid Eros on the contrary his weight would be but *two ounces.* He could jump to the height of a mile as easily as he could jump to a height of four feet on the earth, and he could lift *one hundred and thirty tons* as easily as he would lift two hundred pounds on the earth.

It will be noted that the weight of the large engine on the cover drawing is given as 684,000 pounds. This corresponds to a weight of 500 lbs. on Earth. This is probably the limit a professional strong man could lift on earth.

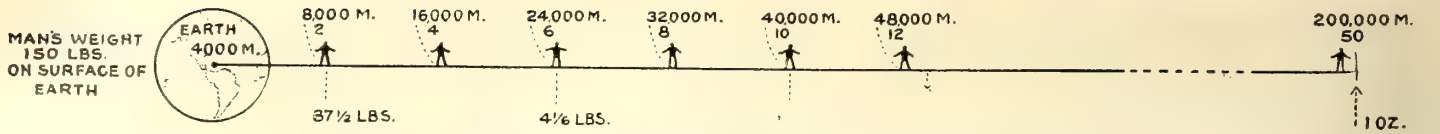
LIVING IN A VACUUM.

This brings us to the interesting subject as to what would happen if we were to visit one of our small planetary bodies on which there is no atmosphere, such as for instance our moon and any of the Asteroids. Being that the gravitational pull is so small on these bodies, the atmosphere—if they had any—probably escaped aeons ago. Consequently, if we were to visit any of these heavenly bodies, we would be placed in an absolute vacuum much greater than we can procure with our best vacuum pumps on earth. How, then, could we walk on such a body and exist? We must always remember that every square inch of our body on earth is weighed down with an atmospheric pressure of 14.7 pounds. The total pressure upon the human body is therefore enormous, amounting to 47,040 lbs. Remove this pressure and our blood vessels would burst like an automobile tire.

The thing to do then, if we are ever enabled to visit the moon or one of the Asteroids, would be to encase ourselves in a strong rubber fabric by having strips of thick rubber sheeting wrapt all around our body, as suggested in our cover drawing. These rubber strips would be wrapt around the body and limbs similar to what our soldiers do with their puttees. It would, of course, also be necessary that we should bring along our own air, and this, too, is suggested in our cover drawing, where a comprest air tank is strapt to the back of the man, an automatic air valve regulating the air supply as it is consumed. By means of suitable chemicals the air could be renewed automatically for an indefinite time. In order that we can see about us, it would also be necessary for us to provide a sort of helmet fitted with a thick glass plate adjusted air-tight to the helmet. The whole contrivance would then be strapt to the body.



This Illustration Depicts with What Force You Must Hurl a Body into the Air so It Will Never Return,—in Other Words, Becoming a New Satellite. If You Could Build a Cannon to Shoot a Projectile into the Air Going at the Rate of Five Miles per Second, It Would Become a New Moon Gravitating Around the Earth in an Orbit of Its Own. On Mars the Velocity Need Only Be 1.1 Miles per Second, While on Eros You Could Throw a Stone into the Air So That It Would Never Return.



Suppose You Were to Rise Above the Surface of the Earth in Some New Space-Flying Machine. This chart Shows How Much Weight You Would Lose as You Get Away from the Gravitational Attraction of the Earth.

The feet as well as the hands would also have to be encased in very snug-fitting rubber, as no part of the human body should be exposed to the vacuum which would draw out the blood immediately. It is well known that when aviators ascend to a great height blood begins to flow out from underneath the finger nails, due to the reduced pressure. It can be easily imagined what will happen if all the pressure was removed and the hand was exposed to the vacuum.

His greatest difficulty, granted he were able to withstand the lack of air and atmospheric pressure, would be experienced in retaining a foothold upon this insecure mass of rock spinning thru space, for so slight is the attractive force that holds him to the surface that *it would be possible for him to jump with sufficient initial velocity to escape from the asteroid,* the velocity of escape being only thirty-six feet per second, and the height to which he is able to jump against the force of gravity being 1 mile.

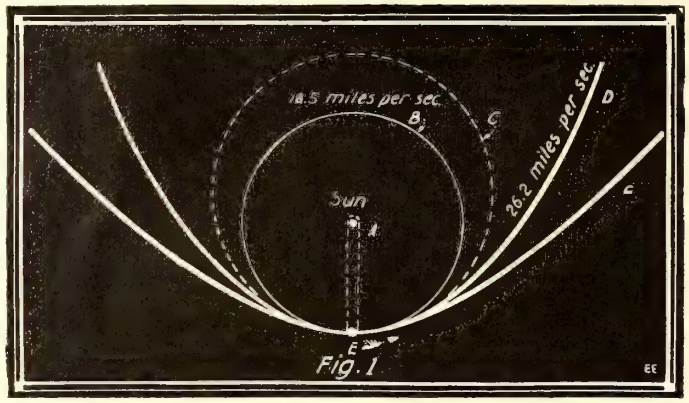
Referring to Table I, we note that the surface gravity of Uranus is nearest to that of the earth and that a man who weighs 150 lbs. on the earth would weigh 149 lbs. on Uranus and would be able to do practically the same amount of work. This arises from the fact that the greatly *increased radius* of Uranus, three and eight-tenths that of the earth, is offset by its greatly *decreased density,* which is only one-quarter that of the earth, the product of the two giving the surface quantity of Uranus. This is also true in a less degree with Saturn and Neptune. The huge bulk of Jupiter, however, considerably overbalances its low density, and a man who weighs 150 lbs. on the earth would find his weight of 378 lbs. a burden to him on Jupiter.

MAN WEIGHS 53 POUNDS ON MARS.

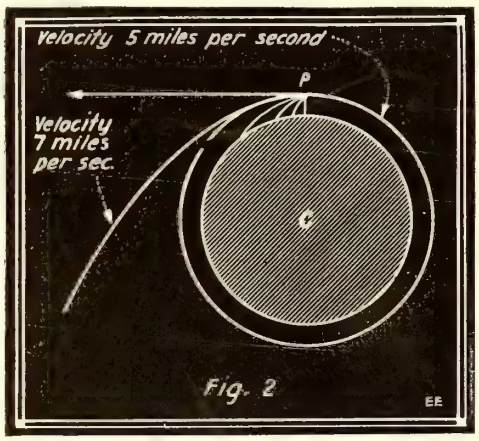
On Mars, on the other hand, he would find he weighed only 53 lbs. and that he could jump nearly three times as high as he could on the earth and lift loads nearly three times as heavy. On the moon he would weigh only one-sixth as much as on the earth and could throw a ball six times as far and jump six times as high. He would lift six hundred pounds as readily as he would lift one hundred pounds on the earth.

Venus most closely resembles the earth among the terrestrial planets and a man would find, if he were suddenly transferred to Venus, that he would only lose twenty-two pounds in weight by the change. He could lift weights fifteen per cent heavier and jump fifteen per cent. higher than on the earth.

Let us note in passing the low velocity of escape for the moon, Mercury and Mars. This is believed to have an important bearing upon the possibility of these bodies possessing and holding atmospheres. The molecules of gases in the atmosphere are moving in all directions at high velocities. It has been computed that the molecular velocity of oxygen is 1.8 miles per second at zero centigrade, of nitrogen 2.0 miles per second, of water vapor 2.5 miles per second, of helium 5.2 miles per second and of hydrogen 7.4 miles per second. Evidently then the earth could not *permanently* hold free hydrogen in its atmosphere or the moon and Mars any of these gases. Even if Mars were originally clothed with an extensive atmosphere it is, according to the kinetic theory of gases, losing it molecule by molecule. Moreover, in inter-planetary space there must be wandering molecules of gases that have deserted the bodies in the solar system that have low velocities of escape. Of course upon even the largest asteroids there could not be any of the atmospheric gases of the earth, as the velocity of escape is so excessively low for all of these bodies.



This Illustrates What Would Happen If the Earth's Orbital Velocity, 18.5 Miles per Second, Were to Change Suddenly. A, if the Velocity Would Almost Cease. B, Present Velocity of Earth. C, Velocity Greater Than 18.5 Miles per Second. D, Velocity 26.2 Miles per Second. E, Velocity Greater Than 26.2 Miles per Second. At This Speed the Earth Leaves the Solar System Never to Return.



To Illustrate Course of Projectiles Hurled Horizontally from P, a Point on the Earth's Surface (Neglecting Friction of Air) at Different Velocities in Direction of Arrow. If Velocity Is Less Than 7 Miles per Second, Projectile Moves in Elliptical Curve Whose Width Depends Directly on Initial Velocity with Which Projectile Is Hurled. If Velocity Equals 7 Miles per Second, Projectile Becomes a Satellite of the Planet, and if Velocity is 7 Miles per Second or Greater, the Projectile Escapes Earth's Attraction and Goes Off into Space.

WEIGHT INSIDE OF EARTH.

Let us consider now, in concluding, what would be the effect upon a man's weight if he should fall toward the earth's center thru a circular shaft (see diagram III), assuming that the earth's density is uniform thruout. Since surface gravity is equal to the density times the radius, his weight at the surface will be decreased as he falls toward the center proportionally directly to his *distance below the surface.* At a distance below the surface equal to one-fifth of the radius his weight will be decreased one-fifth of the value for the surface, that is a man who weighs 150 lbs. on the surface would weigh 120 lbs. one-fifth of the distance to the center or eight hundred miles below the surface. Two thousand miles below the surface or one-half the distance to the center his weight would be one-half the surface value or seventy-five pounds and *at the earth's center*

(*Continued on page* 449)

TABLE I.

	Diameter (In Miles)	Density (Relative to Earth's)	Radius (Relative to Earth's)	Surface Gravity (Relative to Earth's)	Man's Weight in Pounds	Height Man can Jump	Weight Man can Lift	Velocity of Escape	Velocity with which object must be projected to become a satellite moving close to surface in perfect circle
Earth.....	7,918	1.00	1.00	1.00	150 lbs.	4 feet	200 lbs.	7 mi. per sec.	5 mi. per sec.
Sun.....	864,392	.25	109.17	27.64	4,146 "	1.7 in.	7 "	383 "	271 "
Moon.....	2,160	.60	.27	.16	.25 "	24 feet	1,214 "	1.5 "	1.1 "
Mercury.....	3,009	.81	.38	.31	46 "	13 "	650 "	2.2 "	1.6 "
Venus.....	7,701	.88	.97	.85	128 "	5 "	234 "	6.6 "	4.7 "
Mars.....	4,339	.65	.55	.35	53 "	11 "	564 "	1.5 "	1.1 "
Jupiter.....	88,392	.23	11.16	2.52	378 "	1.6 "	79 "	37 "	26 "
Saturn.....	74,163	.11	9.37	1.07	160 "	3.75 "	187 "	22 "	16 "
Uranus.....	30,193	.26	3.81	.99	149 "	4.0 "	201 "	13 "	9 "
Neptune.....	34,823	.20	4.40	.87	130 "	4.6 "	231 "	14 "	10 "
Ceres (largest asteroid)...	485	.69	.0606	.036	6 "	108 "	5,406 "	1736 ft. per sec.	1228 ft. per sec.
Eros (small asteroid)...	10	.60	.00126	.00076	2 oz.	5,244 feet (almost 1 mile)	262,200 " (130 tons)	36 " (*See Note*)	25 "

Note:—Objects leaving surface with velocity greater than values given here would not return.

Note:—The surface gravity is the product of the planet's density by its radius (relative to corresponding values for the earth's), that is, Col. 4 is the product of Col. 2 and Col. 3.



New York City Can Now Boast of the Largest Steam Turbine-Dynamo Generating Unit in the World—100,000 Throbbing Horse-Power. It Comprises a Triplex Turbo-Alternator, Occupying About One-Fourth the Space of the Old-Type Reciprocating Engine Shown at the Extreme Left of the Photo Herewith. The Comparative Size of the 100,000 H.P. Turbine Unit May Be Judged by the Man Standing Beside It—See Arrows. The Old Reciprocating Steam Engine Towered 75 feet into the Air; the New Turbine-Dynamo Stands But 20 Feet in Height. The Current Delivered Is Three Phase, 25 Cycle Frequency, at a Potential of 11,000 Volts.

World's Biggest Turbine-Dynamo--100,000 H. P.

By WILLIAM H. EASTON

TO her already long list of "greatest things in the world," New York City can now add another item, for the Interborough Rapid Transit Company has recently placed in operation at its 74th Street power house a triplex turbine-generator that is as superior to its rivals in power as the Woolworth Building is in height or the arch of the Hell Gate Bridge in length of span.

One hundred thousand horsepower is the amount of power this great engine can develop when pushed to its maximum. It is difficult to find an example that will convey an adequate impression of this figure, but the following may be of some assistance. Suppose our army now abroad, which consists of about a million men, has been landed over night and is marching up Fifth Avenue. Visualize the parades you have seen and then realize that it will take over three days and nights for this particular one, moving steadily forward in regular formation, to pass thru the Arch of Victory. Now, in a contest of strength between the turbine and all of these men taken together, the turbine would probably win.

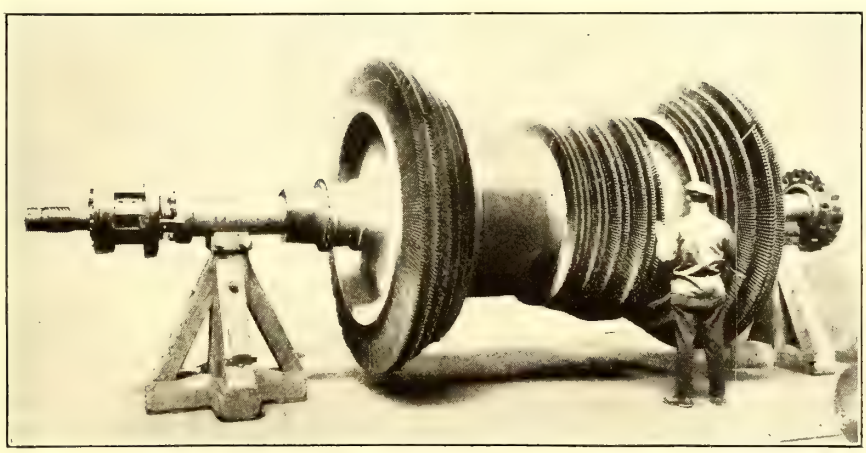
How the Turbine Operates.

The visitor, journeying to 74th Street to see this great turbine, will probably be disappointed in its appearance. It has, indeed, a massiveness that speaks of immense power within, but in size it is dwarft by the old vertical reciprocating engine, of one-twelfth its capacity, beside which it stands; and in addition, since all its working parts are enclosed, it is entirely lacking in the fascination that visual movement imparts. But its deficiencies as a spectacle are real virtues in the eyes of the engineer, for they mean lower first cost, smaller space occupied, reduced installation and operating charges, and a high degree of reliability.

The very conspicuous difference in size between the turbine and the reciprocating engine is due to their different operating principles. The reciprocating engine consists essentially of a cylinder in which a piston is pushed up and down by the steam. The main parts of the turbine, however, are a spindle, carrying hundreds of small vanes, and a casing which encloses the spindle. The steam acting upon the vanes of the spindle revolves it as the wind turns a windmill. The motion of the turbine is, therefore, rotary and as there are no heavy parts to be stopt and started at the end of every stroke, as there are in a reciprocating engine, very high speeds are permissible, thus making it possible to develop great power from a comparatively small machine. The speed of this particular turbine is 1,500 revolutions a minute.

As has been said, the turbine is triplex; that is, it consists of one *high pressure* element and two *low pressure* elements, each connected to a separate electric generator. This gives it the appearance of three distinct machines, but it is actually a *single unit* and all three elements are started and controlled as one. The triplex arrangement is employed because it is mechanically greatly superior to the single element design for a machine of such great power. There is also the very decided additional advantage that, in an emergency, any one or two of the elements can be shut down without stopping the others. All the power eggs are, therefore, not in one basket, and the high efficiency of a single large ma-

(*Continued on page* 453)



A Close View of the Rotating Blades or "Rotor" of One of the Steam Turbines Comprising the Triplex 100,000 Horse-Power Generating Unit Recently Installed for the Interborough Rapid Transit Company, New York City, at Its 74th Street Power House. Almost Beyond Conception Is the Delicacy and Accuracy of Balance of This Wonderful Blading. It requires the Highest Degree of Workmanship to Build Such a Rotating Mass, Which Shall Be Perfectly Balanced When Revolving at 1,500 Revolutions per Minute.

The Rotor Member Here Shown Is Driven Around by High Pressure Steam Flowing Thru the Rows of Blading. A reaction Force Is Set up Owing to the Steam Passing First Between Stationary Blades and Then Thru a Set of Rotor Blades, Etc., Etc., Repeatedly. There Are Two Low Pressure and One High Pressure Stages In This Triplex Turbine Unit. The Steam Enters the High Pressure Chamber First, Then Expanding, It Passes Into the Low Pressure Elements, Thence Passing to the Giant Condensers.



Wide World Photos

An Exceptionally Fine Picture of the Giant British Dirigible—the R-34 Descending Toward the Landing Field at Mineola, L. I., N. Y. The Engines Are Kept Running While Descending, and the Rudders Altered to Steer the Ship Up or Down.

How the R-34 Crost the Atlantic

Details of the Giant 2,000,000 Cu. Ft. Trans-Atlantic Blimp

THE plucky English fliers succeeded in flying across the Atlantic Ocean, a course extending over 3,000 miles, in a gas bag known variously as a dirigible and blimp, and finally as her commander termed her, a "filleted rigid," meaning a rigid or framed gas filled balloon, having filleted or flat segmented sides. After making a successful landing at Mineola, L. I., N. Y., she sailed away on her return to England and landed there after a record-breaking voyage of 75 hours.

At Mineola the R-34 was hauled down and held by powerful cables, a large force of several hundred enlisted men being required to watch her day and night, in the event of wind gusts, storms, change of buoyancy due to the heat of the sun expanding the gas with which she was filled, and a hundred and one other expected but uncertain capers which the gigantic 670-foot "blimp" might cut up.

Some idea of her great bulk can be ascertained from the accompanying semi-sectional view of her, which shows the steering, eating and sleeping quarters, as well as many other interesting features.

LANDING TOWERS FOR DIRIGIBLES.

On her successful return to England the great airship was "anchored" to a new device designated by British Air Force engineers a "landing tower." Several of these towers are now in use in England for "anchoring" these giant lighter-than-air machines. They are provided with elevators to bring the crew and passengers to earth. The airship is held by the "nose" in such a manner as to ride a storm much more safely than if held to the ground. Such a device was described and illustrated in the July issue of this magazine.

Automatic landing and mooring are essential before airships can be put up as a commercial proposition.

Three points are being studied by the British technical departments now. One is moving the airship in the open, the second is the economy of man power required in landing, and the third the necessity for a good reserve of speed. This last is not a question of petrol supply, but of horsepower and the size of the ship.

A recent trial trip of the R-32 gave from 67 to 70 miles an hour, and she has 1,550,000 cubic feet capacity.

The R-34 has 2,000,000, and on her Atlantic trip reached approximately 60 miles an hour, but this is not going to be the speed of the future airship.

Major Scott, before he sailed, said he had no doubt that 100 miles an hour with proportionate "dispersal" lift, which is 50 per cent of the actual lift, would be obtained from airships that would be built with a capacity of 5,000,000 cubic feet.

Unless the size of the airship is increased, engines for this higher speed cannot be fitted, so that the experiments which the Admiralty is going to carry out will be vital to the commercial interests of the future.

Some idea of the wonderful aerial engineering features incorporated in the R-34, the first blimp to cross the Atlantic Ocean, can be gained from the following excellent description by Capt. Samuel T. Moore, commander of the balloon troop helping care for the transatlantic airship.

The forward gondola is the navigator's office and it is from this that the ship is controlled thru speaking tubes, electric bells and signals. The steering gear is also controlled from this gondola, as well as the rudder. On the side of this cabin are "elevator wheels" which control the elevators for changing the altitude when necessary. There is a table in the navigator's office on which charts are made while a flight is in progress. Many scientific instruments are on it, as well as the controller for the radio station. There is an engine in it, and immediately behind it are two more engines on either side. One or two of these engines work while the other sleeps. All the engines on the ship could be kept working if it were necessary, but as a general rule one of them is stopt and cleaned while the dirigible is in operation.

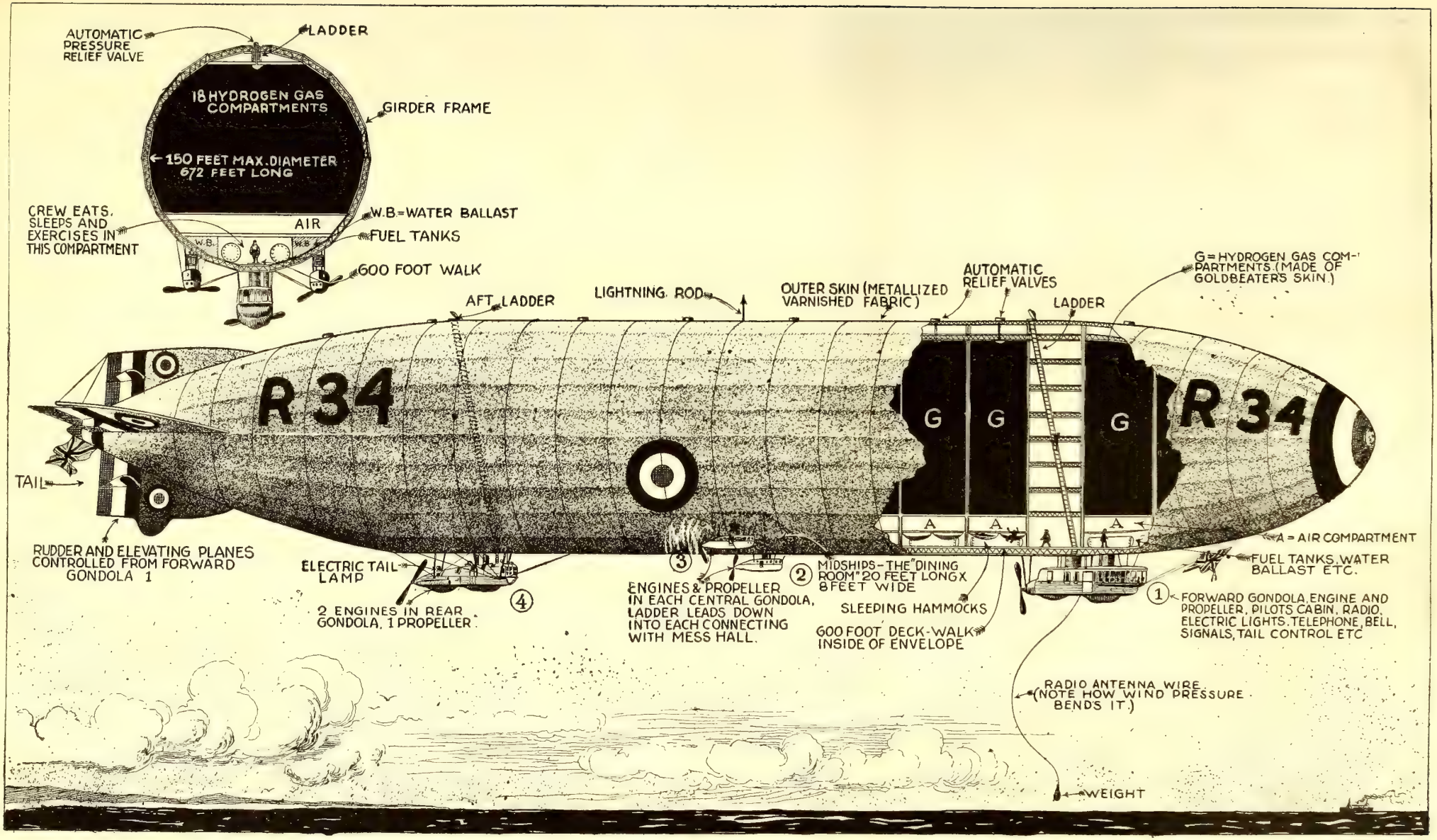
In the aft gondola are two more engines, making five in all—one in bow, two amidship and two at the stern. There are, however, only four propellers, the two engines at the stern having only one propeller. Two men are at work at the engines during the flight, one man operating and the other oiling.

DECK WALK 600 FEET LONG.

Inside the huge envelope there is a deck just 600 feet long and very narrow, covered with linoleum. It is not difficult for a man to balance himself as he walks along this deck, but it would be difficult for two men to walk it.

There are eighteen hydrogen gas compartments inside the shell, as shown in the semi-sectional view herewith. Nine of them have automatic valves, while the other nine are equipt with hand valves. The pressure of the hydrogen is not constant, but varies according to atmospheric conditions, with heat causing an expansion and cold contraction. This is regulated by the valves. If

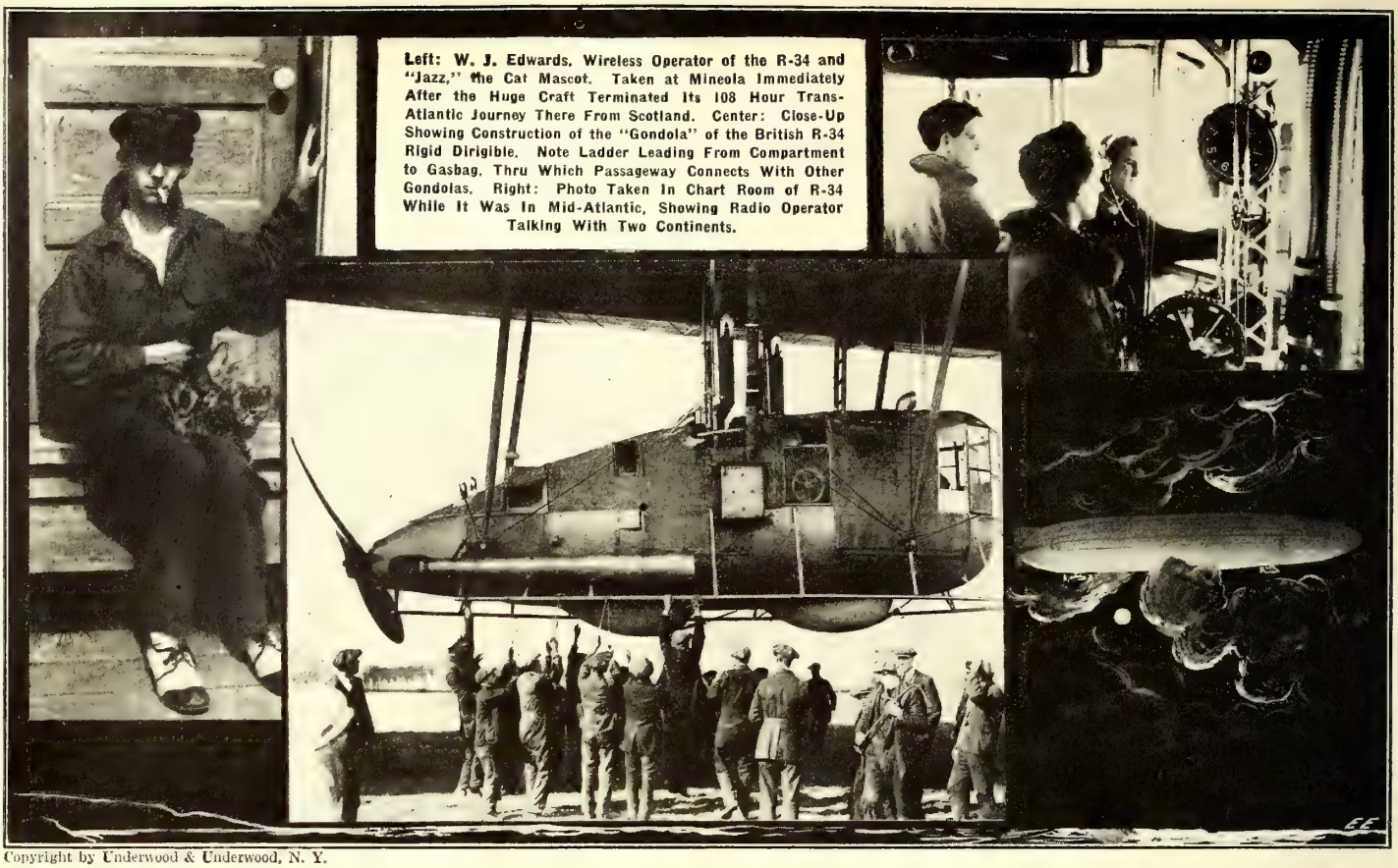
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THE "INSIDES" OF THE TRANS-OCEANIC AIRSHIP—THE R-34. THE FIRST DIRIGIBLE TO FLY ACROSS THE ATLANTIC

Imagine a gigantic airship resembling a huge sausage floating lazily thru the air over your head. This wonderful invention of man, measuring 672 feet in length, is nearly as high as the fifty-five story Woolworth Building in New York City, or three-quarters as high as the Eiffel Tower. The giant British airship, which successfully made the trip across the Atlantic Ocean from England to Mineola, L. I., N. Y., and return, was piloted by Major G. H. Scott and a crew of thirty men. On the trip over from England to America, her commander unconsciously carried a stowaway, a former mechanic who had worked on the ship in England, and who would not be cheated out of the first trans-Atlantic trip. The ship also carried a tabby cat as a mascot. The English Government has plans under way to build several new dirigible gas-filled airships similar to the R-34, but about twice its size. The R-34 carried approximately 2,000,000 cubic feet of gas. The accompanying illustration shows comprehensively some of the novel features in this first "Leviathan of the Air". The crew dined, slept and exercised in the long compartment running along the lower side of the gas envelope. The dining room is placed amidships, and is 20 feet long by 8 feet wide. All the four suspended gondolas carried propellers and petrol motors for operating them, and the members of the crew had access to any of the gondolas as occasion required, by means of covered ladders leading down from the 600-foot walk and passageway at the base of the gas envelope. The crew slept in hammocks suspended from the framework of the envelope, just above the 600-foot walk, as shown in the diagram. In rising from the ground at the start, ships of the R-34 class do not operate their engines, but simply throw off their mooring cables, when they rise rapidly to a considerable height,—8,000 to 9,000 feet elevation. The big ship then finds her natural "equilibrium" point, and the commander gives the order to start the engines and propellers. The giant blimp, termed a "filleted rigid" by her commander, Major G. H. Scott, then comes under perfect control. To cause the ship to descend, is simply a matter of shifting the water ballast and raising or lowering the horizontal tail rudders. The ship is kept on an even keel by vertical tail rudders. Astronomical observations, such as "shooting the sun" with a sextant, are carried on by one of the officers, who climbs up an 80-foot ladder to the top of the airship, there being two of these ladders, fore and aft. The range of the special wireless apparatus is remarkable, signals having been transmitted from the R-34, 1200 miles, from off the Azores to England. Signals from England and America were copied in mid-ocean. Four distinct wireless sets were carried, including one "wireless telephone" set. The Dirigible has a much greater lifting capacity than the NC planes, and can not only carry a higher powered radio set, but can support a longer antenna when desired.



Left: W. J. Edwards, Wireless Operator of the R-34 and "Jazz," the Cat Mascot. Taken at Mineola Immediately After the Huge Craft Terminated Its 108 Hour Trans-Atlantic Journey There From Scotland. Center: Close-Up Showing Construction of the "Gondola" of the British R-34 Rigid Dirigible. Note Ladder Leading From Compartment to Gasbag, Thru Which Passageway Connects With Other Gondolas. Right: Photo Taken In Chart Room of R-34 While It Was In Mid-Atlantic, Showing Radio Operator Talking With Two Continents.

Copyright by Underwood & Underwood, N. Y.

the valves should get stuck, something might happen. They have a manometer by which they read the pressure in the hydrogen tanks. Ten millimeters is dangerous. Should the valves refuse to work a fire might start and the crew be forced to land or leap for life.

EIGHTEEN HYDROGEN TANKS

The eighteen hydrogen tanks are made of goldbeaters' skin, which is the intestines of calves. The final inflation—that is, the loading of petrol and hydrogen—takes place at the minimum temperature after the sun goes down. Flying over a warm city causes expansion, and over the sea, where it is cold, the bag is caused to contract. On the way over, while flying over the ice floes around Newfoundland, there was a contraction of 40 per cent.

When the machine starts to rise and the guy ropes are thrown off, she rises until she finds her equilibrium. It may be 500 and then it may be 3,000 feet. When she finds her equilibrium, the motors start. Meanwhile the wind carries her wherever it pleases. That is the reason why in most cases a start is made between midnight and dawn.

There are eighty-one tanks on board which contain petrol, and weigh approximately 500 pounds each. The capacity of each is seventy gallons. Sixteen of these tanks are fixed to the framework. The others are called "slip-tanks," and have double functions, acting at times as ballast. The water ballast is carried in canvas containers. There are eight emergency containers—that is, four forward and four aft. The water is put in these emergency bags in accordance with the atmospheric conditions. They carry ballast weighing from 500 to 3,000 pounds.

There are three tanks of drinking water and one reserve tank containing distilled water, used in case of a shortage of drinking water. On the way over, the men were limited to a pint of water a day toward the end of the journey.

EATING AND SLEEPING QUARTERS.

The dining room is in the center of the ship, the only place where the deck is wide. It is about twenty feet long and eight feet wide. There are three tables on hinges fastened to the framework, the same as on ocean liners. Of course the officers and men use the same dining room. The food is already prepared but the men could cook if they wanted to by means of an electric stove in a gondola. They have to stand while they eat. The pantry is small, approximately two by four by eight.

The sleeping quarters are not very comfortable. The men sleep in light hammocks suspended from the framework. There are about ten hammocks, which are woven from Italian hemp. There is not much feeling of stability. If a man fell out of one, he would fall thru the fabric and out into the clouds. One cannot get a good, deep, untroubled slumber.

At the extreme end of the envelope there are no gas compartments—that is, for about twenty-five feet from the bow and from the tail there is vacant space. There are only two stationary electric lights inside the envelope, making it necessary for the men to carry electric flashlights.

The cockpits fore and aft are equipt with heliographs. The observer is not comfortable. He is compelled to stand upon an aluminum ladder with his head above the ship. The extra clothes carried by the crew are strapt to the side of the envelope. The crew of the R-34 brought only their dress uniforms with them on their voyage as extra clothing.

PARACHUTES FOR CREW.

Running along the deck inside the envelope are the parachutes and life-belts. These appliances are kept in canvas containers. The life-belts are inflated with air. They go around the chest, and when wrapt up look like a bundle of clothes. Both the parachutes and life-belts are always available. If overland the men were forced to leave the ship, the parachutes might save them, while if over the sea the parachutes and life-belts would both be used and might possibly save them.

It is not comfortable on the ship at all. The static electricity in the air might cause a fire and explosion. For this reason the men wear rubber slippers, sometimes cloth, for fear that the sparks from the nails in leather shoes might start a fire. The lightning rod is a piece of steel cable with a tassel on the end.

THE RADIO EQUIPMENT.

The R-34 is probably the largest of the lighter-than-air machines. It is exclusively of British design and construction, and is navigated entirely by the navigation officer from the forward gondola. This officer works from a bridge, much the same as the bridges on trans-Atlantic steamers, and controls the airship. In back of the navigation officer's headquarters is the "Wireless Room" fitted with four wireless sending and receiving outfits, the range of these varying considerably.

Lieut. R. F. Durrant of the *Royal Air Force* claims the following ranges for his Radio apparata: With a three-step ampli-

(*Continued on page* 438)

To the Editor of the Electrical Experimenter:

I regret that owing to circumstances beyond my control it was deemed advisable to postpone the publication of the article which I had intended for your August number. But the objections to its appearance will be shortly removed and I shall be pleased to forward it in due course for embodiment in your October issue.

Irrespective of this, I think it well on this occasion to notify your readers, as a precaution, that I am not one of those who display the sign "Do it now" on their desks and office doors. My motto is "Do not do it now. Think it over".

Very truly yours,

N. TESLA.

Under-Water Surveying by Reflected Sound Waves

By H. WINFIELD SECOR

ASSOCIATE MEMBER AMERICAN INSTITUTE ELECTRICAL ENGINEERS

LOCATING invisible objects at distances of several miles under water is not such a new scientific fact, as several schemes for carrying out the detection of submarines by these sound waves, radiated from the propeller and engine of the undersea craft, were conceived and applied more or less successfully during the progress of the World War, and enemy submarines were trailed by means of submerged microphones or electrical sound detectors. But it has not been possible heretofore to utilize ordinary apparatus, such as a *single* sound detecting instrument located at a *single* point, to *accurately locate any object at an appreciable distance to within a few feet.* However, a New York inventor and electrical engineer, Mr. E. E. Ries, has been working for a number of years on a most ingenious *reflected-sound* scheme for locating various objects such as submarines, icebergs, charting ocean and river beds, etc., and the present article deals with the remarkable principle of sound wave triangulation, as evolved and perfected by Mr. Ries.

Our readers may probably remember having read several years ago of an "iceberg detector" operating on the sound wave principle, devised by Mr. Ries, in which two sensitive microphones fitted with horns were mounted at the extreme ends of a yardarm high up on the mast of a ship. To locate the distant iceberg, even in a fog or at night as well as day-time, a powerful siren placed exactly midway between the

The Ries Under-water Sound Detector and How it Works.

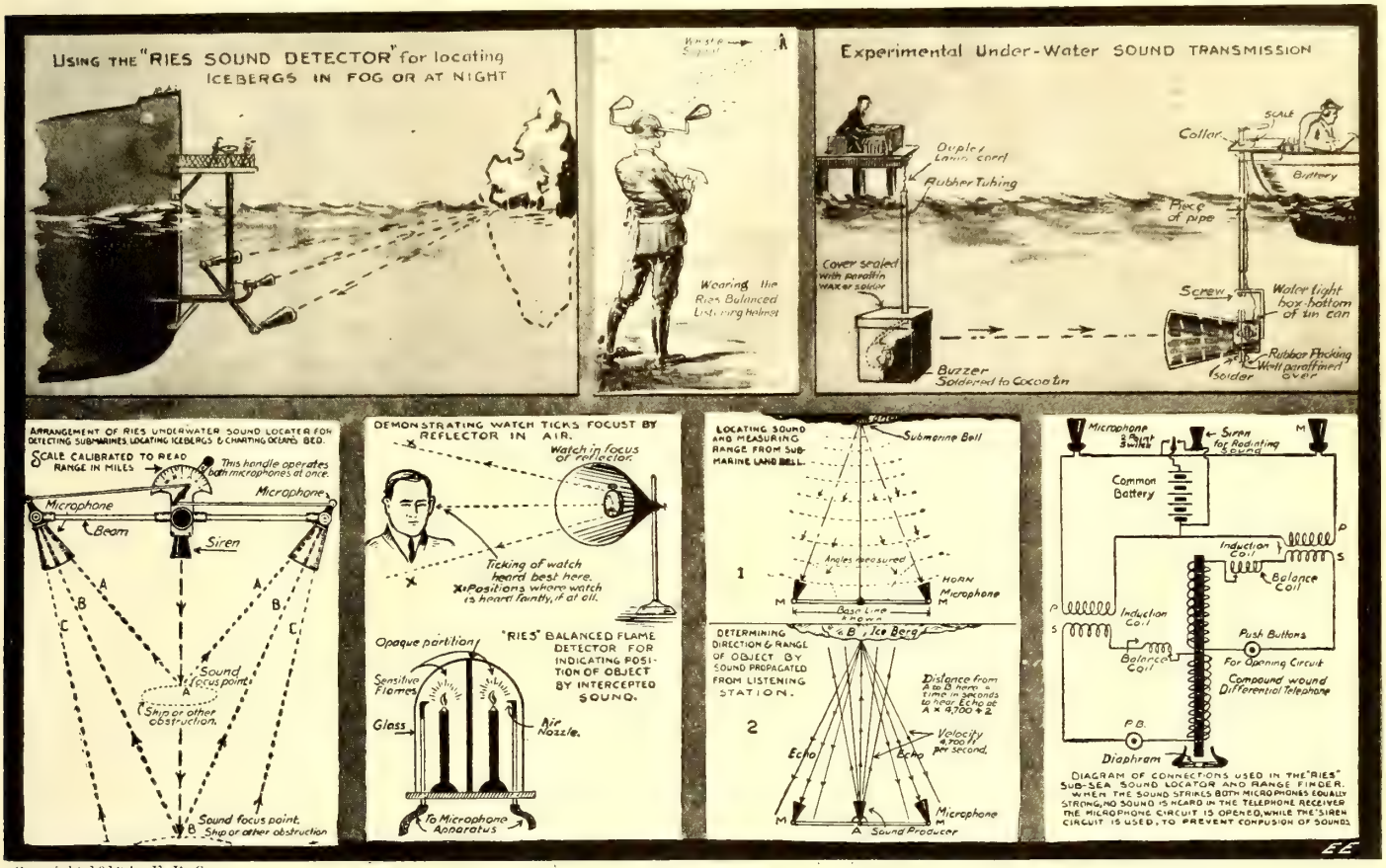
microphones on the yardarm or spar, was sounded. The yardarm carrying the microphones was then swung on the mast as an axis, until the "echo" reflected from the iceberg was picked up several seconds later in the microphones. By a special scale device attached to the pivoted microphone elements, the angles which they subtended when both were focust on the spot from which the echo rebounded, showed the distance in feet or yards, as the case might be.

Before going further into the details of Mr. Ries's most ingenious and promising system of "Subaqueous Surveying" by means of reflected sound waves, it will prove interesting to look into some of the principles of sound wave physics underlying the functioning of this latest scientific achievement. Moreover, as Mr. Ries pointed out, his system of sound wave triangulation overcomes all the weaknesses of the single, straight-line sound detectors, by utilizing a greater base line in his triangular determination of the source of the sound or echo, and by this means he confidently believes that ships, submarines, icebergs or other obstructions, including the depth, contour and nature of the ocean bed or rocky coast, *can be located quickly and precisely to within a few feet, even at a distance of eight to ten miles or more.* This seems all the more probable when the wonderful principle on which his system operates is more fully understood.

SOUND WAVES IN AIR AND WATER.

In the original scheme for locating icebergs or other objects projecting above the water, as devised by Mr. Ries some years ago, the propagation and reflection of sound waves, i.e., the echo, was based on the phenomenon of sound wave transmission thru the air. Sound travels thru the air at a speed of approximately 1,120 feet per second; it is well to keep in mind also that a sound traveling toward a certain point such as a rock or iceberg and rebounding from the surface of said object by reflection, will cause an echo traveling at the same speed also, or 1,120 feet per second. Hence, when listening for the echo, which you may sometimes do in parks or in mountainous regions where there is a rocky formation which will give a good clear echo at a considerable distance, you may time the distance with an ordinary watch provided with a second-hand, by counting the seconds required to hear the echo. But the time noted should be divided by two, and then multiplied by 1,120 in order to get the distance in feet. Sound wave propagation thru water is very much the same as that thru air, with the difference, however, that sound travels thru water at a much greater velocity than thru air, owing

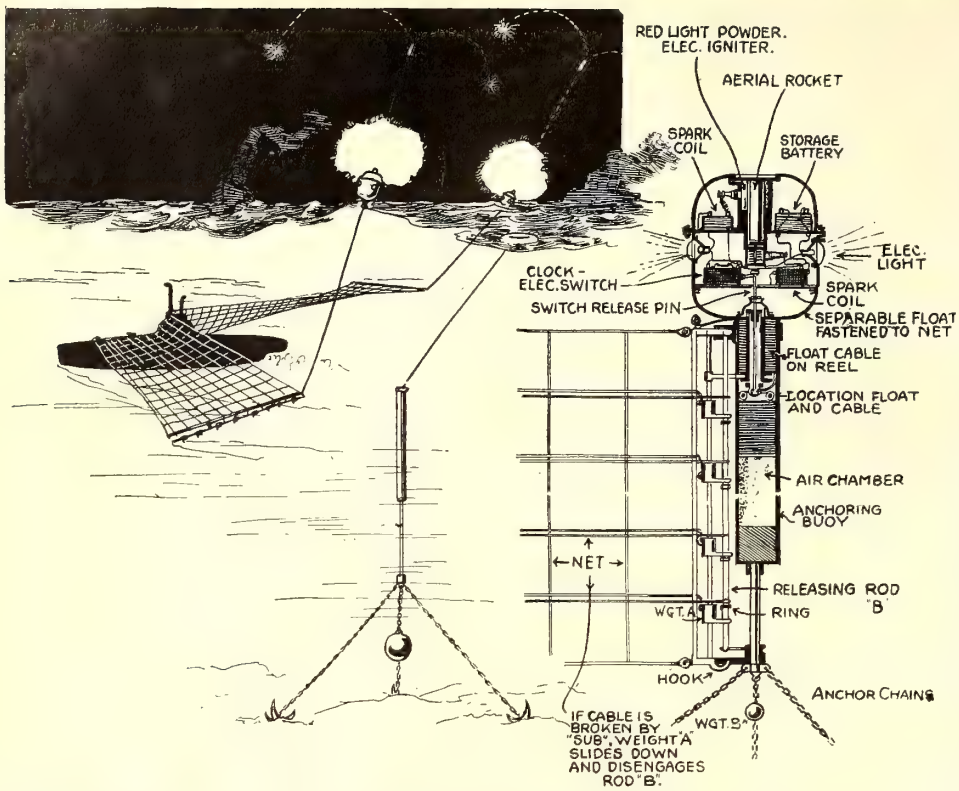
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The "Ries" Improved Under-Water Surveying and Locating Scheme, Utilizing Reflected Sound Waves Propagated thru the Water, Promises to Solve Many of Our Greatest Problems. Among These We Find the Locating of Sunken Ships, the Charting of River and Harbor Beds, Detecting and Locating of Enemy Submarines to Within a Few Feet of Their Actual Location, Etc. The Principle of Triangulation Employed Makes the Invention Extremely Feasible and Precise.

A Telltale Submarine Net



Submarines Will Have to Become Almost Human to Get Thru the Under-Water Nets and Mines Barrages of To-morrow. Here's a Telltale Net That Entangles the "Sub" and Sends up Rockets Signaling the Fact. Electric Light "Markers" Are Also Brought into Play.

THE vast experience gained by naval designers and inventors during the progress of the great war has taught them many things. The various means of protection against submarines have been quite extensively tried out, and while many theorizers have predicted failure for *anti-submarine nets,* still many hundred miles of nets were constructed and successfully employed during the war. A new form of *telltale submarine barrier* or net was recently invented and patented by one John P. Geraghty, of Jersey City, N. J. His invention covers a system of detecting submarines solely by the use of protective nets, so that anti-submarine operations can be carried out directly, and a few dozen "ash cans" (depth bombs) let go on the spot where the submarine is eventually located by the sub-sea microphones, et cetera, as now used by all of the leading navies.

The outstanding features of Mr. Geraghty's invention are that as soon as a submarine touches the net and tries to cut its way thru, or else bumps the net so hard that it carries it away, telltale signals will instantly be given, and which are effective either by day or by night. At night, rocket signals are shot forth from the anchor buoys of the net as soon as the net has been damaged or carried away by the lurking enemy sub-sea craft engaged on a surreptitious visit to the harbor or bay thus protected.

In this form of anti-submarine protective net, the net, which is of special design, is detachably fastened to sturdy anchoring devices, so that when a submarine strikes the net it can, with ordinary pressure, tear the latter away from the anchorages, which immediately causes signals or telltale means to be operated so that patrol boats, such as submarine chasers and destroyers, can at once give battle to the unseen enemy. The anchoring devices are provided with clever releasing catches, which when a certain amount of pressure is applied to the net, collapse and allow the net to be released from the anchorages. As soon as this happens, however, the collapse of the catches

(*Continued on page* 483)

Electrocuting Huge Leopard

It was a "shocking" affair, but those members of the Los Angeles moving picture colony who are in the habit of working with animals are breathing sighs of relief, for David, the big leopard of the "movie" jungle is no more. Sentenced to death by a jury of his peers, the big cat paid the extreme penalty by being electrocuted. According to Mr. Edwards, manager of the film company who owned the beast, most of the animals used in film work are very tame, but David had been acting treacherously for several months, and rather than risk the injury of anyone who might be acting with him it was decided to end his career. At first shooting with a high-powered rifle was considered, but fearing that this would disfigure the beautiful pelt which the company wished to preserve, the engineer of a large electric power station nearby was consulted and electrocution was decided upon. A large steel plate was placed on the floor of the cage and connected to a 6,000-volt power line at the power house. David was then placed on the plate, and another wire fastened to his leg, the juice turned on, and David was no more.

The execution of animals has received considerable investigation, especialy in the city of Boston, Mass., where there is located a specially equipt institution for electrocuting horses, cats, dogs, etc. The apparatus and special provisions arranged to carry out this work were described some time ago in the ELECTRICAL EXPERIMENTER. The method is not only advantageous in many different ways, such as the ease and certainty which which the animal may be killed, but also has received the highest commendation from humane investigators and scientists. The theory of electrocution tends to show that the high velocity of the current travels faster than the nerve wave itself, and therefore the animal is dead before any shock can be felt.

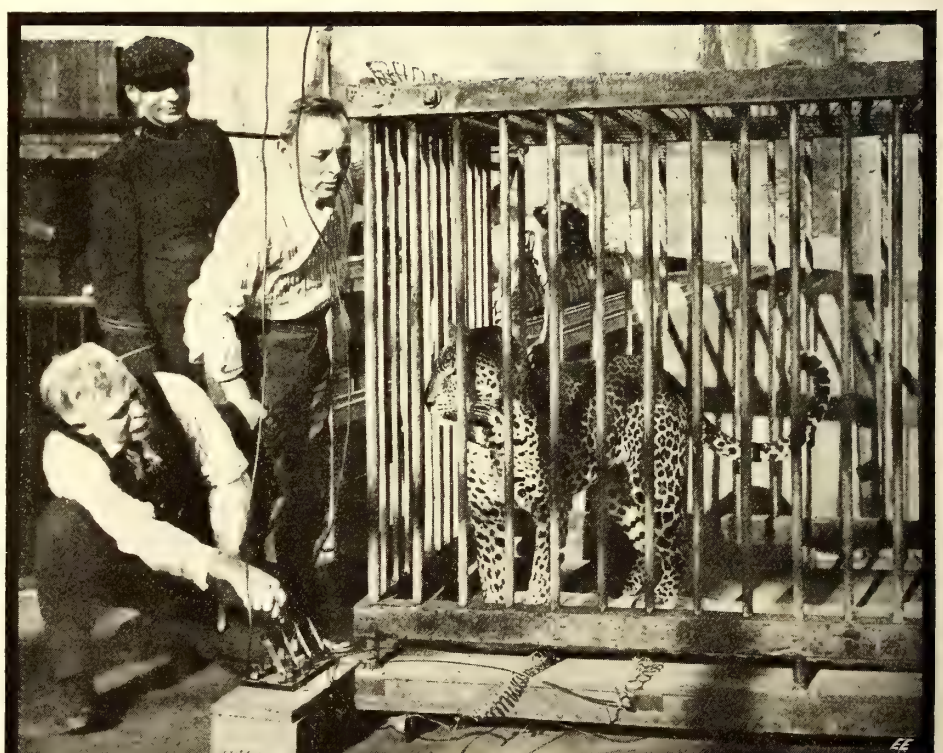


Photo by Keystone

"David"—the Big Leopard of the "Movie" Jungle—About to Breathe His Last. One Throw of the Switch and He Paid the Final Penalty for His Treachery, Which Had Endangered the Actors' Lives.

Sir William Crookes' Psychical Researches

By HEREWARD CARRINGTON, Ph. D.

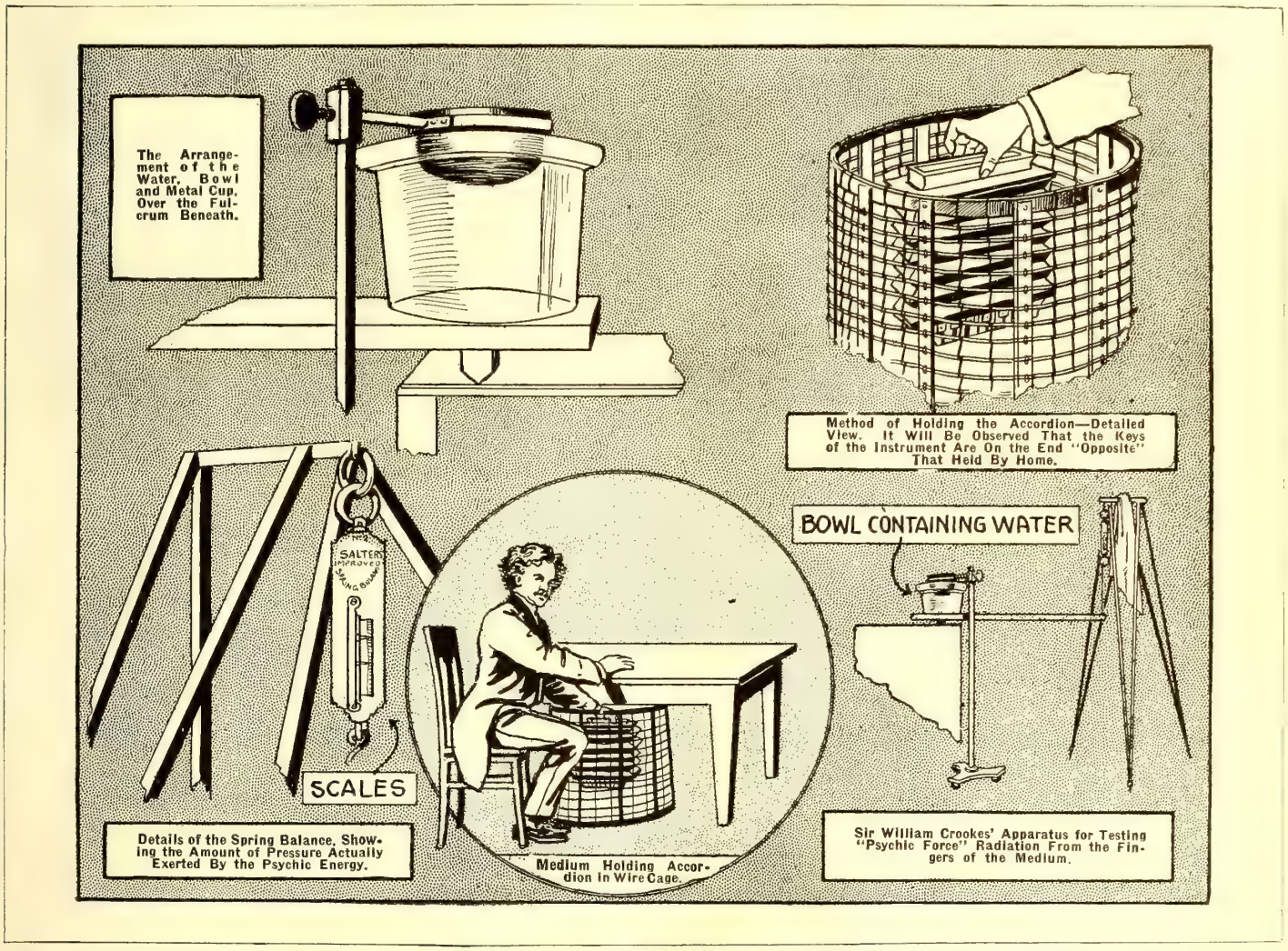
THE late Sir William Crookes, O.M., F.R.S., will always be regarded as one of the greatest scientists—as he was one of the greatest "psychical" students—of all time. His achievements in the fields of chemistry and physics alone insure the perpetuation of his name in scientific circles. He was the discoverer of the element thallium; he it was who first investigated many of the phenomena of radiation, which led to the ultimate discovery of the "Crookes tubes"—named after him—and which in turn have led to many important discoveries in the realms of chemistry, physics and medicine (the X-rays, etc.). He made many valuable contributions to the study of radium; he invented the "radiometer," which we now see in nearly every oculist's shop; he wrote many standard works upon chemical analysis, sugar manufacture, dyeing, printing, metallurgy, sewage, diamonds, and many other topics—thereby establishing his name as one of the finest, most ingenious and most practical scientific minds in the world, and leaving to posterity a veritable monument, in the shape of lasting and valuable achievement, of great practical benefit and value to mankind.

Sir William Crookes, however, was known not only for his interest in the problems of physics and chemistry, but also by reason of his interest in "psychic" phenomena, and his book "Researches in Spiritualism" is a classical manual on the subject, oft quoted, and a model of clarity and impartiality. Curiously enough, his researches into the phenomena of spiritualism were being undertaken during the very years (1870-74) when, in the opinion of many physicists, Sir William was doing his best work in chemistry, so that the charge cannot be brought against him that "he only became interested when in his dotage"; on the contrary, he was then in his prime—about forty years of age. It is true that Crookes maintained his interest to the day of his death, but he *wrote* very little upon the subject, contenting himself with patient research and investigation, which tended but to confirm his earlier researches. A brief summary of these cannot fail to be of interest.

The majority of these experiments—which were chiefly conducted in Sir William's own home or laboratory—were made with the medium Mr. D. D. Home—a medium who produced extraordinary "physical" manifestations, and who was never detected in fraud in all his long career (Home was an intelligent man, who wrote several excellent books upon the subject himself). One of the earliest experiments was that with an accordion, held lightly between the thumb and fingers of Home's hand by the end *opposite* the keys. His other hand was visible and rested on the table. The accordion, thus held, was placed within a circular wire cage, which could be charged

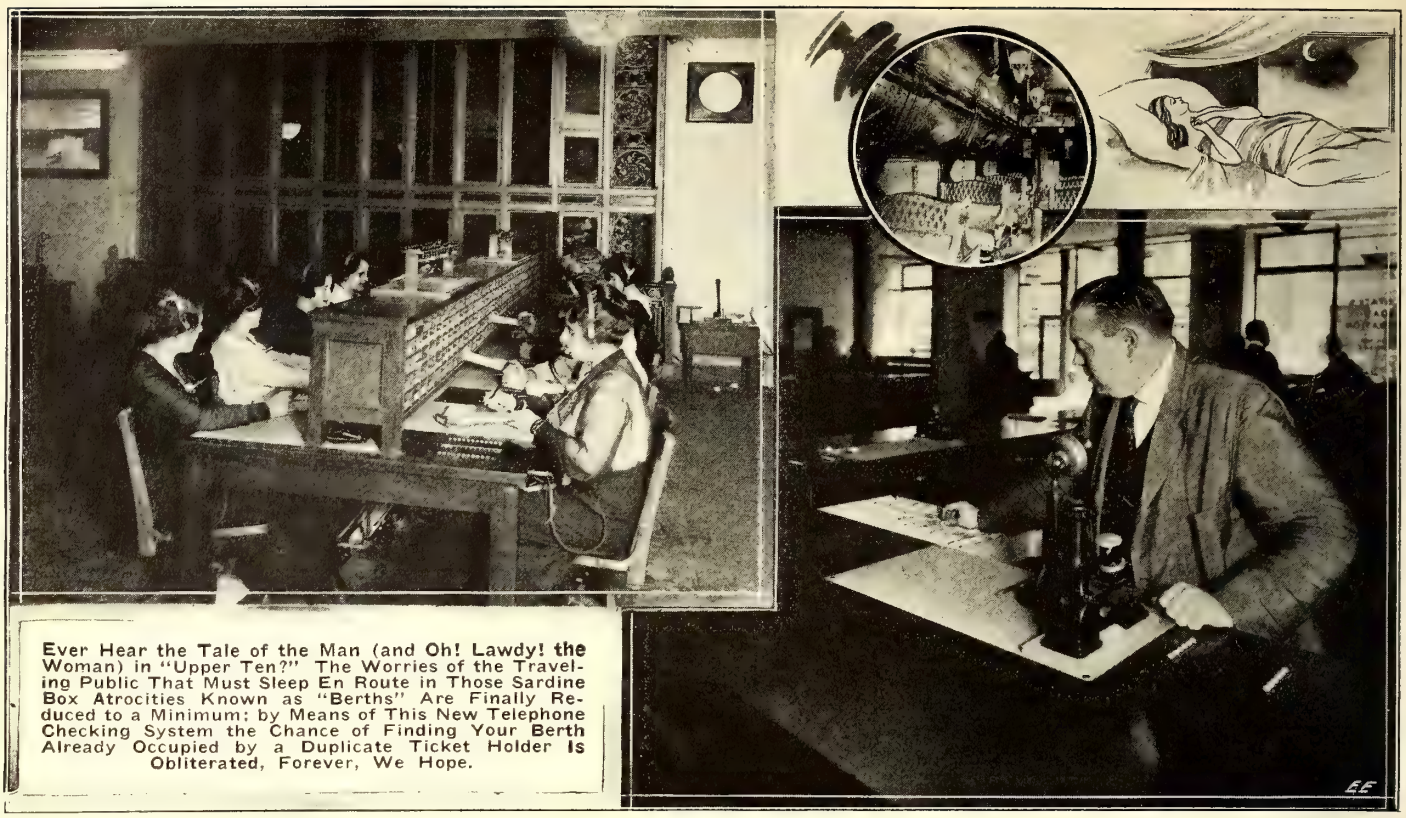
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Scientific Proof of Psychic Force or Spiritualism



IN publishing this article, we are aware that it is a very unusual subject to appear in a scientific magazine. We however, have approached the matter with an open mind, neither condemning nor upholding it. The reader must be the judge. We do not publish it with the mental reservation that "there might be something in it, after all," but we do believe that anything at all in science over which there has been a great controversy should be discussed as intelligently as it is possible. The author of the present article, Dr. Hereward Carrington, is a member of the Society of Psychical Research, and he is also the author of several interesting books, among others "Death: Its Causes and Phenomena;" "The Problems of Psychical Research;" "The Coming Science;" 'Psychical Phenomena and the War."

Sir William Crookes, one of the greatest scientists that ever lived, became converted to spiritualism after long and exhaustive experimental evidence which today seems irrefutable. Dr. Hereward Carrington clearly describes some of Sir William's experiences in this article, which should prove of unusual interest to our readers, whether it will convince them or not.



Ever Hear the Tale of the Man (and Oh! Lawdy! the Woman) in "Upper Ten?" The Worries of the Traveling Public That Must Sleep En Route in Those Sardine Box Atrocities Known as "Berths" Are Finally Reduced to a Minimum; by Means of This New Telephone Checking System the Chance of Finding Your Berth Already Occupied by a Duplicate Ticket Holder Is Obliterated, Forever, We Hope.

Telephone Solves "Lower Berth" Squabble

THOSE of you who have tried in vain to obtain a *lower berth* on a railroad train, only to find out that a friend of yours purchased one from a different window *after* you applied for yours, will doubtless be interested in the new method of booking applications which is in use at the present time at one of the large railroad terminals in New York City.

According to the old method, diagrams of each pullman car, with blank spaces for each berth, were distributed among the various stations and ticket offices. When you purchased your ticket, the number of your train ticket was entered in the space representing your berth. In this way the ticket agent knew just what berths were occupied and which were not. Yes, he did!

When the train left the station these cards were handed to the pullman conductor, who settled disputes as to the occupancy of the berths, according to the ticket number entered on his card. If two people claimed the same berth, the one whose ticket number appeared on the card was the fortunate individual.

(*Continued on page* 481)

New Continuous Panorama Advertising Display

It is undoubtedly a fact that the long suffering public has been wont to see many advertising devices both good and bad exhibited in store windows, etc., designed with the intention (?) of securing their attention. Of these some have been rather unique and served their purpose admirably, but there have been many that have fallen by the wayside.

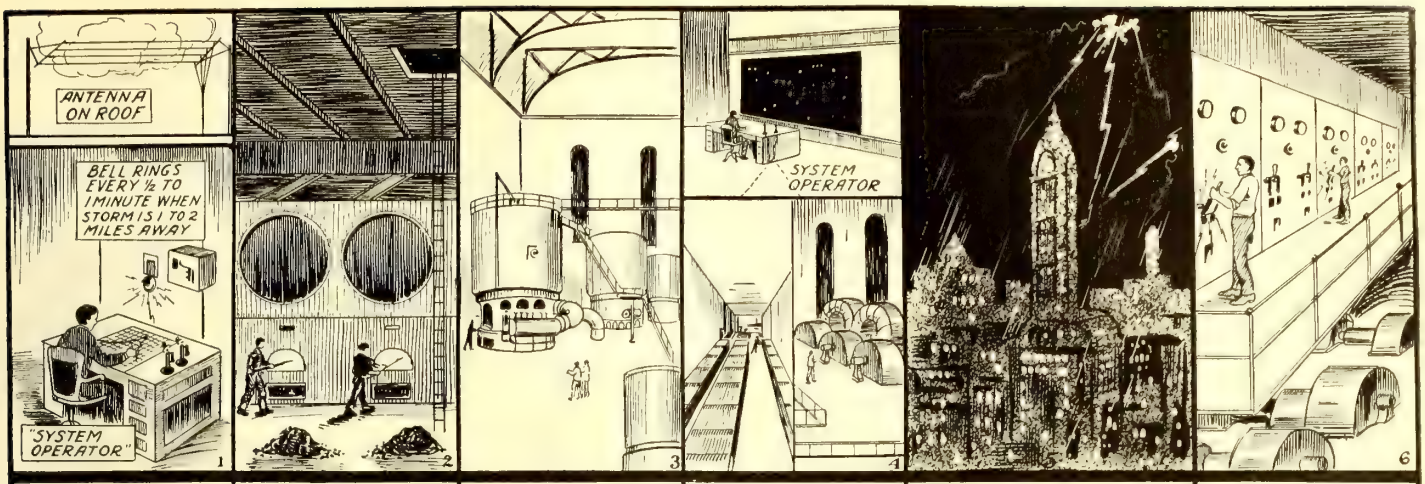
With these few words of introduction to our plot we come up against the difficult task of describing this new advertising device that to all intents and purposes eclipses them all. The main difficulty is to find a way that will make the explanation reasonably clear. It is



A Mystifying Show Window Attraction—the Scene on the Revolving Disc Constantly Changes.

called the "Endless" display machine, and as an advertising specialty it seemingly surpasses anything heretofore shown, in that it presents to a manufacturer, dealer or storekeeper a very neat and attractive way of telling the history of the manufacture of the goods he may be selling, with a wonderful grouping of photos much the same as a moving picture or panorama. It is only by some such means that customers are usually interested, as the eye readily transmits a picture to the mind that is bound to stick. In addition to the continuous moving picture there are a number of shelves provided at the base for the display of small wares.

The circle covered by the moving disc is thirty inches in diameter, and is capable of showing three separate pictures on each sheet. It is adapted to display any advertising matter which is now used or has been used in posters, car cards, phrases, and in fact all written, printed or photographic matter. Each machine can hold 20 or more sheets each thirty inches in diameter; they are notched around the edge with a tough linen border which precludes their becoming torn or mutilated while passing thru the machine. The discs are slit and joined end to end in a flat pile inside the machine with the two free ends joined in a sort of twist, thereby enabling the action to be continuous both back and front. They are held in place both by a pivot in the center and also by the driving motor, which is of 1/40 horse-power and so geared that two friction pulleys bear on each side of the machine. Between these pulleys are set the edges of two discs and by a simple gearing process, each set of friction pulleys works in the opposite direction, thus making possible the continuously moving panorama.

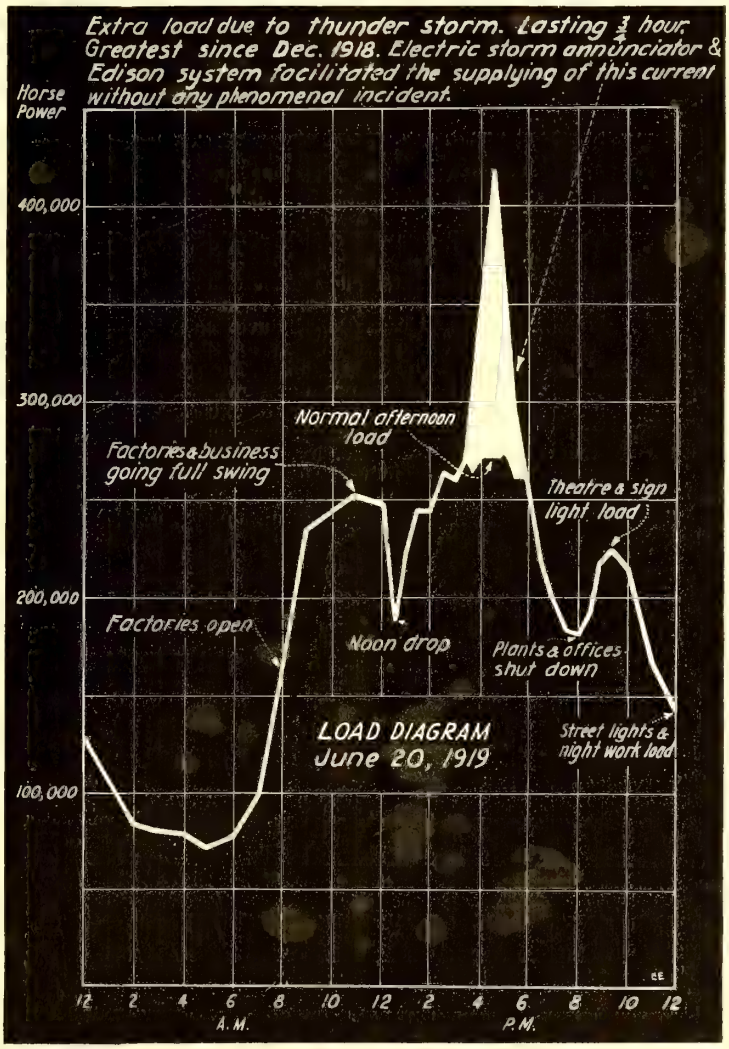


200,000 Horse-power in One Hour

ON Friday, June 20th, 1919, the electric light and power service of the New York Edison Company was put to the severest test which the Waterside Station had ever experienced since December, 1918. This was a day on which a summer thunder-storm, coming up in mid afternoon enveloped the city in darkness equal to that of 10 o'clock at night, the consequence being that about 2,000,000 electric lights were turned on almost instantaneously and the Edison Company had to meet this demand for more "juice." It occurred when factories and offices were going at full swing, hundreds of which suddenly switched on all the lights when the storm broke. Several factors enabled the company to supply the enormous demand for current. One of these we have described in a previous issue of the ELECTRICAL EXPERIMENTER — the "wireless storm announcer," which again stood in good stead.

This consists of a slightly modified form of an early model wireless receiving station, using a *coherer* and a bell as a decoherer, together with the necessary relays. In addition in the aërial circuit, are two spherical balls resembling a spark gap. These are placed 1-64th inch apart, and are used to prevent the causing of a false alarm by the surges emanating from nearby wireless telegraph sending stations. A condenser is placed in the ground circuit to prevent stray currents and a short-circuiting switch is used to silence the bell and protect the apparatus from heavy surges due to electrical storms, which may harm the apparatus and materially impair its usefulness.

The demands of this generating station were raised by this increase in the use of current from approximately 250,000 horsepower, which is the normal daily business load, to nearly 425,000 horsepower, and due to the fact that all offices and factories were "carrying on" at the time; this load would naturally be almost exclusively of a lighting nature. From these figures an increase of 175,000 horsepower would mean about 2,000,000 50-watt lamps being turned on suddenly. Naturally enough, something had to be done in order to meet this demand, and inasmuch as the change from normal to the *peak* load came within less than an hour, it involved a close race against time to get the boilers and generators into operation in time to meet the approaching darkness that the coming storm would bring.



This Daily Load Chart Shows How the New York Edison Company's Output Increased Nearly 100% During a Recent Thunder-Storm.

At a large generating station such as at Waterside, there is generally one man and his assistants, who are able to conduct the affairs of the station with remarkable skill and precision—the "system operator," as he is called at Waterside. The system operator invariably keeps posted on the demands that are or may be made on the station for power and light, so as to direct the disposal of all generating machinery. Thus the station will afford the highest quality of service and will operate with maximum efficiency, i.e., he ascertains how many boilers should be maintained under load, and how many should be "banked," which machines shall carry the load and which shall remain idle. He also directs the switchboard operators as to which feeders shall be used to dispose of the output. As this routine is an everyday affair, it is conducted quite automatically, but the life of the system operator also has some of its thrills, especially when a storm approaches the city at a rate of about 45 miles an hour. The little thunder-storm detector, a view of which is reproduced here, does its share of the work. When a storm is approaching, and about one to two hours away, the gong on this storm announcer will strike about every fifteen or twenty minutes. This is only a "warning," and not much attention is paid to it, as it is very probable that the storm

(*Continued on page 450*)

Possibilities of High Frequency Currents

By JOHN E. PRITCHARD

IN all branches of human endeavor there has been that characteristic trait to attain perfection. This condition has never been reached and never will; but like a variable approaching a limit, the difference between perfection and non-perfection can be made very small.

In the early development of electrical application, it was generally conceded that direct current transmission was a marvelous advance toward the ideal method of power delivery. Its flexibility over all others was evident, at that time. This advancement opened a new field of industrial engineering. Investigators were spurred on by successes, so naturally the field became extensive. Then the *disadvantages* of direct current became prominent. Economy demanded that power units be centralized. It was found that to transmit large currents long distances at low voltage, required very *large conductors* to reduce the heat losses, which are equal to the current squared, multiplied by the resistance. This draw-back was partially surmounted by the high voltage direct current generator; but due to the mechanical as well as current transformation difficulties, it has not been widely adopted.

LOW FREQUENCY ALTERNATING CURRENTS

Low frequency 60 cycle A. C. machinery, thru persistent research, has to-day reached



Melts From the High Frequency Furnace, Some of Which Resist Fusion Up to Temperatures as High as 1700° Centigrade. Such Include Tin, Lead, Zinc, Aluminum, Brass, Copper, Iron Cast and Electrolytic (Which Was Melted in Vacuum Without the Presence of Carbon, Even in Traces), Nickel, and High Silica Glass. As an Interesting Indication of the Unique Character of the Induction Possible, a Mass of Small Iron Nails Is Shown at the Extreme Right, Which were Cintered Together by the Action of Powerful "Eddy Currents." While This Action Is Proceeding, During the Early Stages of the Melting, Small Arcs and Sparks Tend to Weld the Many Particles Together. This Effect Is Obtained Only In a Crucible That Is Electrically Non-conducting.

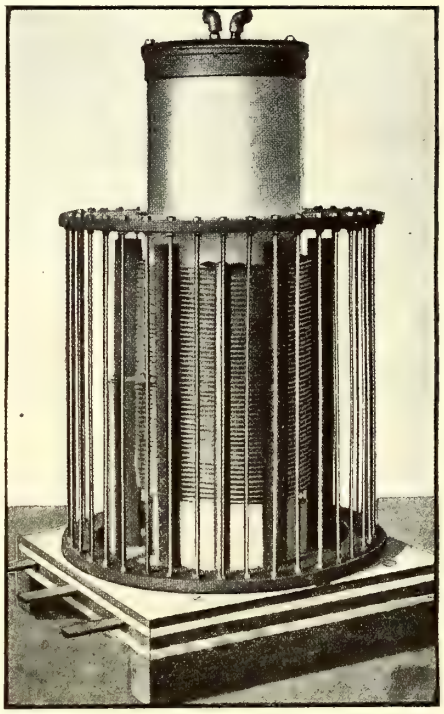
a high degree of perfection. But even with our great power houses and their long transmission lines lighting great cities, propelling ponderous electric trains over high mountains and furnishing energy for every conceivable form of prime-mover in the industries, there exist many factors detrimental to perfection.

The reason for the great use of alternating currents is the ease with which they can be *transformed from one voltage to another.* They can be generated at a comparatively low voltage and stept up to a higher voltage. In the transmission of great power at *high voltage* there is required but a *small current,* and this, in turn, requires only *conductors of small cross-section.*

RESONANCE IN A. C. CIRCUIT.

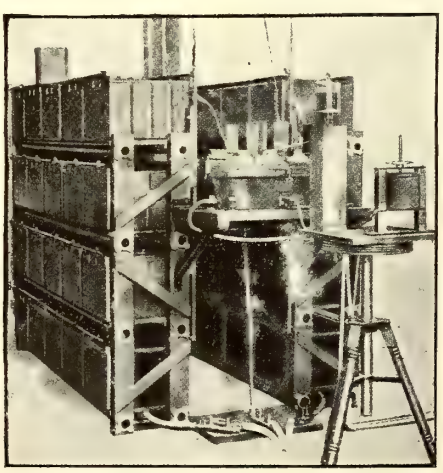
Transformation is accompanied with

The High Frequency Furnace and Electric Power Transmission



Typical Vacuum-Type Inductor Unit of New High Frequency Furnace Developed by Prof. Dr. E. F. Northrup, Princeton University, Marking a New Era in the Electrical Refinement of Metals.

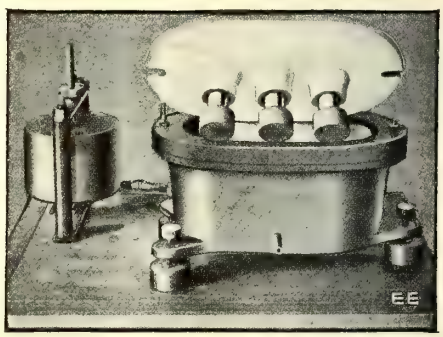
heat, magnetic leakage, hysteresis and eddy current losses. First class design has reduced these to a minimum. Also, there are *disadvantages* caused by inductance and capacity in every circuit. This lowers the *power factor.* The lower this is, the more current is required to produce power at a given voltage. This gives rise to excessive heat losses. The power factor may be made unity or nearly so, by *balancing* the reactive effects of inductance and capacity. When this condition exists, resonance is said to take place in the circuit and then



High Frequency Electric Furnace Condensers and Spark Gap. These Furnace Outfits Have Been Built in Sizes Up to 50 Kilowatts.

Ohm's law holds true, C=E/R. It is very desirous not to have this in practise, due to the great strain placed on the circuit. The voltage, as well as the current, may reach abnormal values under such conditions. In fact, the potential on a long transmission line may be 10 per cent higher at the distant end than at the generator end, due to these resonance conditions. In one case a 10,000-volt A. C. transmission line showed 11,000 volts at the distant or load end of the circuit.

This phenomenon may be illustrated by the mechanical analogy of a pendulum six feet long, on the foot of which is hung a weight of one hundred pounds. Strike the weight with a force of ten pounds. Call this the *positive* impulse. When it has traveled the full length of its arc, give it another ten pound blow. This is the *negative* impulse. Now the pendulum will oscillate freely. The time for a single vibration will always be equal, regardless of the length of its arc; therefore the impulses will occur at equal intervals of time and will be analogous to an alternating current delivered to a resonant circuit. The amplitude of the swing will get greater and greater until finally the energy represented in the moving weight is *many times larger than the individual impulses.* These are called *free vibrations.* But if the forces are not applied at the instant of the weight's



Interior View of Discharge Gap. The Discharge Gap Shown Is Adapted for Either Single or Two-Phase Operation. It has No Moving Parts and Is Substantially Noiseless. The Gap Is Very Effective in Producing Strong Oscillations and May Be Employed for the Conversion of Large Amounts of Power Into Oscillatory Currents.

return to center, part of the energy will be lost in heat. These are *forced vibrations.*

Alternating currents, in present day practise, applied to induction motors and transformers, are impeded by resistance, inductance, and capacity; giving rise to these forced vibrations. This condition causes voltage drop, low power factor, hysteresis or iron losses, and eddy current losses. A *synchronous motor* on the line with an over-excited field, furnishes an equivalent of capacity and tends to neutralize inductance and thereby makes the vibrations free. A condenser would do the same, but it would be too large to be practical.

HIGH FREQUENCY ALTERNATING CURRENTS.

High frequency alternating currents and machinery for producing them are comparatively new. This field of application is not extensive. There has been considerable development on the large scale in wireless telegraphy and telephony. But here the power has not, up to the present time, exceeded a few hundred kilowatts, and it

(*Continued on page* 474)

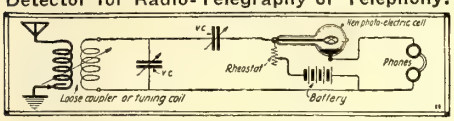
NEWEST ELECTRICAL DEVICES

PHOTO-ELECTRIC CELL SUPPLANTS SELENIUM.

Experimenters in many fields of science, including those interested in astronomy and certain branches of the electrical and radio arts, have very often faced the problem where to obtain a good selenium cell—



New Light-Sensitive Photo-Electric Cell and Below—a Diagram for Using the Cell as a Detector for Radio-Telegraphy or Telephony.



the well-known instrument which, when exposed to light, lowers its electrical resistance, thereby causing a relay connected with it to operate one or more local circuits. Not only was the question of where to obtain the cell often unanswerable, but the best selenium cells which have been available now and then on the American market have left much to be desired. This is so for several reasons. First, the element *selenium*—even tho it possesses a most wonderful natural quality of changing its electrical resistance in proportion to the amount of light thrown on it, and raising its resistance as the degree of darkness is increased—does not do this instantaneously, nor anything like it.

The newest advance in science is the *photo-electric cell.* This device, which has only recently been perfected so as to be available on the commercial market, is shown in the accompanying illustration and diagram. Not only is it useful where *light-operated* circuits are necessary and desirable, but it can moreover be used for receiving radio signals, as its designers have pointed out. Its arrangement in the radio receiving circuit is shown in the accompanying diagram.

The photo-electric cell apparatus is somewhat similar in principle to the selenium cell, in that it changes its inherent electrical resistance in proportion to the amount of light falling upon it. As its designers and builders state, the cell is not liable to lag as in the case of selenium, and there is no dark current whatsoever. It is said to be very constant and reliable in its action, and can be used to great advantage in stellar photometry. The applied potential for this cell is 220 volts. A cell of this type has a wider field of usefulness in many respects than a selenium cell, and it will carry a considerably larger current.

This photo-electric cell is very cleverly made up with a screw base fitting a candelabra socket. The rubidium screen inside the bulb connects to one terminal of the screw base, while a wire leads down from the silvered glass electrode facing the screen to the second contact member of the screw base. All that is necessary in connecting up the cell is to attach the two circuit wires to each of the two terminal screws on the base.

MAKING YOUR OWN FLASHLIGHT BATTERIES.

One of the latest advances in the flashlight art is the home-made battery outfit illustrated in the accompanying photograph. These outfits are priced so as to give about 25 per cent reduction in the cost of the batteries if purchased in the regular way, and each outfit will make three *two-cell batteries* or two *three-cell batteries,* there being suitable materials included to make up six flashlight battery cells. The outfit is supplied in two styles—one battery outfit includes a tubular flashlight, while the second outfit has a renewal equipment only, comprising the necessary parts, chemicals, etc., to make the six single cells as aforementioned.

As the makers point out in their instruction brochure accompanying the battery outfit, one of the principal advantages of this set is that the cells do not deteriorate in the least while they are standing, and so the person using these flashlight batteries has the satisfaction of knowing he is adding from 50 to 100 per cent to the life of his flashlight battery, which ordinarily is wasted, so far as the life of the battery is concerned, by standing on dealers' shelves, and in transit between the factories and dealers.

The liquid solution used in mixing the paste for the cells is placed in a graduated bottle. The proper quantity for each cell is marked off on a graduated label, which shows just what quantity to pour into each cell. Next, a chemical powder is placed in the solution and stirred well with a mixing stick accompanying the set. The carbon element, after being immersed in water for a few moments, is placed down



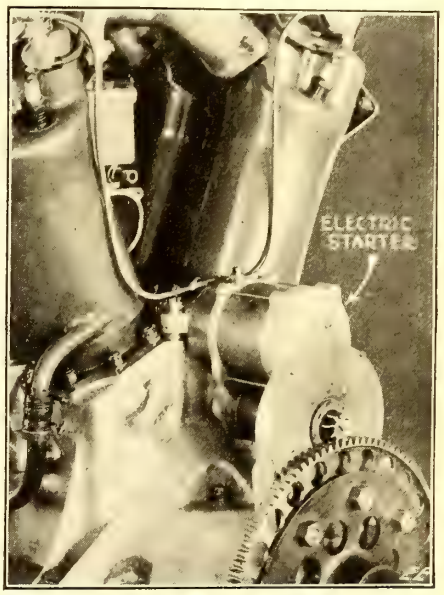
The Latest in Flashlights! Make Your Own Batteries.

into the zinc cylinder containing the solution, which has been thoroly stirred, and by pressing the cork supporting the carbon element down flush with the zinc cup, it is held firmly in place by bending over three zinc prongs. A cardboard cylinder suitable for holding three cells accompanies the outfit.

NC PLANES HAD ELECTRIC SELF-STARTERS.

It is not generally known that the NC flying boats which accomplisht the successful trans-Atlantic flight were the first heavier-than-air machines in this country to be equipt with electric self-starters for each of their big Liberty engine motors.

The result of the Navy Department's decision to so equip its seaplanes undoubtedly aided the success of the enterprise, for the NC-3, lost in the sea and fog near the



The Famous "NC" Planes Had Their Liberty Motors Fitted with Electric Self-Starters, as Shown in the Photo Herewith.

Azores, all her engines stalled, wet and cold, would never have been able to taxi into Ponta Delgada under her own power without the assistance of mechanical means for starting her propellers.

The picture shows this little starter attached to the propeller shaft of one of the big Liberty motors which drove our seaplanes thru the air.

This little device consists of a small 12-volt electric motor operated by a storage battery, connected thru a geared reduction to an automatic screw drive. On the end of the screw shaft is cut an 8-tooth pinion which meshes with a larger gear mounted on the propeller shaft. The starter will turn over the engine at 40 to 50 R.P.M. with a consumption of 100 to 110 amperes and a maximum of 1,300 foot-pounds is available on the engine crank shaft, for breaking loose a cold engine. When the engine begins firing the screw drive automatically demeshes from the crank shaft gearing. The storage battery weighs 26 lbs., and has a rating of 24 ampere-hours—or sufficient to supply enough current to make 150 starts on one charging.

An interesting incident of the American trans-Atlantic flight was that all three planes carried extra propellers, intending if one should break to descend to the water, change propellers, and start off again. They depended on the starter to make this possible.

It is also said that the C-5 (Blimp) met such strong headwinds on her trip from Montauk Point, Long Island, to Newfoundland, that the force of the wind stopt her propellers, and it was necessary to ascend to a higher level to avoid them, the starter with which she was equipt starting the engines while in mid-air.

Photo courtesy Westinghouse Electric and Manufacturing Company.



Even This Chinese Chef Likes to Cook on the Modern Electric Range. Meals Are Prepared on This Range for Workers on a California Ranch.



How Cool and Orderly the Electric Range Kitchen Looks. No Heat Wasted Here in Warming Up the Kitchen and No Smoke, Gas or Smell.

Electric Cookery—A Snap!

By GRACE T. HADLEY

Society for Electrical Development

THE history of human culture might be said to be largely the science of food preparation. Thru the ages the arts of fire were slowly developed. Wood, coal, oil and gas have been successively used in the production of artificial heat for the purpose of cookery. Until the last century fire was the most useful thing in the service of man.

To-day electricity is doing all that fire ever did, and is doing it better. Electric cookery is as superior to fire cookery as the electric light is to the tallow dip. Electricity is performing tasks beyond the limits of flame. Fire to-day yields motive power with many times the economy it did one hundred years ago. This motive power is the source of modern electric currents. This power as electric current enters silently and swiftly into the modern home and is the source of electric heat in the modern cook stove.

As refinement of living increases, electric cookery solves the problem of easy control, of elimination of waste, the uncertainties of temperature. The heat can be regulated with almost mathematical precision. When it is no longer needed the current can be turned off and no waste occurs. The time is close at hand when cookery will cease to be carried on by "guess-work." Many women already realize that it pays to put this work on a more scientific basis.

The temperature factor in cookery is one that ought to be thoroly standardized. In the art of baking a loaf of bread, for instance, there are many factors that must be precise, in order to insure best results. There is no reason, if conditions are exactly the same, especially temperature conditions, why the cook should not be successful with her baking, regardless of "wind in wrong direction."

The objects of cookery are to render food more digestible, to make the food more appetizing and to improve its appearance. In the cooking of animal food, the improvement of appearance and flavor is most important. Cooking foods rich in protein may decrease digestibility to some extent, but the increased attractiveness of well-cooked meat may render it more digestible by causing greater flow of digestive juices.

ROASTING.

Roast Beef.—Remove the baffle plate. Turn both oven switches to *High* and let oven heat twenty minutes. Place the roast on the rack in the dripping pan, rub with salt and dredge the meat and pan with flour. Put in the roast to sear for about four minutes to each side. Then put in the baffle plate and turn *lower* oven switch to *Medium*. After twelve or fifteen minutes turn the *upper* oven switch to *Medium*. The total time of roasting should be fifteen minutes to the pound. If the meat is lean, put drippings or hot water in pan for basting.

There is said to be a saving of about 15 per cent in roasting meat electrically. Considering the price of meat to-day, this is quite an item. The following actual test of a 4 pound roast is interesting, illustrating the exact steps in the process of roasting the meat and the actual loss of weight by shrinkage:

Weight of roast, 4 pounds.

Preheat oven to "4," requiring twelve minutes at 110 volts.

Prepare roast; turn upper unit off.

Roast on "Full" five minutes per pound (lower unit).

Roast on "Medium" five minutes per pound (lower unit).

Roast on retained heat one hour.

Weight after roasting process, 3 pounds, 7 ounces.

Time of roasting, 1 hour 40 minutes.

Watts, 990.

Roast Chicken.—Turn the oven switches on *High* for twenty minutes in advance. Run the chicken over with soft butter and salt, dredge chicken and pan with flour. When the flour is well browned reduce the oven heat to *Medium;* baste well. When the breast meat is tender the chicken is sufficiently cooked. A chicken requires about one and a half hours, or about twenty-three minutes to the pound.

BAKING.

Biscuits.—The best results are obtained by having a hot oven to start with, so turn oven switches on *High* for thirty minutes in advance. If pans are placed on middle grate the biscuits will bake an even brown on top and bottom in ten minutes. If placed on the top grate the pans will need changing to the bottom grate as soon as the biscuits are well browned on top. Leave the oven switches on *High* during entire baking.

Bread.—Turn oven switches on *High* for thirty minutes in advance. The loaves should begin to brown in the first fifteen minutes of baking, after which the heat should be reduced to *Medium* for thirty minutes.

Muffins.—Turn over switches on *High* for twenty minutes. Bake twelve to fifteen minutes on *Medium* heat.

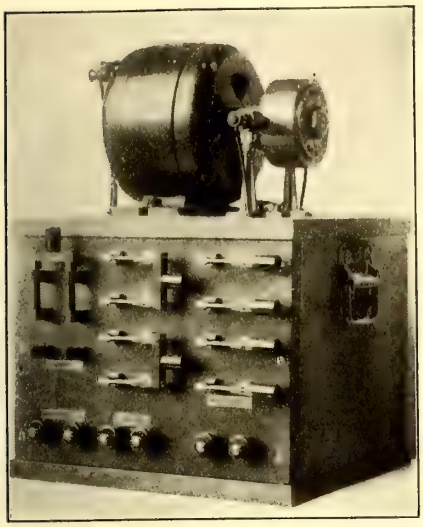
Sponge Cake.—Place the cake in a cool oven. Turn the oven switches on *High* for ten minutes, then to *Medium,* and bake from thirty to forty minutes longer. The cake is done when it falls back to a level and springs to the touch.

Cup Cakes and Pastry Shells.—Turn the

(*Continued on page* 451)

New Things Electrical

A NOVEL ELECTRIC FAULT LOCATER.



A Novel and Efficient Fault Locater for Electrical Testing of Cable and Transmission Circuits. It Detects and Locates Faults On Cables Carrying As High As 15,000 Volts.

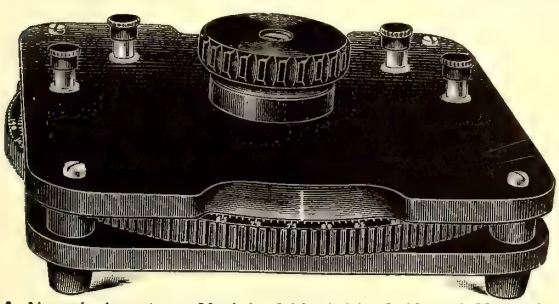
The new electric *fault locater* is a device designed for the purpose of locating all kind of faults that are inherent on overhead electric lighting and power lines carried on poles, and also on lead covered cables insulated with paper, rubber or cambric, which may be drawn into underground conduit systems.

The device is claimed to be capable of detecting and locating the faults upon cables carrying a working pressure up to 15,000 volts, alternating current, 60 cycles frequency. This apparatus is fitted with a special analyzer and interrupter.

Another valuable feature of this apparatus is that it readily locates grounds and short-circuits on steel taped armored cable, two or three conductor, laid directly in the earth.

A VARIABLE SELF AND MUTUAL INDUCTOMETER.

The inductometer illustrated herewith consists of two pairs of stationary coils and one movable coil, the latter being mounted on a disk placed between two outer plates holding the stationary coils. The disk may be rotated and has two scales, one calibrated in millihenries reading self-inductance and the second in degrees. The instrument is ordinarily provided with a maximum inductance of 50 millihenries, but instruments with higher maximum values or lower values can be obtained.



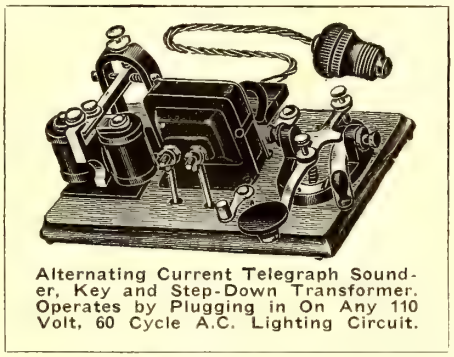
A New Laboratory Model of Variable Self and Mutual Inductance, Having a Maximum Inductance Value of 50 Millihenries. Larger Sizes of the Inductometer Are Available.

The inductometer has six link-shaped coils. The four fixt coils are mounted in pairs in the two outer fixt plates, which are held together by four screws and separating pieces to form the body of the instrument. The two movable coils are mounted on the inner disk and are placed with their long axes at right angles to a diameter. The outer plates and the disk are made of molded bakelite. To use the instrument as a variable mutual inductometer the fixt and movable coils are used as primary and secondary respectively and no connection is made between them. The mutual inductance is found by subtracting a constant from the scale reading and dividing the remainder by two. This constant is given with each instrument, altho it may be readily determined by the user at any time. It is claimed that errors due to stray field effects are eliminated and that the meter has a desirable ratio of maximum inductance to minimum inductance.

ALTERNATING CURRENT TELEGRAPH INSTRUMENT.

This A. C. telegraph instrument consists of A. C. sounder, steel lever key, and step-down transformer, mounted on base, as shown in illustration, with cord and attachment plug. No battery is used with it. It can be used on the 110 volt, 60 cycle alternating current lighting circuit by screwing the attachment plug into lamp socket.

Two or more instruments may be connected in series, just the same as instruments with batteries, by attaching the primaries of the transformers in multiple to the 110 volt 60 cycle lighting circuit with the secondaries and the sounders all in series, which is done by simply screwing the attachment plugs into lamp sockets and connecting the instruments in the usual way, thru their binding screws or terminals. Two terminals or binding posts and a single point switch are mounted on the base of each instrument.



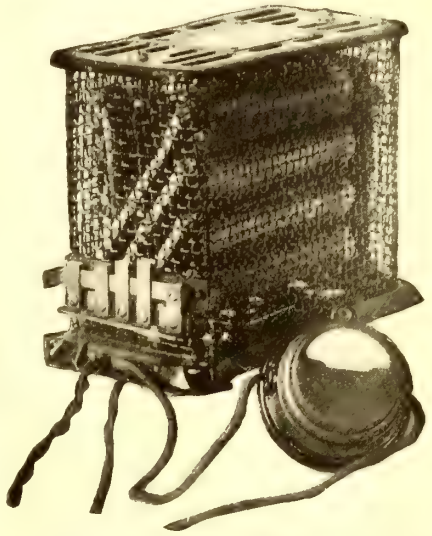
Alternating Current Telegraph Sounder, Key and Step-Down Transformer. Operates by Plugging in On Any 110 Volt, 60 Cycle A.C. Lighting Circuit.

In working two or more instruments on a line, polarity of impulses must correspond. If instruments work independently (with switches closed) but do not work together with the switches open, simply reverse one of the connecting blocks and they will respond properly.

When it is desired to operate two or more instruments on a line, the terminals are used for connecting the instruments in series; when used this way, the single point switches should be left open. Closing a switch localizes the instrument, so that it can be used for practise without interfering or being interfered with by other instruments on the line.

These alternating-current telegraph instruments are coming rapidly to the fore in commercial as well as private practise. They save the initial expense and the heavy maintenance cost of batteries.

NEW D. C. BATTERY CHARGING RHEOSTAT.



Do You Have to Charge Storage Cells from Direct Current Circuits? If So, You Will Find Extremely Valuable This Latest Battery Charging Rheostat and Ammeter. A Switch Varies the Current Strength.

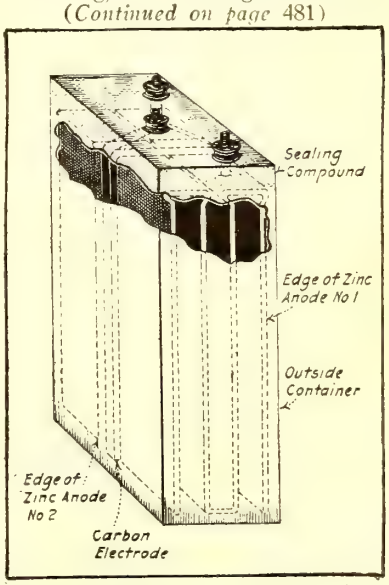
It is the purpose of this new charging rheostat to control the flow of direct current thru the battery, where the voltage of the charging circuit or line is much higher than that of the battery to be charged. This is done by means of a series of special high resistance coils made up in portable form, together with a current regulator switch giving charging rates of 1½, 3, 4½ or 6 amperes.

The voltage range of the rheostat takes in a single cell of battery up to 9 or 12 cells of 18 or 24 volts. The back pressure from a battery of higher voltage than this would cause a slight reduction in the ampere charging rates.

TWIN CELL DESIGN OF DRY BATTERY.

A new design of dry battery which is known as the "Twin Cell" is here illustrated. This design as shown in the illustration contains three electrodes, one positive flat carbon electrode, 7/16 in. thick by 1¾ in. wide, by 6 in. long, and two negative electrodes,

(*Continued on page* 481)

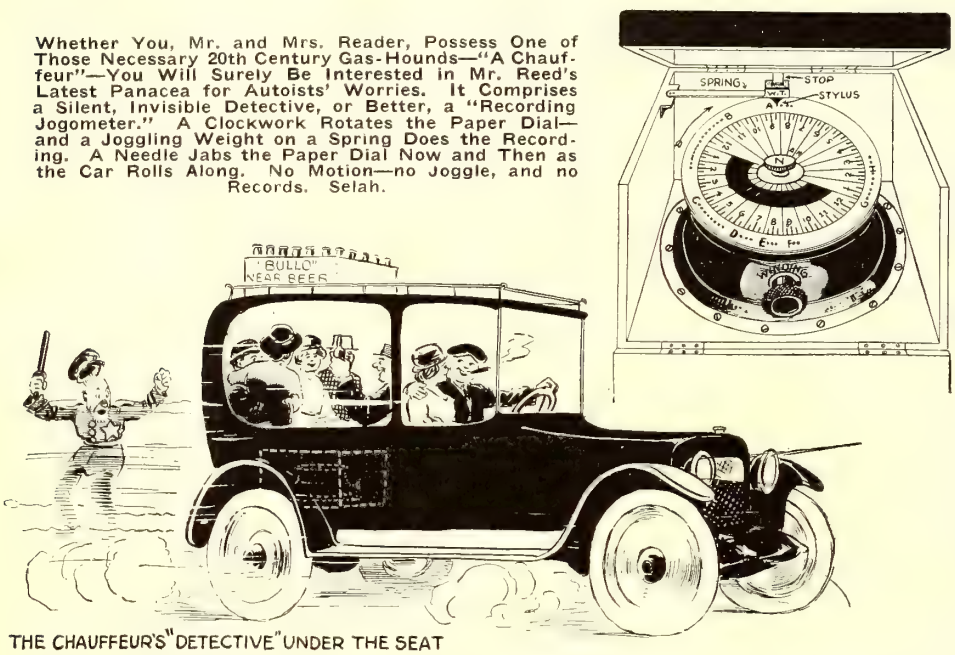


Novel Design of Twin-Cell Dry Battery. It Develops a Voltage of 1.5 to 1.55 Volts On Test and On Short-Circuit a Current of 35 Amperes.

Recording Your Chauffeur's Joy Rides

By Thomas Reed

MY neighbor, Theophilus Marbleback, had a chauffeur named "William," which innocent-sounding name was camouflage for a most guileful nature. "Circumstantial evidence" indicated that he was much addicted to joy-riding, and "Marbleback" desired me to invent an instrument for recording, unknown to "William," the moments devoted to this practise. He said that keeping tabs on the speedometer register was useless. That usually reliable instrument recorded only sorrows, not joys, for "William" deftly disconnected it during his mirthful moments. He didn't disconnect the gasoline bill, which came in at the end of the month robust and hearty, showing (if you integrated it only with the legitimate journeyings) a mysterious mileage of about five to the gallon; but apart from that, he was a busy and efficient little disconnector, and I was advised that my detecting device had better not depend upon the car's mechanism in any way, or it would be sure to reverse the excellent principle of the cascaret, and *sleep while "William" workt.*



THE CHAUFFEUR'S "DETECTIVE" UNDER THE SEAT

Whether You, Mr. and Mrs. Reader, Possess One of Those Necessary 20th Century Gas-Hounds—"A Chauffeur"—You Will Surely Be Interested in Mr. Reed's Latest Panacea for Autoists' Worries. It Comprises a Silent, Invisible Detective, or Better, a "Recording Jogometer." A Clockwork Rotates the Paper Dial—and a Joggling Weight on a Spring Does the Recording. A Needle Jabs the Paper Dial Now and Then as the Car Rolls Along. No Motion—no Joggle, and no Records. Selah.

"Marbleback" had a grand theory that if he could once get the goods on "William"—show them to him all registered up on some neat mechanism that would appeal to his fancy—the faithless "gas-hound" would be touched with repentance and mend his punctured conduct. Of course it was a perfectly chimerical idea, because the only result of touching a chauffeur is to make him leave you and go jumping off over the landscape looking for another car-owner who is sane and normal, and will stand for the things he has to stand for. Still, the problem interested me by its very difficulty. You know, if you have a certain amount of success in dealing with relatively simple things like high-frequency currents, you get sort of cocky, and feel like tackling a really complex and baffling job like putting something over on a chauffeur. So I took the matter under advisement.

Falling into the glassy-eyed and muttering condition common to inventors, my reflections were about as follows: "H-m, recording-thing got to move whenever car's going. What'll move it? Can't use gas-explosions, spark-discharges, rotation of wheels; 'William' put kibosh; must be concealed from 'William.' What other motive-power inseparable from car in motion? Aha, rush of air! Nix. 'William' spot anemometer, stick match in works. Oh, hum. What? Say, that's the system—the joggle! Some joggle always present, even on smoothest roads. Pervades every part of car. Hidden joggle-recorder what's wanted. A 'jogometer'—how's that?"

Fig. 1 shows the *recording jogometer* complete. It's an auto-clock in a locked box of strong "William"-resisting material (3-inch armor plate will do) attached immovably inside the tonneau, or caboose, or whatever you call that part of the car where the passengers sit. The clock has no hands, but the hour-arbor is adapted to carry a paper dial, printed with time-divisions, which can be changed by unscrewing the nut N. The hand-gears must be altered so that the dial will revolve once in 24 hours instead of the usual 12.

Poised over the dial is the weight WT, attached to the end of a thin flat spring, free to vibrate between the dial and the stop placed just above. The lower side of the weight is sharpened off into a point, which embosses the paper dial as the weight drums upon it under the influence of the car's vibration.

Now then, let's conduct "William" thru a sample day, and see how it works. Look at the short line of dots "A" between 8.15 and 9 a. m. That's "Marbleback" riding down to his office on a bright sunny morning, full of hope and "pep."

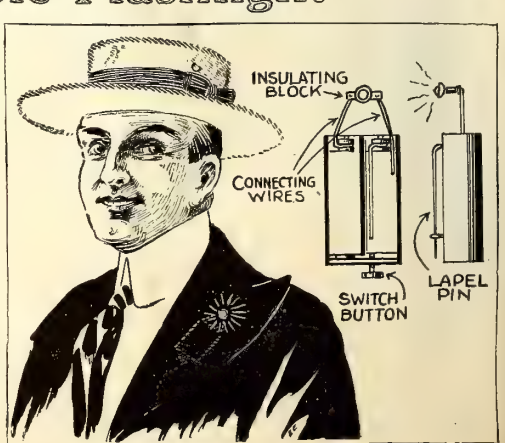
"B," from 11 to 2, shows Mrs. Marbleback shopping among the stores and beauty-parlors, flitting like a bee from flower to flower, so busily that the line appears continuous, and releasing with each fairy touch a little bill, which wings its way toward "Marbleback's" office.

At 2 o'clock ("C") she goes to the matinee, and the car is quiet till 4.30 ("D"), when she takes a turn around the park to see if any fashions have escaped her, calls for "Marbleback," and brings him home before he can "contract" any poker-games or leg-show stare, arriving at 5.30.

Now sound the "creepy music," for here is where the sleuthing starts. On the day in question, the "Marblebacks" past the evening at home, and from the point "D" onward, the record should have been a blank. But what do we see? the telltale arcs "D," "E," "F," "G," and "H," which betray "William's" nocturnal society life! Naughty, naughty "William," we are onto you! At "D," after an hour in the garage to make sure of dismissal, you were riding home to supper. Snatching a hasty meal, you hied yourself at 7.30 ("E") to the home of your blonde enchantress—Sadie Spasm, coffee-pusher and near-movie-queen. But from 8.45 onward ("F") whither, oh whither tends this hour's continuous journey, while Sadie leans back on the silken cushions, with all the inside lights lit, rehearsing "Theda Bara" on her way to the Duke's warehouse after another keg of pearl necklaces? Whither, prithee, but to the Rat's-Nest Inn, hospitable home of the joyous jazz, 40 short miles adown the pike. That blank till 1 a. m. means soup on the tablecloth at Childs' tomorrow, "William," beans for the gent who ordered "ham and," and for you a "head," a grouch, and perchance the can; but what boots it when youth and beauty drive? At "G" the relentless *jogometer* pictures "Theda" returning with the keg and "William" with the jag, and at "H" the car garage-ward plods its weary way. Selah!

A Button-Hole Flashlight

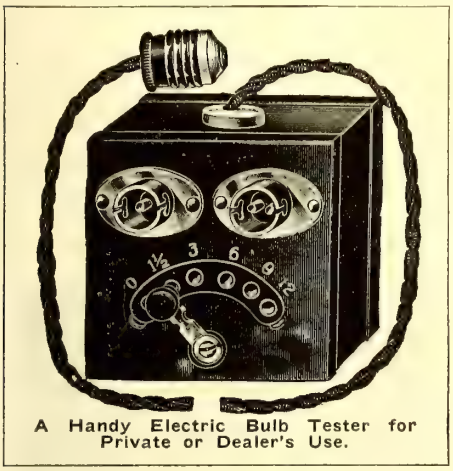
One of the latest innovations in the always convenient and invaluable electric flashlight is the one here illustrated, which fits in your coat lapel. A patent was recently issued to Mr. Edwin Frank Thomas of Meriden, Conn., on this extremely small model flashlight, which operates on a specially built and very compact style of dry battery. The casing holding the battery is fitted with a lapel pin of the same form as that used on brooches and other jewelry, enabling the wearer to easily attach the flashlight to the coal lapel or other garment. The lamp is turned on and off when desired by a simple turning of the switch button fitted in the bottom of the battery casing. The battery is a two-cell unit, and current is carried to the miniature incandescent lamp thru the supporting wires in the manner apparent.



Try These on Your Auto

AUTO BULB-TESTING DEVICE.

A new electrical automobile lamp-testing device is here shown. The tester is designed for all sizes of auto electric lights



A Handy Electric Bulb Tester for Private or Dealer's Use.

fitted with Ediswan bases. When a dealer sells an electric light bulb, he can test it before the customer's eyes, showing that the bulb is good and obviating any dispute afterward when the purchaser puts it in his car and happens to burn out the bulb thru some fault of his own.

PUSH THE BUTTON AND GET YOUR "GAS."

In the accompanying illustration an electrically operated outfit is shown which is intended for use in garages and service stations for pumping gasoline. This outfit is electrically operated, and is controlled by a push-button switch. The electrical control is arranged so that when the push-button is deprest, the pump continuously discharges gasoline at the rate of 25 gallons a minute, or may be reduced to a mere drip. When the button is released, the pumping stops automatically. The rate of flow is regulated by a speed control handle. The electric motor provided is enclosed in a strong iron case which is impervious to moisture or gases, permitting the outfit to be located out of doors. A large filter is built into the outfit to remove water and foreign matter which may be in the gasoline.

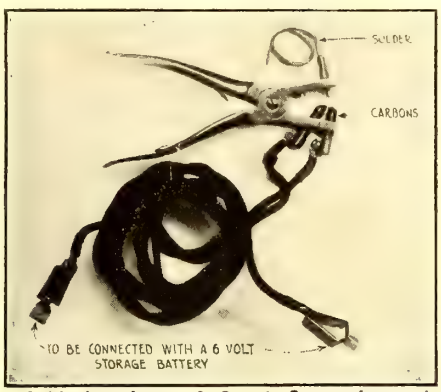


I Want 5 Gallons of "Gas." Alright, Deposit Your Coin, Push the Button and Get Your Gas.

A NOVEL 6-VOLT SOLDERING TOOL

This new soldering tool, which has recently been patented, embodies some features never before employed in an electric soldering device, its inventor claims. The one shown in the photograph is made to be attached to a 6-volt storage battery. It can even be attached to the storage battery in an automobile, or on ordinary lighting voltages in connection with a step-down transformer.

All of the heat is applied at the exact point where it is needed, and just for the instant needed, so it does not require one-tenth of the electrical energy that is used by other soldering irons of equal capacity. One of the features which appeals to the user is that it is always ready for instant use; no waiting to heat up the tool before it can be used. Wire can be soldered together in less than 10 seconds; it is not only soldered but sweated right in.



A Soldering Iron of Great Convenience to Autoists. It Works on a 6 Volt Storage Battery.

This soldering tool is light and simple in construction and the solder is always ready for instant use, as it is carried in the tool.

YOU CAN LOOK RIGHT INTO THIS BATTERY

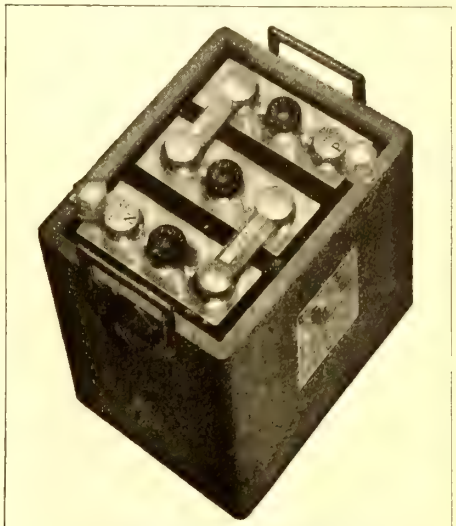
No one would think of buying or living in a light-tight, windowless house. Windows in a storage battery are just as essential. Every battery user will easily recognize the importance of knowing the exact condition of his plates and separators and the quantity of electrolyte in the battery at any moment. This great improvement in storage battery design makes it possible to know always what is going on inside your battery.

In the ordinary storage battery each cell has a hard rubber cover, and when the cells are sealed into their case the only possible view of the interior is thru the small vent hole in the cover. No satisfactory index to the condition of the vital parts can be obtained in this limited way.

The new storage battery here illustrated has a strong transparent cover on each cell. This window is actually stronger than the hard rubber used on other batteries, so there is even less danger of breakage. It is not affected by acid, and the tops and connections can be more readily kept clean and free from corrosion.

The solution, or electrolyte, in a storage battery must always be kept about ¼ inch (but no more) above the tops of the plates. Under no circumstances should the plates be allowed to project above the liquid.

Peep thru the window in this battery and



How High Is the Electrolyte? Look in the Window and See.

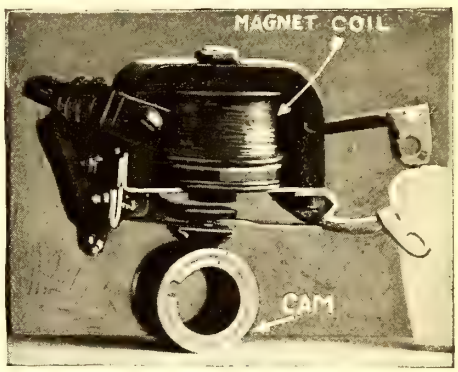
two red arrows will be seen projecting inward from the terminal posts. These indicate the exact level to which the electrolyte should rise in the cell.

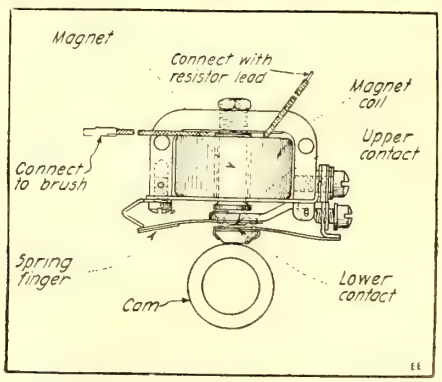
A NEW CAM REGULATOR FOR AUTO DYNAMOS.

By William H. Easton.

Every automobile electric generator must have some means for keeping its voltage fairly constant under all normal operating conditions. Without such a device, the voltage would vary with every change in the speed of the engine and every alteration in the load of the generator and the current generated would be useless for either lighting or battery charging.

(*Continued on page* 483)



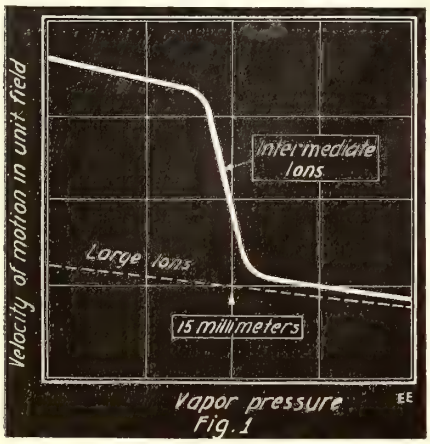


The Simplest Auto Generator Regulator for Maintaining Constant Voltage—a Magnetic—Cam device. Can Be Used With or Without Storage Battery.

The Mystery of Atmospheric Electricity

By ROGERS D. RUSK, M. A.
Late of the Meteorological Section, U. S. Army Signal Corps.

THE air is in a continual state of electrification because it contains at all times small particles charged with electricity. Even the scientists themselves do not know just what these particles consist of because they are different from the electrified particles found



This Curve Shows Clearly How the "Intermediate" Ions of the Air Change Their Velocity Like Magic at 15 Millimeters Vapor Pressure, and Become "Large" Ions. An Interesting Discussion on This Phenomena Is Here Presented.

anywhere else. We are seldom aware of the existence of these particles because of their very small size and due to the further fact that all bodies at or near the surface of the earth *are at practically the same potential as the earth.* However, if all the electricity in the air could be collected for use at one time, there would be more, by far, than we would know what to do with. Benjamin Franklin startled the scientists of his day by bringing lightning down on a kite string, but we can go him one better today.

ELECTRICITY OUT OF A CLEAR SKY.

Even on the clearest day, if we send a kite up a few thousand feet, a distinct difference of potential can be noticed between the ends of the kite wire, often enough to give a severe shock. The cause of this electrification has been the subject of much discussion, but the biggest problem is to find just what these minute charged particles consist of.

Ions or small particles charged with electricity can easily be produced in most any gas by means of an electrical discharge or by the influence of X-rays or radium, but the ions found in the air are different from these; in fact, they are different from those found anywhere else, hence it is that they present a puzzling problem to the scientist. In general there are three types of ions which are found in the atmosphere called the *large, small and intermediate.* The small ones which have been known to exist for a long time are the same as those produced in any gas by the means above mentioned. When either an electric discharge, X-rays or radium rays causes an electron or element of electricity to be detached from an atom or molecule to which it belongs, then it leaves that atom or molecule charged with the same amount of electricity of the *opposite* sign, and the charged particle is called an *ion.* Sometimes these particles group themselves together, thus forming ions of larger size. Instead of these,

The Physics of Nature's Electricity Simply Explained

however, there are still larger ions found in the air which could hardly be formed from even large groups of small ions, for reasons to be mentioned later.

The larger ions of the air and the intermediate ones are closely related and are the ones which so far are puzzling the scientists. Aitken, whose work along this line is justly famous, believes that the larger ions of the air are not aggregations of smaller ions, because when the smaller ions are formed by radium in a dust-free gas, the larger ions never appear. For this reason he believes the larger ions are really *dust particles* which have caught a charge of electricity. The word dust, however, is a convenient word to cover up our ignorance of just what the large ions actually are. In fact, they exhibit some properties which make them very interesting, and which show that they are far from being simple particles of dust.

October Number of the Electrical Experimenter

A New American Salvaging Machine with which hundreds of vessels sunk during the World War will be raised. A description with elaborate illustrations, prepared by an engineer who walked on the bottom of Long Island Sound in this marvelous machine, by Joseph H. Kraus.

Do Radio Waves Produce Sparks in and Ignite the Gas in Balloons and Dirigibles? This question is answered by an Electrical Expert of high standing.

Sun Spots and the Observatory That Photographed Them—an especially interesting article, by Isabel M. Lewis, of the U.S. Naval Observatory.

Treasure Ships Located by Electricity, by H. Gernsback.

Making a Machine for Telegraphing Pictures—Part 2, by Leroy J. Leishman, Telephotographic Expert.

Investigating Psychical Phenomena with Scientific Instruments, by Hereward Carrington, Ph.D.

"Jerry Up," a thrilling tale by an American searchlight electrician who served in France, by Charles K. Fankhauser, Jr.

Radio Problems in Aviation, by Edward Rice Doyle, late Lieutenant U. S. Army Air Service, U. S. A.

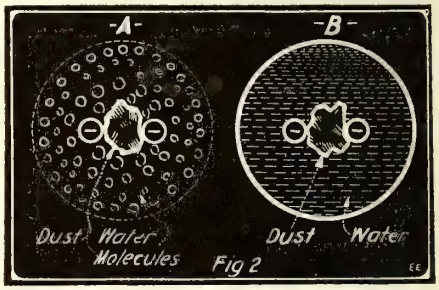
Magnetic Storms—how sunset, wind and other weather phenomena actually cause "magnetic storms," by Prof. Lindley M. Pyle, Department of Physics, Washington University.

How Science Applies the X-ray to Numerous Industrial Problems.

Electric Automobile to Compete with Gas-Driven Vehicles, written by its designer, Harry E. Dey, E.E.

WHAT ARE ATMOSPHERIC "DUST" PARTICLES?

These *dust particles,* if they are such, must not be confused with ordinary wind dust particles such as those blown up from a street. They are much finer and smaller, so much so in fact that they are capable of remaining suspended in the air for a very long time. Such particles are too small to be detected by ordinary means of observa-



A.—An Intermediate Air Ion Consisting of Negatively Charged "Dust Particle" Surrounded by Dense Atmosphere of Water Molecules.
B.—A Large Ion Formed by Water Vapor Condensing to a Liquid About the "Dust Particle."

tion and they can best be observed and counted by the famous *cloud method.* This method is to take a sample of the air and put it under reduced pressure which allows it to expand until the moisture in the air begins to collect around the *dust nuclei,* making them visible. In determining the relative size of the original particles another method must be used, and that is to compare their *mobilities. The mobility of an ion is its rate of motion in an electric field of one volt per centimeter, and is a measure of its mass.* The larger the mass the slower the particle will move under the given force.

By this method the larger ions are found to be *over a thousand times larger than the small ions and the intermediate ions about half way between.* It is argued that if these were *dust particles* only, then all sizes would be found instead of *three* distinct types. Recent discoveries tend to show there is something more than dust and electricity in the large ions and that it is this something else which causes the formation of the large ions which are not found anywhere else. It is all due to the discovery, a few years ago, that water vapor may condense in two ways on a rigid surface under certain conditions. Either it may condense in the ordinary way as a pure liquid, or it may condense more slowly and form a very dense atmosphere of separate water molecules about half way between a gas and a liquid, which will suddenly change to a liquid with an increase of the vapor pressure.

Now the significant thing is that if the mobilities of the ions are measured carefully while the pressure of the water vapor in the gas is being increased, a point is reached where the intermediate ions suddenly begin to move slowly like the large ions as shown in Fig. I, and this has suggested to J. A. Pollock and others the following explanation: The larger ions and the intermediate ones are formed of minute, rigid dust-like particles about which a small amount of water vapor has already started to condense. About some of these

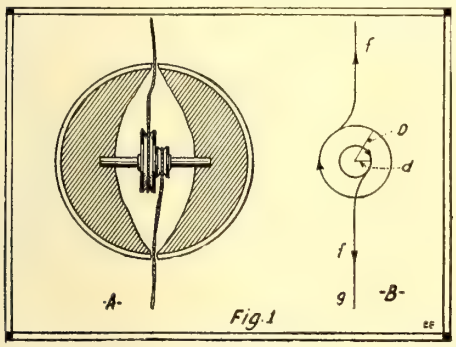
(*Continued on page* 473)

Experiments in Physics

By JOHN J. FURIA, A. M.
DEPARTMENT OF PHYSICS, N. Y. UNIVERSITY

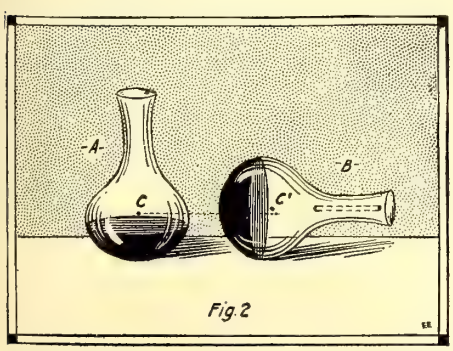
2--Illusions

PRACTICALLY all of the so-called "illusions" that are brought before the public, whether on the stage, at private entertainments, or sometimes in swindles, are based on fundamentals of physics. Hence it is fitting in a series of articles on "Experiments in Physics" to deal with this topic. Illusions may be divided into four classes: (1) Optical, (2) mechanical, (3) chemical, and (4) slight-of-hand. The first two types are of especial interest to us from the standpoint of pure physics.



The "Obedient Ball" and How It Is Made from a Wooden Crochet Ball Hollowed Out as Shown. In This Space Are Placed Two Small Silk Spools with Strings Attached. The Ball Rises or Falls on the String at Command.

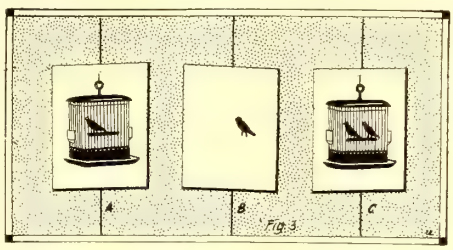
Perhaps the most mysterious of the magician's tricks, and one which appeals to all boys, is the *obedient ball.* All ball players appreciate the value of an obedient ball, especially the kind of ball that will "come to papa." As usually presented to the public from the stage the magician passes a piece of string thru the center of a good sized wood ball and then holds the string vertical. At his command the ball slides up the string, down the string, or else remains stationary. The *obedient ball* can be easily made at practically no cost. Divide a crochet ball in half by the use of a very fine saw. Carve out enough of the insides so as to have enough room for two small silk spools to revolve freely, see figure (1) A. The spools are glued together and fastened to the inside of the crochet ball by a dowel rod used as an axle. String is wound around each of the spools and the ends led out thru holes at the end of a diameter of the ball, perpendicular to the axle. The ball is glued together, sandpapered, stained and shellacked, and if a good job is made of it no one will suspect that the ball has been cut open.



Altho Not Filled with Spirits, This Obedient Bottle Will Lie Down and Stay Down Only for Its Master—the Magician. How Does It Work? Read on!

Figure (1) B explains why the ball will rise, fall or stand perfectly still. If the string is held loosely, the ball will fall, due to the pull of *gravity* on it. As force is applied to the ends of the string, gradually a point will be reached where the force of gravity is just overcome by the advantage gained by pulling the upper string (since the diameter of the spool to which the upper string is attached is larger than the diameter of the spool to which the lower string is attached). Greater force will cause the ball to move upward. It should be noticed that as one spool winds the other unwinds in each of the cases where the ball rises or falls. Hence the total length of the string in view changes according to the difference in the diameters of the spools. It remains for the performer to detract the attention of his audience away from this fact. The illusion is one of pure physics, more particularly mechanics. The equation for the motion may be written as follows:

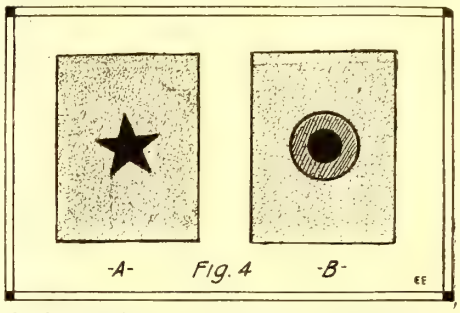
Let g represent the force of gravity, f the force applied to the string by the performer, and D and d, respectively, the diameters of the spools. $Df - d(g + f)$ causes the motion. When f is zero (when the performer holds the string loosely) the tendency to move upward (Df) is zero and tendency to move downward is dg, and the ball moves downward. When f is such that $Df = d(g + f)$, the tendency to move upward equals that to move downward,



If Two Cards Are Drawn to Resemble Figures A and B, Placed Back to Back on a Cord and Then Spun Rapidly, Two Birds Will Appear in the Cage, as at C.

and the ball remains stationary. When f is large enough so that Df is greater than $d(g + f)$, the tendency to move upward is greater than that to move downward, and the ball moves upward.

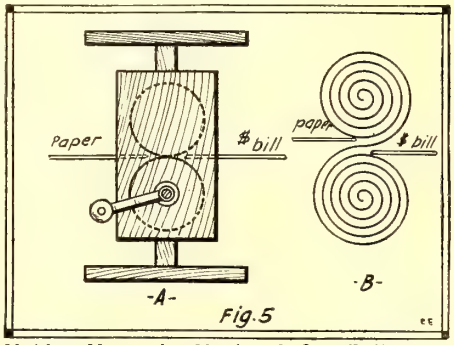
Speaking of the *obedient ball,* the event of July 1st (last) leads us naturally to the *obedient bottle.* A small wood bottle (empty since July 1st) of the shape indicated in figure (2) A, is placed on the table and told to "lie down—and stay down," and the bottle does so. (Nothing remarkable.) The performer then picks up the bottle and passes it around, defying anyone else to cause it to "lie down—and stay down"! No one is able to do so. The performer then takes the bottle again, coaxes it and causes it to lie down as before. This is another case of pure physics, more particularly mechanics. The bottle is weighted with lead as shown in figure (2) A, so that its center of gravity C is very low. It is seen from figure B, that placing the bottle on its side causes the center of gravity to be raised to the position c'. It is well known in mechanics that a body is in stable equilibrium (will return to the same position when displaced) when its center of gravity is at its lowest. Hence it follows that the bottle will always return to its stable equilibrium position (standing up). How, then, does the performer cause it to lie down. He keeps concealed up his sleeve or "palmed" a long narrow weight which he slips into the neck of the bottle whenever he wishes it to lie down. The addition of this long narrow weight causes the center of gravity for the upright position of the bottle to be high, so that placing the bottle on its side causes the center of gravity to be lowered; hence this will now be the position of stable equilibrium. In picking up the bottle before passing it to the audience for examination, the performer allows the weight to drop back into his hand again.



An Interesting Illusion Experiment Based on the Persistence of Vision. A Black Star Drawn on a Blank Card, When Spun Rapidly, Will Change Into Two Circles—One Gray and One Black.

In order not to disappoint those accustomed to "seeing double," the following is inserted for trial any time after July 1st. Draw a bird in a cage on one side of a blank card. On the *reverse* side draw another bird. Attach a piece of thread to the top and bottom of the card and twirl the card about this thread as an axis. TWO *birds will be seen in the cage.* Many variations of this illusion can be tried. The cage alone on one side and the bird on the other; a glass of "Bevo" on one side and an open mouth on the other, etc., etc. The result obtained is due to physiological rather than physical reasons. The phenomenon is known as *persistence of vision.* The retina of the eye retains any image thrown upon it for a moment after the object has been removed. Hence when

(*Continued on page* 479)



Making Money by Magic. A One-Dollar Bill Run in One Side of the Machine Comes Out a Ten-Dollar Bill, or a Piece of Paper Changes Into "Real Money." Ain't It Wonderful? Yes, It Is—NOT!

Practical Chemical Experiments

By ALBERT W. WILSDON

Cleaning and Washing Agents
Part II

WATER and a few other solvents are commonly used to remove dirt, sometimes called "matter out of place." Some of these substances readily dissolve in water; others like the fats, will dissolve in ether

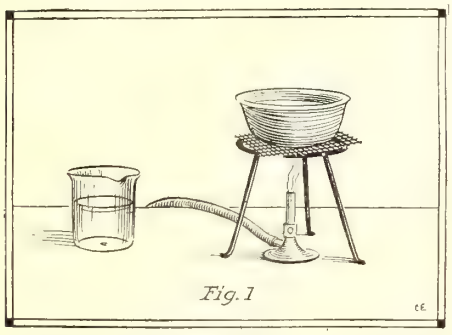


Fig. 1

Showing the Simple Apparatus Required to Perform Experiment No. 1. A Bunsen Burner, a Beaker, Tripod, Gauze and Heating Dish.

or gasoline; and still others, for instance the resins, will dissolve in alcohol. Some form of alkali, such as wood ashes, was formerly used with the water, to assist in removing the dirt. This, it was discovered, possest a very destructive action upon the goods, so a *saponified* fat, the product produced by the action of an alkali on a fat, or what we now call *soap*, came into universal use. This, as is well known, when made of good materials will not injure the goods. Soap was used instead of lye from the lixiviation of ashes, long before the chemistry of the process became known. It was not until 1813 that Chevreul publisht his scientific researches on the composition of fats and the processes of soap-making.

Manufacture of Soaps.

The raw materials used in the manufacture of soap are an alkali known as *caustic alkali*, which may be either sodium or potassium hydroxid. The sodium hydroxid will produce a hard soap, while the potassium hydroxid produces a soft soap. These are made by boiling the carbonat with slaked lime, following out the equation

Sodium Carbonat + Calcium Hydroxid = Calcium Carbonat + Sodium Hydroxid.

From this mixture the calcium carbonat settles out, and the solution of the caustic alkali is boiled down to a solid, and is put upon the market under the name of *concentrated lye*, or the concentrated solution is used directly by the soap-maker.

Recently the caustic soda has been made directly by the electrolysis of sodium chlorid. The sodium deposited at one pole is dissolved in water, and the chlorin is used for making bleaching powder.

The second ingredient of a soap is either a vegetable or animal fat or oil, or a resin. Such oils as that of the palm nut, cocoanut,

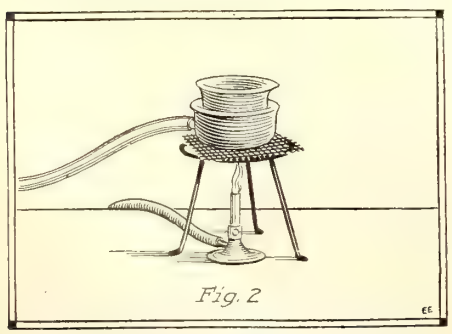


Fig. 2

How Evaporation Is Effected on the Water Bath of the Solution Obtained from Experiment No. 1. Apparatus Shown Is Used in Experiment No. 2.

olive, hemp seed, linseed, cotton seed, fish or lard may be used, and fats like beef tallow, mutton tallow, lard, or house grease.

The process of *saponification* may be occasioned either by the action of water or steam at high temperatures and pressure (especially in the presence of a dilute mineral acid), by the action of caustic alkalies, or sometimes by the use of lime. The fats may be briefly described as consisting of ethers of the triatomic alcohol-radical, containing *glycyl*. By treatment with alkalies or high-pressure steam, they yield *glycyl alcohol* (glycerin) and stearic or other fatty acid. The name given to the compound of the acid and glycerin is *stearin*, *palmitin*, or *olein*. In the case of stearin, the equation representing the saponification would be:

$$\underset{\text{Stearin}}{C_3H_5(C_{18}H_{35}O_2)_3} + \underset{\substack{\text{Caustic}\\\text{Potash}}}{3KOH} = \underset{\text{Glycerin}}{C_3H_5(OH)_3} + \underset{\text{Soap}}{3KC_{18}H_{35}O_2}$$

With palmitin or olein, the reaction is similar. If the fat or oil is solid, it contains a preponderance of stearin or palmitin, but if liquid, there is an excess of olein.

In making soap on a large scale, a kettle, provided with both a closed and open steam coil, so that the soap may be boiled either by the heat or the free steam, is used. A

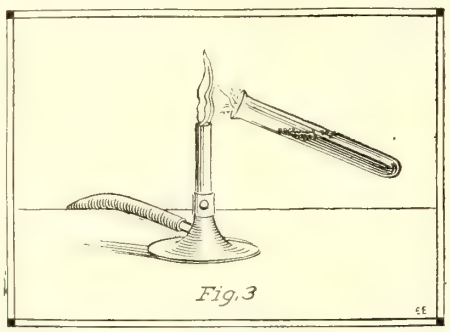


Fig. 3

Applying the "Sodium Test" in the Flame of a Bunsen Burner. Experiment No. 4.

kettle that will hold 100,000 pounds of soap is 15 feet in diameter and 21 feet high, and is made of ⅜ inch boiler plate. The melted fat and lye are run into the kettle and mixed by the aid of free steam and boiled for some time, or until the soap has a dry, firm feel between the fingers; it is then *salted out* by adding common salt. In boiling, the saponification represented in the above equation has taken place, and when the salt is added this causes the soap to separate from the caustic lye and glycerin. After boiling, to mix thoroly, the mass is permitted to stand in the kettle till the soap rises to the top, and then the lye may be drawn off at the bottom of the kettle. Some more strong lye is then added, and the boiling is continued till the material is fully saponified, which the experienced soap boiler knows by sight, feel, and taste, and then the content of the kettle is again allowed to stand for a while, and the additional lye is drawn off. The soap is then boiled with some water, and is permitted to settle again, to allow the separation of more alkali, dirt and impurities, called *nigre*. After standing several days, the soap is pumped into the *crutcher* which consists of a broad, vertical screw working within a cylinder, which is placed in a larger tank. Here it is thoroly mixed, and any perfume or scouring material may be added. The soap is then drawn off into rectangular *frames*, holding about 1000 pounds where it is allowed to solidify. The sides of these frames are removed and the

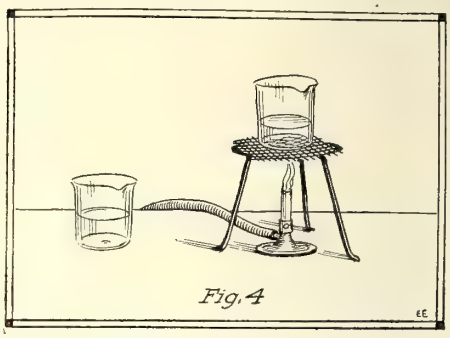


Fig. 4

Simple Apparatus Used in the Preparation of "Prussian Blue," as Described in Experiment No. 5.

soap is cut, by means of wire, into slabs and then into bars. If put on the market in the form of cakes, the bars are prest into the desired shape.

For making white soaps, tallow, palm oil, and cocoanut oil are used. Castile soap, if genuine, is made from olive oil, sometimes with the addition of cocoanut or rape seed oil. It is useless to attempt to make a good soap out of an inferior material. In making lower grades of soaps, cheaper fats are used, and frequently those that have a rancid odor. This is sometimes *corrected* by the addition of a strong perfume, like oil of *mirbane*,—nitrobenzine, made from coal tar. Yellow soaps almost always contain considerable rosin; that is they are made by the usual process, except that quite a large proportion of rosin replaces the fat. This has valuable soap-making qualities, and would not be classified as an adulterant of soap. Cocoanut oil saponifies without boiling, so it is used in making the *cold process* soap. This material also admits of the use of a larger quantity of water, so that the soap will be hard and still contain as much as 70 per cent of water. Soap is mottled by stirring into it, while warm, some coloring substance, such as copperas, ultramarin, or an anilin color.

Sand soap, pumice stone, and compounds of a similar character are made by incorporating sand or powdered pumice, with the ground soap, and this ought to lessen the price of the soap very materially. These substances can act only mechanically; that is they *sandpaper off the dirt*. A silicated soap is made by mixing with the ordinary soap some silicat of soda or

(*Continued on page* 475)

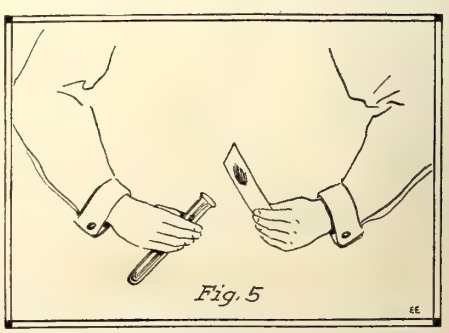


Fig. 5

Holding a Piece of Paper Moistened with Lead Acetate and Permitting the Gases to Act Upon It, Showing the Presence of Hydrogen Sulfid. Experiment No. 7.

THE CONSTRUCTOR

Thermo-Electricity Experiments

By THOMAS W. BENSON

IT was first noted by Seebeck, of Berlin, that when a juncture of dissimilar metals was heated a current of electricity would flow. This phenomena was studied by Cumming, Sturgeon, Pellaci and many others, for it gave promise of providing a means for *developing electricity direct from heat, without the use of steam engines and generators.*

Altho no practical application has been made of the discovery, beyond its application to *pyrometry* for heat measurements, several interesting devices can be easily constructed to demonstrate the phenomena.

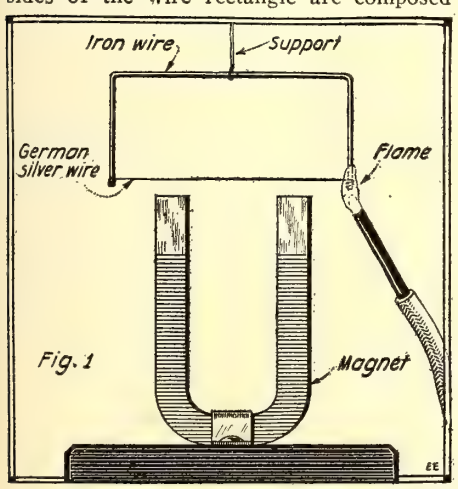
The most powerful currents are generated by heating junctures of the more crystalline metals, such as antimony and bismuth, the other metals lying between these in regard to the strength of the current generated with a given rise in temperature. The following list gives the thermo-electric order of the more common metals:

+Bismuth	Tin	Zinc
Platinum	Gold	Iron
Mercury	Silver	—Antimony
Lead	Copper	

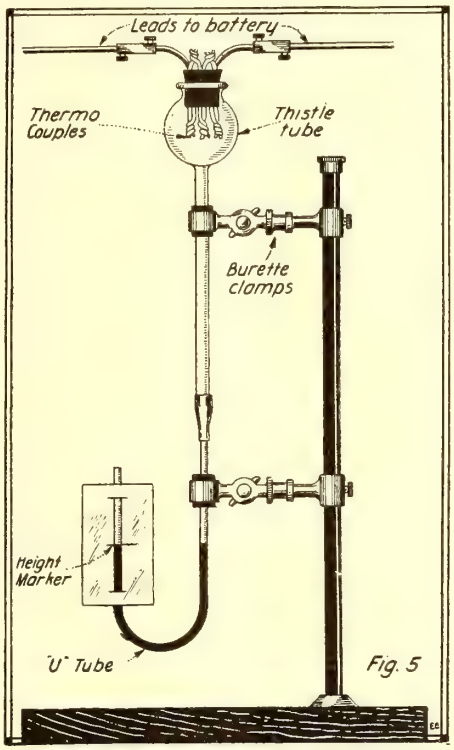
Any two of these metals when joined together and the junction heated results in a current flowing thru the exterior circuit from the metal highest on the list to that lower. The *reverse* is true should the junction be cooled. The further apart the metals are in the table the greater will be the electromotive force.

It is seen that bismuth and antimony will give a so-called "couple" having the highest E.M.F. These are rather difficult to obtain and handle, so for experimental purposes we will substitute iron and German-silver wire. These two metals are employed in the construction of thermo-couples for electric pyrometers, and will serve our purpose admirably.

The electro-dynamic effect of *heat generated* currents can be shown by a device similar to that illustrated in Fig. 1. Three sides of the wire rectangle are composed of iron, the fourth of German-silver. The frame is suspended over a permanent magnet and heat applied to one corner as shown. The frame will turn thru an angle of 90° due to the currents flowing in the loop.



The Electro-Dynamic Effect of Heat Generated Currents Can Be Shown by the Simple Device Here Illustrated. An Iron and German Silver Wire Rectangle Is Suspended Above a Magnet. The Loop Turns When Heated.



An Interesting Apparatus for Demonstrating the "Peltier Effect," or the Production of "Cold" by Electricity.

A large number of turns of wire could be made to form a *heat compass.* The details of such a device are shown in Fig. 2. A small bundle of soft iron wire is bound with paper glued into place. Take a number of lengths of iron and German-silver wire and wrap them in the same direction on the core, in alternate coils as shown. Twist the ends of the wire together so that every other joint is on top. The ends of the more distant coils being connected together by a loop of wire, thus forming a sling to support the compass.

When this apparatus is suspended over a hot copper or brass plate, the currents flowing around the windings will cause it to act as a *compass* and the core will place its axis in a line with the natural magnetic field of the earth.

A form of *thermo-electric motor* can be constructed as shown in Fig. 3, to demonstrate electro-magnetic rotation. Here we have a ring of iron wire attached to which are a number of vertical German-silver wires, bent over at the top and joined at the center to a pivot. The latter rests in a tiny depression in the pole of a horseshoe magnet, allowing the cage to turn freely.

By applying a small flame to the frame at the juncture of the G.S. and iron wires between the legs of the magnet a current will flow thru the vertical wires and rotation will result from *magnetic repulsion.* The device will attain quite a high speed if carefully constructed.

A thermo-battery can be cheaply made that will deliver a fairly heavy current in the following manner: Take a 1" pine board 6" square and drill with small holes at the intersection of lines drawn in both directions ¼" apart. The board is then impregnated by placing in melted paraffin. Alternate 2" lengths of iron and G.S. wire are pushed into the holes and their ends tightly twisted together on both sides of the board, the end wires being led to binding posts.

When the battery is stood with one side in the sun, the other being shaded, an appreciable E.M.F. will be generated. **If laid on a block of ice in the sun it will ring a vibrating bell!**

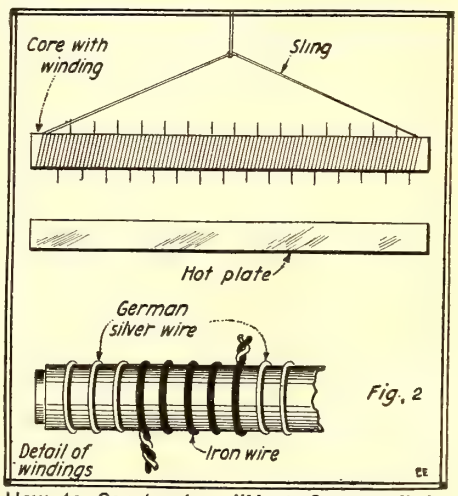
A somewhat similar form of *thermo-pile,* comprising antimony and bismuth bars, in the hands of Forbes and Milloni led to the beautiful discovery of the polarization of heat.

Andrews noted that a current was generated when platinum wires are inserted in a bead of fused borax, potassium chlorid, chlorids of potassium and strontium, iodid of potassium, sulfate of soda, and even when boracic acid is used. These results, however, are due to a *thermo-chemical* action and formed the basis for the work of Edison and others on the *heat cells.* The action differs from the *true* thermic action of dissimilar metals.

Conversely we have electro-thermic effects whereby heat and cold result from an electric current passing between dissimilar metals. The production of cold by this means is rather startling and is known as the *Peltier* effect.

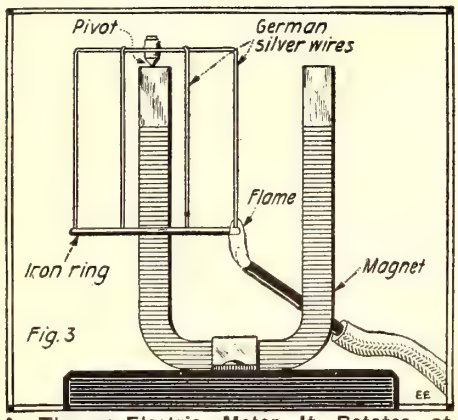
Apparatus to demonstrate the latter effect can be assembled as shown in Fig. 5. A large thistle tube has connected to its lower end a U-tube with a small bore, by means of a length of rubber tubing. The U-tube is partly filled with colored water.

A cork that fits the mouth of the thistle tube has six holes bored thru it into which



How to Construct a "Heat Compass," by Winding Turns of Iron and German Silver Wire About an Iron Wire Core. In Use It Is Suspended Above a Hot Brass Plate.

are inserted short lengths of iron and G.S. wire, about five strands of wire being put in each hole. These are twisted together to form thermo-couples and the cork inserted in the mouth of the thistle tube. A little paraffin wax melted over the cork will seal the whole effectively.



A Thermo-Electric Motor—It Rotates at Quite a Speed When a Flame Is Applied to the Armature, Made Up of Iron and German Silver Wires. A Most Interesting and Little Known Device.

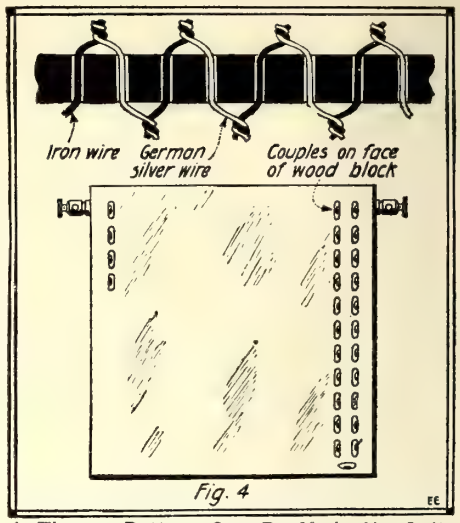
When the positive and negative poles of a battery (gravity type preferred) are connected to the iron and G.S. wire respectively, the junctures inside the tube will drop in temperature and the air contracting will cause the water in the open leg of the U-tube to drop. For best results the current should be regulated by a rheostat so that it is not sufficient to heat the wire used in the couples.

A current having a fairly high E.M.F. and low amperage gives the best results.

The exact cause of the current generated in a thermo-couple is still an unsolved problem. It is not due to any oxidization or chemical effect for it has been found that a bar of the same metal with different temperature of its opposite ends will give a slight current, the cold portions becoming *negative*, the hot parts *positive*. A thoro understanding of the phenomena demands more complete knowledge of matter structure and the inter-atomic forces.

A fuller realization of the forces in action may revolutionize present methods of current generation and perhaps refrigeration.

Thus there is a very fine field open for experimentation by the industrious student. By experiment we learn many things heretofore undreamt of.



A Thermo-Battery Can Be Made Up Quite Cheaply by Mounting Iron-German Silver Wire Couples on a Board as Shown. Laid on a Block of Ice in the Sun, It Will Ring a Bell.

A "Selective" Electrolier Switch

By Albert H. Beiler

The writer recently tried to make an electrolier switch which could control from one to five lamps. The lamps were on a chandelier and it was undesirable to turn each lamp on or off at its socket. They were placed on the chandelier as shown in Fig. 1. Owing to the fact that it was desired to make the lamps light in a symmetrical arrangement, it was not necessary to control each lamp singly, but merely to get a switch which could light one, two, three, four or five in a *symmetrical order*.

Number of Lamps	Number of Each Lamp	Control Circuit
1	3	B
2	1, 5	A
	2, 4	C
3	1, 3, 5	A, B
	2, 3, 4	B, C
4	1, 2, 4, 5	A, C
5	1, 2, 3, 4, 5	A, B, C

For example, if two were desired, it would not look well to light one and four, or two and three, but a combination like one and five, or two and four would do nicely. Accordingly, the wiring to the lamps was arranged as shown in Fig. 2. With this wiring the circuits would have to be controlled as summarized in the table above.

There is thus a common wire going directly from one main to one terminal of each lamp and three control wires which go to the *selector switch*. This switch is constructed as described below.

Secure a piece of hard wood 5 x 5 x ⅞ inches. Lay out a hexagon of 3 inches diameter, as shown in Fig. 4. Drill ⅜-inch holes at the eight points indicated about ¼ inch deep. The seven numbered holes should have small holes go clear thru the wood and just large enough to permit a No. 14 wire to pass thru (No. 50 drill). The unnumbered hole is a blank whose purpose will become apparent later. Twist some bare No. 14 wire into little spirals, as shown at 3A, and put one in each of the seven numbered holes so that the end passes out thru the bottom. Then stop up the small holes where the wires protrude with sealing wax, so that each ⅜-inch hole is a sort of liquid-tight cup with a conductor lying along its bottom. The wiring is shown in Fig. 3 running to four binding posts, which had best be labeled as indicated in India ink to avoid confusion later. The base may now be chamfered and stained to make it look well. The holes should then be connected by the lines shown and the triangle so formed should be labeled as indicated in Fig. 4.

The bridging arms should now be made. These are two triangular pieces of ⅜-inch fiber or hard rubber, the triangles measuring 2 inches on a side (Fig. 5). The holes are drilled ¼ inch from each vertex, and are tapt to receive 8-32 machine screws. A ⅞-inch machine screw is put into each hole at a vertex. These three screws are then connected to each other by No. 16 wire twisted around each and neatly forced into grooves, scratched into the fiber for the purpose by a sharp awl or scriber. A small porcelain knob is fastened to each triangle by a washer and screw fitting into the center hole.

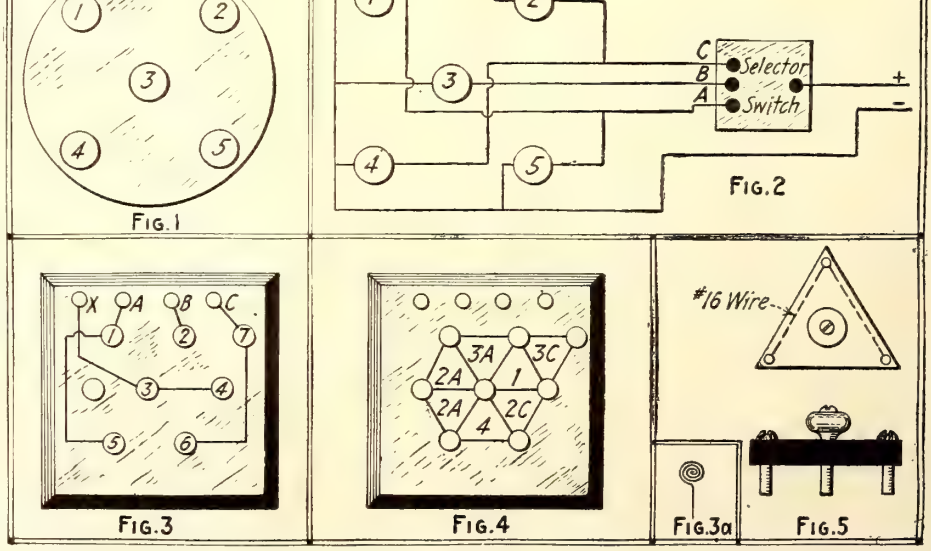
If the triangles are constructed properly each will fit into any three holes at the vertices of an equilateral triangle in the baseboard. The numbered holes should then be filled with mercury to about 3/16 inch from the top. Binding posts A, B and C are connected to control wires A, B and C, and the common wires goes to the other side of the main (Fig. 2).

It is obvious then that any combination noted in the table may be obtained by covering the triangle whose number indicates the number of lights to be lit. For example, to light *four* lamps, one of the triangles is placed in holes 3, 5, 6, so as to cover triangle No. 4, etc. Up to and including four lamps, only one triangle need be used, but for five a combination like 2A and 3C or 4 and 3C is needed, requiring two triangles.

The arc formed when a triangle is lifted out is inappreciable, being broken simultaneously at two places. Should it be desired, however, to break a circuit carrying more than about 5 amperes, it will be better to construct a base of fiber.

This switch may be made at a cost of about 25c, whereas an electrolier switch of commercial manufacture to satisfy this wiring costs upwards of $4.00.

Many modifications of this novel switch can be worked out with a little ingenuity on the part of the builder. This switch lends itself well to many laboratory circuit requirements.



The Construction of a Selective Chandelier Switch for Turning on or off Various Combinations of Lamps, Is Here Described by Mr. Beiler. Special Arrangements for Larger Groups of Lamps Can Be Worked Out Easily.

Making a Machine for Telegraphing Pictures

Part I

By LE ROY J. LEISHMAN

Expert In Telephotography

IT is a very simple matter to *telegraph pictures.* A crude machine for this purpose was suggested seventy years ago. The idea is therefore not entirely new to students of electricity, but the science has been so neglected that it is still nebulous to the average person.

How little the general public knows of *telephotography* is shown by the fact that when two of my machines were exhibited on the Orpheum and Pantage's vaudeville circuits two years ago, the demonstration was fascinating, baffling and uncanny to the audiences everywhere. Even most of the newspapers had never heard of such a thing before.

A person with an electric picture transmission machine may therefore entertain and baffle his friends and townspeople, besides conducting a great deal of experimenting which will be instructive and highly beneficial to himself.

By the time this article appears, popular interest in telephotography will be heightened by the use of telegraphed pictures by many of America's leading newspapers. Several papers have already publisht "news pictures" periodically, *and pictures have been telegraphed across the continent at regular intervals and displayed on bulletins.* The practicability of the scheme is shown by the fact that excellent pictures have been transmitted 4,856 miles! Many newspapers have recently subscribed for a service that will supply one hundred and fifty news pictures a year, *making it possible for them to publish a picture of an event the day it happens, regardless of geographical location or distance!*

So the person with the necessary apparatus to telegraph pictures will find himself the center of interest everywhere.

It has often seemed puzzling to me why more electrical students have not experimented with telephotography. Many letters which I have received lead me to believe it may be due to a popular misconception that such experiments are too costly. I therefore recently designed some *Picture Telegraphing Instruments* which are low-priced enough to suit every experimenter who may be interested. To further interest the readers of this magazine in this fascinating and instructive field, I am explaining in this article how a simple telephotographic set can easily be made. However, the chief fascination and instruction is in the operation of the finished machines and in the various experiments that can be made with them.

No exact dimensions will be given for any of the various parts, as the material at one's disposal sometimes makes it advisable to change some of them; and then the others must be altered accordingly.

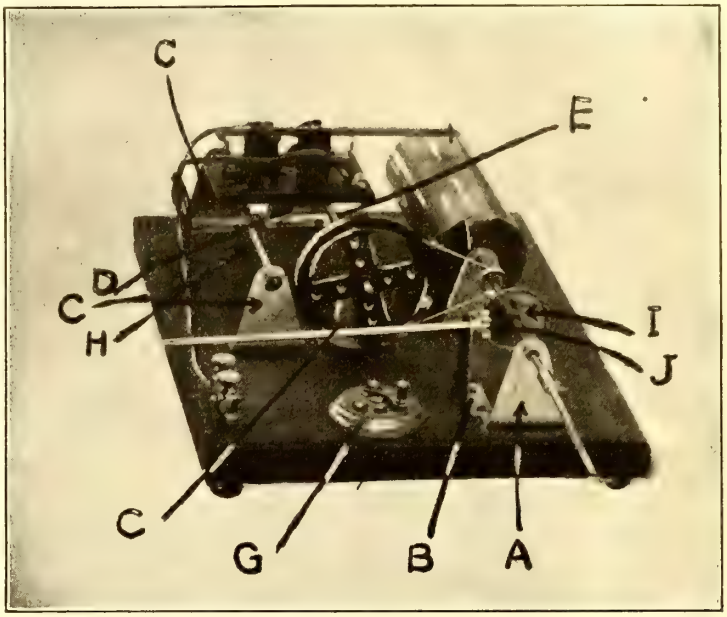
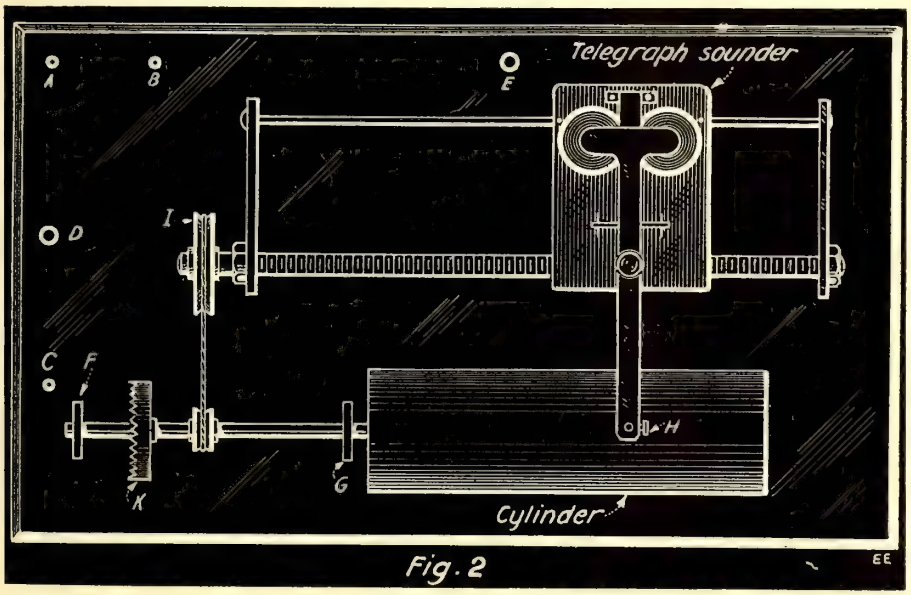


Fig. 1.—The Telephotographic Machine Here Described. It Opens up a New Era in Scientific Experiments for the Electro-mechanical Student and Provides a Stepping Stone to this Newest Branch of Applied Science.

GENERAL DESIGN FEATURES OF APPARATUS

Let us first get an idea of the general appearance of the device we are going to make. A glance at figures 1 and 2 will show that the machine resembles very much an old style cylinder phonograph. The cylinder of the picture transmitting machine holds the pictures to be telegraphed in the same manner that the phonograph cylinder holds the record to be played. The sending and receiving carriage corresponds with the phonograph reproducer, and it passes slowly from one end of the cylinder to the other on a threaded shaft as the cylinder revolves. In this manner the carriage needle finally touches every part of the picture. The threaded shaft on which the carriage travels *must* be absolutely parallel to the cylinder. The reproducer on a cylinder phonograph has a half nut that rests against the threaded shaft, so that the reproducer may be lifted up and moved to the other end of the cylinder. This necessitates another shaft, parallel to the threaded one, on which the reproducer pivots. A picture transmitting machine is similarly equipt.



Top View of Telephotographic Machine Here Described in Detail. The Parts Required in Building it Are Few and Simple, But Should Be Made with as Great an Accuracy as Possible.

The size of the complete apparatus depends upon the dimensions of the pictures to be telegraphed, as this determines the size of the cylinder; and the shafts and base must be proportioned accordingly. A convenient size for the picture is about 5 by 6 inches. As plenty of margin must be allowed, this necessitates a cylinder about 2 inches in diameter and 5½ inches or 6 inches long. Electrical contact must be made with the rolled copper plate which is slipt on the cylinder, so it is most convenient to make the cylinder from metal tubing. Ordinary pipe will not do, as the cylinder must be very true and perfectly uniform thruout. Brass or nickel-plated fixture tubing is excellent. A metal bar or disc must be soldered in each end, and holes *accurately drilled* in the *exact centers* to fit the shaft. As the cylinder is light and supports no great weight, the shaft may have a small diameter, so a rod can be selected for this purpose which will fit the gears available. Erector, Meccano or other rods are satisfactory, and can easily be fitted with gears which are obtainable in the regular sets or at any hardware store. The cylinder rod should be 3 or 4 inches longer than the cylinder and must be *perfectly straight.* Place it thru the holes in the cylinder ends and solder it so that one end is flush with one end of the cylinder.

After the cylinders have been made, the length of the base can be decided upon, as this dimension should exceed that from one end of the cylinder to the other end

(*Continued on page* 446)

Home-Made Compound Microscope

By Carl F. Muckenhoupt

A COMPOUND miscroscope is beyond the reach of many experimenters because of its prohibitive price. Since such an instrument is very useful, and desired by many experimenters, I describe below the theory of the microscope, and the method of building one cheaply.

Fig. 1 shows how the tiny object OP is enlarged by the objective at O'P', which image in turn is re-magnified by the eye-piece, and seen as at O"P". To avoid complexity, only the rays from the head of the little arrow are shown, but rays from the other end would pass symmetrically oppo-

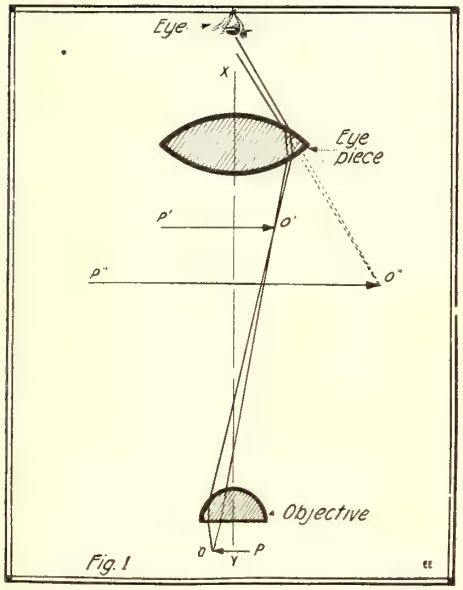


Fig. 1. This Diagram Shows the Path of the Focal Rays Thru the Optical or Lens System of the Home-Made Compound Microscope Here Described and Illustrated. The Eye-Piece Lens Shown Is a Double Convex One, While the Objective Lens Is of the Plane-Convex Type. Most Good Microscopes Have Two Lenses in the Eye-Piece.

site the main axis XY, and come to final focus at P", just as those shown focus at O". We see that by placing the object just outside the focus of the short-focus lens, an enlarged image is cast at some distance, which in turn is magnified by the eye lens. A good microscope has two lenses in the eye-piece, instead of one, to make a field free from chromatic and spherical aberration.

A good microscope is shown at Fig. 2. The tubes are preferably of thin sheet metal, rolled over a stick to the proper diameter, and then soldered. They may, however, be made of pasteboard. The main

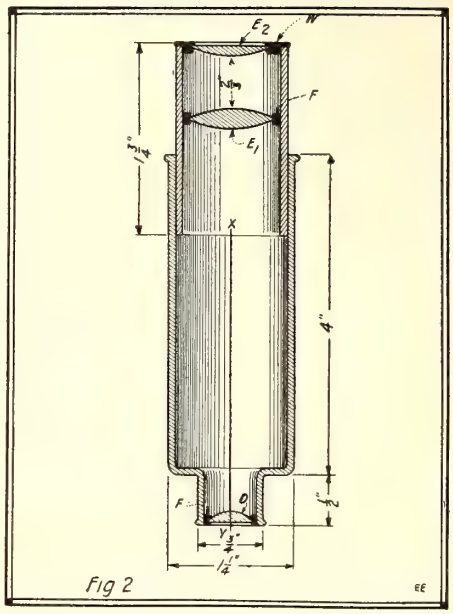


Fig. 2. This Sectional View of the Microscope Shows How the Metal Tubes of Brass, Copper, or Other Covering Are Arranged to Slide Within One Another; the Objective Lens Being Placed at O, and the Two Image-Magnifying Eye-Piece Lenses at E-1 and E-2.

tube is 4 inches long by 1¼ inches in diameter. A ring is soldered to its bottom end, with a ¾ inch hole in it. In this, in turn, the little objective tube, ½ inch long by ¾ inch diameter, is soldered. Make sure everything is well soldered, and then paint the inside of the whole affair a dull black, *not* shiny black. For the eye-piece, make a tube 1¾ inches long, and of a diameter to fit the main barrel snugly. This may take some time, for it must not work too tightly, or be too loose. Paint this black inside as well.

Power	Focal length of E_1 and E_2	Distance between E_1 and E_2	Distance between O and E_1
50	$2\frac{2}{3}$ inches	$1\frac{7}{9}$ inches	$6\frac{1}{3}$ inches
75	$1\frac{2}{3}$ inches	$1\frac{1}{9}$ inches	$5\frac{1}{3}$ inches
100	$1\frac{1}{4}$ inches	$\frac{5}{6}$ inch	$5\frac{1}{8}$ inches
130	$\frac{8}{9}$ inch	$\frac{9}{16}$ inch	$4\frac{7}{8}$ inches
		Note: For low powers the eye piece tube is very long	

Data for eye pieces for various powers; the letters are those of fig. 2 -E_1 is always double, and E_2 is always plano convex.

The lenses naturally come next. O, the objective, is a ½ inch focal length, *plano-convex* lens. These can be secured from your optician. E_1 is a 1-inch focus, double convex lens. E_2 is a 1-inch focus, plano-convex lens. Take care to have these last two of the same kind of glass. O is mounted by making a ring to fit the bottom of the objective tube, and with a hole slightly smaller than the ½ inch focus lens. Center the lens over the aperture as shown, and glue a ring of felt F, with a hole smaller (slightly) than the lens, to the metal ring. When fast, clean the lens thoroly, and solder carefully to the little objective tube as shown by Fig. 2.

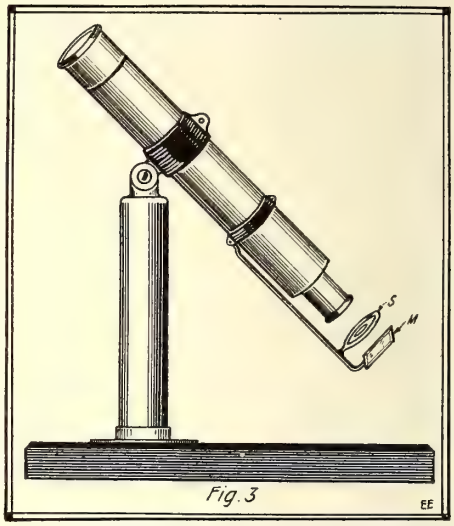


Fig. 3. A Simple Arrangement for the Home-Made Microscope Which May Be Modified and Improved by the Ingenuity of the Constructor, by Adding a Rack and Pinion or Other Precision Focusing Gear.

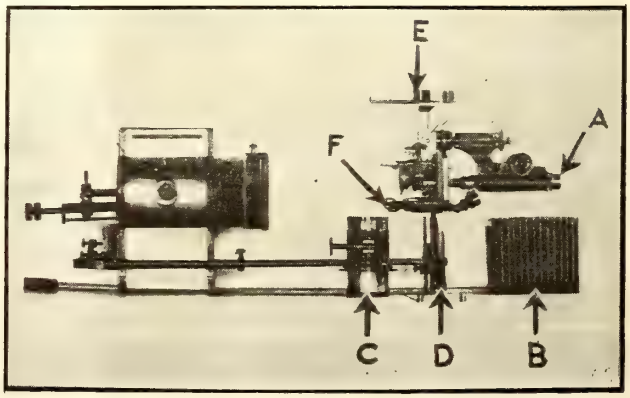
In one end of the eye-piece tube, fasten a ring of wood W, with a hole smaller than the plano 1 inch focus. Cut out the wood until the lens fits well, then screw a cap on the end with an aperture of about ½ inch. Mount E_1 2/3 of an inch from E_2, by forcing a ring in the tube, at right angles to it, and gluing felt around the lens. Push the eye-piece in until E_1 is about 4⅝ inches from O. This need not be exact unless you want to know the power exactly. The objective should be about 9/64 inch from object, which must be brightly illuminated. This distance need not be exact either. If both distances are exact, the power is 112.

Any one can devise his own stand, or use the scheme shown in illustration Fig. 3.

A Micro-Photographic Projector

The ease with which this apparatus is constructed is its main feature, provided, of course, one has the microscope and an ordinary projection lantern. I will proceed to the explanation of the letters in the picture.

Remove the entire front combination of lenses C, and the bellows, B. Bend the tube of the microscope, on the hinge provided, until it is at right angles to the foot E. Turn upside down and fasten to the front support D by two ordinary small wood clamps. Remove the eye-piece A, and you have a most excellent projector. It is much more satisfactory if one has a sub-stage condenser as shown in the photograph.



How an Effective Micro-Photographic Projector Was Constructed from a Stereopticon and a Microscope.

This unique arrangement of physical laboratory apparatus should find a great many uses, especially among lecturers and teachers, who find it necessary to enlarge or throw on a screen micro-photographic views of minute organisms, et cetera. Either an electric arc or incandescent lamp may serve as a source of light or else an acetylene light. Careful focusing of the complete apparatus is necessary to obtain a clear image on the screen. Drawings are often made in this way of minute objects by projecting them on white paper.

I have used this apparatus for class-room work and for making pictures of microscopic objects with fine satisfaction.

Contributed by E. K. GIFFEN.

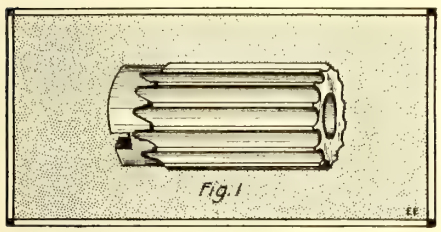
Experimental Mechanics

By SAMUEL D. COHEN

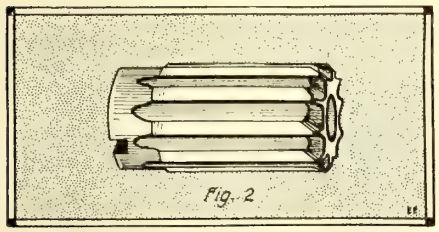
LESSON XIV

REAMERS CONTINUED.

IN order to save the material which would be used for the shank, the shell reamer having a hole thru its center by means of which it is mounted on the arbor, is largely used. By making the reamer in this manner *one* arbor can be utilized for a number of sizes. The general appearance of a shell reamer is illustrated in Fig. 1. This type is known as a *fluted shell* reamer. In Fig. 2 a *rose shell* reamer is shown. The cutting edges, fluting, and back taper of this latter type are the same as those of the rose reamers. However, in all other particulars, the tool is the same as an ordinary fluted shell reamer.



The Shell Reamer—This Form Is Widely Used in All Machine Shop Work. It Is Used on an Arbor.



A Typical Rose Shell Reamer. This Tool Has a Cutting Edge Provided on the End of Each Tooth as Shown.

The arbor used with the shell reamer is shown in Fig. 3, the shell reamer being provided with a keyway, which freely fits the key B. The reamer, when at work, is rotated by means of this key and keyway. The hole thru the reamer tapers, the taper being ⅛ inch per foot. Manufacturers of reamers have adopted certain standard sizes of arbors, and each arbor corresponds to a certain number of sizes of reamers; thus several sizes of reamers are provided with the same size hole, and can be used with the same arbor. The arbor as well as the hole in the reamer must be ground after hardening to insure the true running of the reamer. The outside of the reamer is provided with flutes and cutting edges for the greater part of the length. The short length at the end provided with a keyway, is turned down below the diameter of the cutting edges. This is done to prevent any burr which may be set up by the driving key on the arbor from interfering with the hole being reamed or disfiguring the cutting edges of the reamer.

The fluted shell reamer type as shown in Fig. 1, is provided with a greater number of flutes for the same size than are ordinary fluted chucking reamers, because the flutes must be shallow on account of the hole thru the reamer. The flutes are cut, however, with the same kind of fluting cutters as are used for reamers generally. The corners at the end of the fluted shell reamer are slightly rounded.

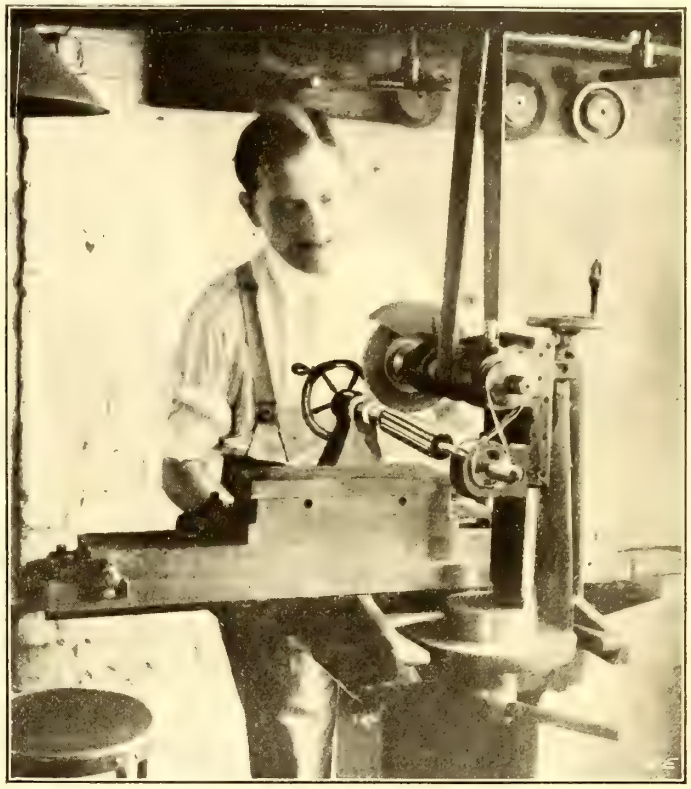
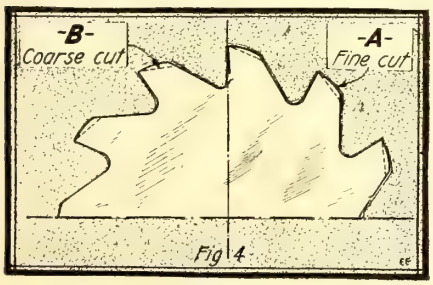


Fig. 5. Reamers Are Usually Ground to Final Size on a Precision Grinding Machine of the Type Here Shown. With Such a Machine the Reamer Can be Ground to Any Taper Desired with an Accuracy of One-Ten Thousandth of an Inch.

The arbor used for driving shell reamers consists of a stem or arbor proper C, as illustrated in Fig. 3, provided with a collar D, fastened to the arbor by means of a taper pin. A tongue B is milled at the end of this collar, which constitutes the key fitting the keyway in the reamer. Precaution should be taken during the "milling process" to ascertain the exact centering of the tongue in the collar. Care should also be exercised in milling the keyway in the reamer. When grinding the outside of the reamer to size, this work should be done on an arbor similar to that on which it is to be used. The arbor as well as the driving collar should preferably be made from tool steel and the collars should be hardened. The arbor as generally manufactured, is made in fourteen sizes, the diameter of each being measured at E, half-way between the end of the key and the solid part of the body of the collar, D. The arbor has a flat milled on the shank for the set screw by which it is clamped and held in position in the machine where it is used.

Too great or too little clearance on the teeth of a reamer will tend to produce unsatisfactory results, the first invariably causing the reamer to wear to a greater extent, as the shavings get in between the cutting edges and the work to be reamed, thus slowly grinding away the cutting edges. Also there is a tendency to bind the reamer in the hole, consequently injuring the hole as well as the reamer, and causing more exertion in performing the reaming operation.



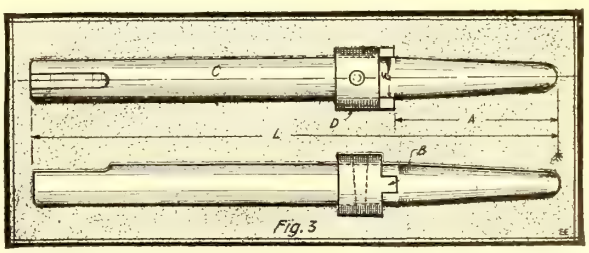
Showing Two Ways of Grinding Reamer Teeth.

The Steel Arbor Used for "Driving" Shell Reamers Consists of a Stem C, Provided with a Collar D, Fastened to the Arbor by Means of a Taper Pin. A Key or Tongue B Is Milled on the Collar to Hold the Reamer.

The *flat relief* or *clearance*, altho mostly used, is not the most desirable, because the cutting edge is not properly supported. Best results are obtained by a clearance, as shown in Fig. 4. The difference between this clearance or relief and the flat is obvious from the illustration, where the relief is shown by dotted lines "B." It is usually termed the *eccentric relief*, and its use is strongly recommended, as it adds greatly to the capacity of the reamer for producing a smooth hole. The relief is produced by placing the reamer in a grinding machine as usual, not on centers in line with the spindle, but on auxiliary centers provided with adjustable side ways, so as to enable them to be set at different positions for different relief required on various sizes and kinds of reamers. The reamer is thus held eccentrically. A rocking motion is then imparted to the spindles holding the auxiliary centers, and in this manner, the grinding wheel traveling back and forth along the reamer, will produce an eccentric relief.

The eccentric relief, however, is not in

(*Continued on page* 438)



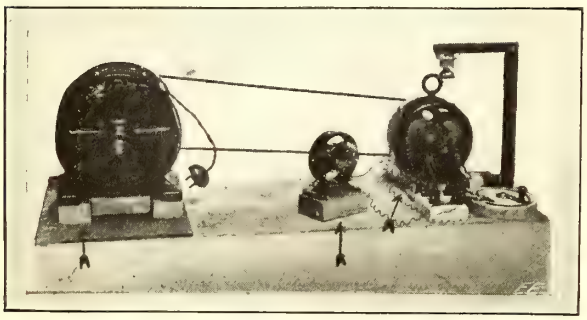
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

MOTOR AND GENERATOR SILENCER.

In carrying on experiments in electricity and having only 110 volts alternating current at my disposal, I recently added a



Do You Have Trouble With Noisy Motors? Eliminate It! Mount the Offending Machine on Sponge Rubber As Indicated by the Arrows.

motor-generator set to my equipment. As my experiments were necessarily performed at night, due to work in the daytime and having due consideration not to annoy the people on the opposite side of the house at late hours with the humming of a motor and dynamo, the selection of a quiet running piece of apparatus became of prime importance.

A high grade, 6 volt, 6 ampere dynamo was obtained which proved reasonably quiet, but when firmly secured to a 1½-inch board with a one-eighth horsepower motor likewise mounted, driving it, the noise was quite offensive. Most small motors of the alternating current type are very quiet when well bolted onto a concrete or iron foundation, but when mounted on a wooden plank 1½x12x30 inches it is another story. The first motor of 1,750 R.P.M. type was very good, but a little too noisy, and by obtaining a similar machine running at but 1,140 R.P.M., the noise was cut down fully two-thirds.

Of course, these results were encouraging, but my progress was still retarded by the noise made which I knew was not good to put "kids" to sleep by.

It finally occurred to me to use some soft silencer such as cork or rubber, and after numerous experiments with everything I could think of, I was finally successful. For the ⅛ H.P. 1,140 R.P.M. motor I secured three pieces of regular *art gum* from a 10 cent store. These blocks of soft "rubber" measured exactly 1x2x3 inches. They were mounted with LePage's glue to both the base of the motor and dynamo, and when placed on the board, the two machines could be operated with an exceedingly tight belt tension with no "walking" of the apparatus, even after hours of operation.

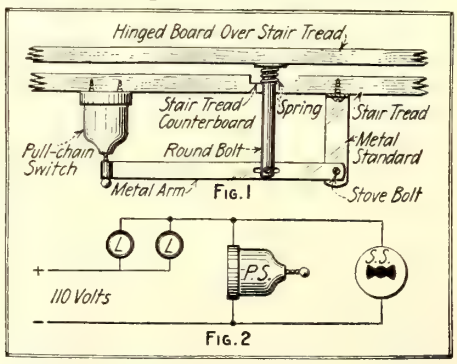
Contributed by C. V. TURNER.

[*Editorial Note—Those having noisy phonograph motors will find it efficacious to mount the feet of the motor on art gum or "sponge rubber." Tests have shown excellent results.*]

SECOND PRIZE, $2.00

CONTROLLING THE CELLAR LIGHTS.

The arrangement with which this is accomplished is shown in Fig. 1. A pull-chain switch of proper size to handle the lamps on the circuit is mounted on the *under surface* of the uppermost stair tread. The chain is shortened to an inch or so, and is attached to a metal arm pivoted on a metal standard which is screwed to the tread a short distance from the switch. At a point near the standard the metal arm is slotted to take a small stove bolt which fastens the slotted round bolt movably to it. This bolt passes thru a hole in the tread which is also counterbored to allow the bolt head to lie flush when the coiled spring under it is fully deprest. A board cut to the same size as the tread should be hinged to the riser above it so that the board will lie flat against the top of tread when stept upon. Coiled springs should be placed between the two at each end, to keep the front edge of the board separated about half inch or so from top of tread. This is all that is necessary as the small movement of bolt is increased by the leverage of the metal arm. The action of the device is obvious. As the top board is trod upon, it is deprest, moving the bolt downward against its spring, which movement is amplified and communicated to the pull-chain of switch by the metal arm, thus turning the switch "on." When weight is released, the board and other parts return to their original positions. When the board is again trod upon, the action is repeated, this time turning the switch "off." No dimensions are given as the sizes of the various parts will vary according to the size of switch and



The Cellar Lights Are Turned on and off Automatically by This Stair-Tread Switch Wrinkle. The Moving Tread is Attached as Shown to a Pull-Chain Socket.

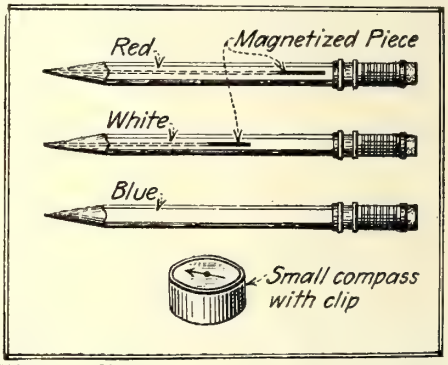
other conditions. As it is sometimes desired to leave the lights (LL) "on" while repeatedly passing up and down the steps it will be well to install a snap switch (SS) in the usual position and connect it in multiple with the pull-chain switch (PS) as depicted in diagram Fig. 2.

Contributed by J. A. WEVER.

THIRD PRIZE, $1.00

THREE MAGIC PENCILS—A MAGNETIC HOAX.

EFFECT: Three colored lead pencils are given out for examination, red, white and blue, for example. The performer leaving



Want to Mystify Your Friends With Some Hindu Pencils? Here's How: With a Magnet Placed at Different Positions in Two or More Pencils, Conceal a Small Compass in Your Cuff. The Rest Is Easy—You Can Tell at Once Which Colored Pencil Is Inside an Envelope, Even Tho It Was Wrapt up While You Were Absent from the Room.

the roon. tells anyone to choose any color pencil they wish, while he is out of the room, and to wrap it up in any color piece of paper or cloth, and to hand it to him securely wrapt when he returns to the room. Upon receipt of same the performer passes hand over pencil and tells exact color.

SECRET: Two of the pencils are "faked" in this manner. One of them is drilled with a 1/16 inch drill in the rubber end about 1 inch, and the other one is drilled half-way down or in the middle. Two pieces of Stubb's drill rod, ½ inch long by 1/16 inch diameter, are hardened, magnetized and inserted in the drilled holes and a piece of lead is inserted after the magnetized pieces and are made flush with top of wood in rubber end of pencil, the rubber is placed on top and the trick is ready; the third pencil contains no fake whatever. In leaving the room the performer attaches to his shirt cuff, inside, a small compass (some of these compasses can be obtained as small as a dime, or even of less diameter), which aids him in detecting what pencil is wrapped up or concealed in the cloth or paper in this way: He slowly passes pencil in front of compass and watches needle until it quivers, which it will do when that part of pencil containing the magnetized steel passes needle. If the needle moves when the *end* of pencil is near it, the performer knows it is the *red* one. If it moves when near the *middle* of pencil, he knows it is the *white* one; if needle does not move, it must of course be the blue one. As the back of hand faces audience, the compass is invisible.

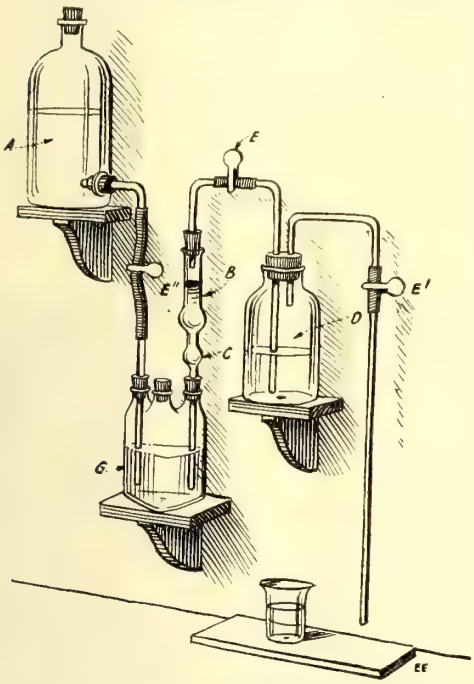
Many variations of this magnetic trick will suggest themselves to the wide-awake experimenter. Such as the magnetic "brass" ball—the inside of the ball is filled with iron filings and the small filling hole stopt up with brass.

Contributed by R. S. MYERS.



A NEW FORM OF HYDROGEN SULFID GENERATOR.

From time to time, in various issues of your splendid magazine, I have noticed *hydrogen sulfid generators* of numerous



This Highly Efficient Hydrogen Sulfid Generator Can Be Made Up from Glassware Found About Every Amateur Chemist's Laboratory.

types and styles described, but I have come to the conclusion that none of them work as easily or are constructed so simply as the one I now have in use in my chemical laboratory. I give herewith a drawing of the same, and will try to render a coherent explanation of its manipulation.

I will first make a notation of the apparatus used:

1 Aspirator bottle.*
1 Woulff bottle (three neck).
1 Calcium chloride drying tube.
1 Large bottle.
Glass tubing.
Rubber tubing.

I will now give a list of the apparatus and liquids denoted by the letters in the drawing:

"A"—Hydrochloric acid.
"B"—Iron sulfid.
"C"—Mineral wool or asbestos.
"D"—Water.
E, E', E"—Pinchcocks.
"G"—Hydrochloric acid.

I don't think it will be necessary to go into detail in reference to the construction of the apparatus, as I believe the sketch fully covers that, but give here a few points on the manipulation:

Open the pinchcock E" and allow the HCl to flow into the Woulff bottle; this will compress the air in the Woulff bottle. When the HCl stops flowing from the aspirator bottle, owing to the compression of the air, close the pinchcock E". Now open the pinchcock E and the HCl (G) will rise in the calcium chloride drying tube, thereby covering iron sulfid (B). (If the compression of air is not sufficient in the Woulff bottle to do this, again open pinchcock E" until the HCl rises in the drying tube sufficient to cover iron sulfid (B). Open pinchcock E and the gas generated will pass over into the large bottle containing the water (D). In this bottle the gas will be washed, and will also form a supply of the gas above the level of the water. Open the pinchcock E' and the gas will flow in a steady stream.

When one is thru with the gas all that is necessary is to close pinchcock E' and then close pinchcock E. Gas will continue to generate and will, owing to no outlet being open, force the HCl, covering the iron sulfid, back again into the Woulff bottle.

When the strength of the HCl, "G," becomes exhausted it can be removed from the Woulff bottle and, owing to the filtration caused by the mineral wool "C," is ready for evaporation for the recovery of the ferric chlorid. Another feature is that one has at all times hydrogen sulfid water on hand owing to the washing of the gas in the large bottle thru the water D. The reason for using a three-neck Woulff bottle is this: that when the pressure in the Woulff bottle, caused by the compression of the air, and also the gas liberated when pinchcock E, is closed immediately after use, will sometimes become too great for the strength of the glass, and so as a "safety first" measure, the three neck bottle is used so that the cork in the center, not in use, will act to liberate the surplus pressure.

Contributed by
WILLIAM N. NUSHAWG.

* An Aspirator bottle is not necessary, as the liquid (A) can be syphoned out of any ordinary bottle.

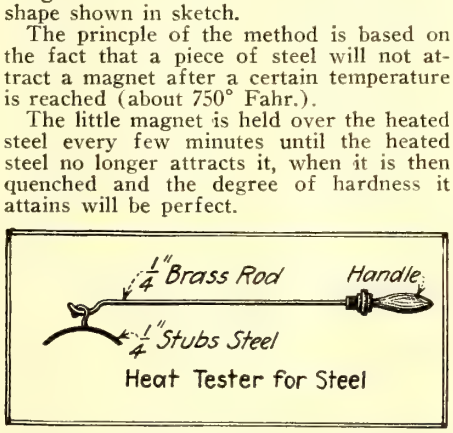
MAGNET TEST FOR HEAT OF STEEL.

One of the best and little-known methods of determining the correct heat at which to quench a piece of steel to obtain the best results, without the use of a pyrometer, is the following:

Take a piece of ¼" Stubb's steel about 2" long, tap a small hole in the center for a small screw eye, then harden and magnetize after bending to the shape shown in illustration. Place in screw eye and hang on the end of a brass rod bent to the shape shown in sketch.

The princple of the method is based on the fact that a piece of steel will not attract a magnet after a certain temperature is reached (about 750° Fahr.).

The little magnet is held over the heated steel every few minutes until the heated steel no longer attracts it, when it is then quenched and the degree of hardness it attains will be perfect.



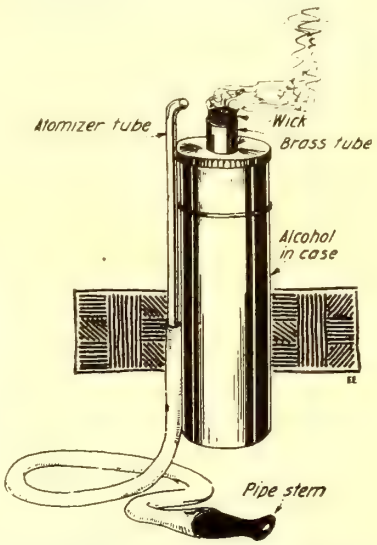
The Principle of This Steel Heating Tester Is That Above a Certain Temperature Steel or Iron Will not Attract a Magnet. Hence: When Is a Magnet not a Magnet? Answer. When It Is Red Hot.

Of course, the steel is to be drawn again to the required color. The above method is known to a very few mechanics.

Contributed by T. W. BENJAMIN.

AN ALCOHOL BLOW-TORCH FROM JUNK.

Want a nice little blow-torch? Below are given the details of an easily made blow-torch that will give as good results for soldering, etc., as the regular torch. It is constructed from a nickel-plated shav-



Who Wants an Alcohol Blow-Torch? Every Electrical Man, and Here's How to Make One from a Shaving Stick Case for Nothing. If You Are a Religious Prohibitionist You Can Burn Gin or Whiskey in Your Torch.

ing-stick case. The top of this case has a hole about three-quarters of an inch cut into it, and a piece of brass tubing inserted and soldered. Thru this runs the cotton lamp wick, dipping into the alcohol, contained in the case. Cotton wicking can be purchased in any hardware store. A piece of an atomizer tube, bent as shown in the illustration, is soldered or otherwise secured to the side of the case, connecting with a rubber tube. At the end of this a mouthpiece from "Pop's" old pipe stem is fastened. This makes a good, neat torch, welcome in any work shop or "lab."

Contributed by GEORGE H. TRUITT.

MAKING CHLOROPHYL.

Chlorophyl is the green coloring matter common to growing plants. Take a handful of parsley and triturate in a mortar with enough alcohol (95%) to cover the mass. Decant the green liquid and allow it to evaporate spontaneously. The chlorophyl remains as an intensely green substance. This may be used to color candies and as cake icings.

Dye from Onion Skins: Take the outer skins from half a dozen onions (medium-sized) and boil in water until the color is extracted. This is a very suitable yellow dye.

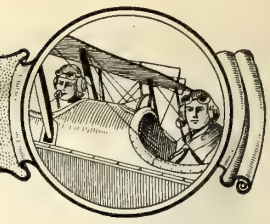
Test for the Purity of Olive Oil: Shake equal volumes of the oil and nitric acid. Pure oil should turn from pale to dark green in a few minutes. If it changes to brown, red, or orange, the addition of a foreign oil is indicated.

Heat for five minutes in a water bath at 100°C. It should become pale yellow to orange yellow. On standing it will, if pure, become a yellow solid.

Contributed by FRITZ ZILLESSEN.



RADIO DEPARTMENT



The "Fog Warning" Radio Telephone

THE accompanying illustrations show the interior mechanism used in the wireless telephone "fog warning" signal installed at the Point Judith Light near Narragansett Pier, R. I. This is one of the most treacherous sections on the Atlantic coast for ships to negotiate. For some time the DeForest "Radiophore" has been in use at this lighthouse station. It comprises an old type cylinder phonograph fitted with a record and repeating mechanism, which operates an Oscillion vacuum bulb, in such a way that the following warning is sent out by wireless telephone waves from an antenna, to ships as follows: "Point Judith Light," which is repeated three times. Then the skipper on the boat, or his wireless operator, hears, "You are getting closer, keep off," at about ⅓ volume of the first warning. Until the vessel approaches the danger limit, it does not hear the necessary final warning, but simply the first "location" warning.

The energy used in operating this warning signal is one-fourth kilowatt. The Oscillion vacuum tube generator of the radio frequency oscillations, is a 3¾-inch bulb. Heretofore the wave length was varied automatically for the different signals by a motor-driven variometer, but owing to the difficulty experienced by the ship radio operators in trying to pick up the constantly changing wave length signal and to hold it, the warning is now sent out on a fixt wave length of 600 meters, whereas with the constantly changing wave length previously used, the final message, "You are getting closer, keep off," was liable to be mist.

The first real test of this apparatus has been taking place at Point Judith Light (near Narragansett Pier), and the apparatus is arranged on a very compact scale so that it can be attended to by the regular lighthouse keeper and assistant. A regulation gasoline engine connected with a 36-volt direct-current generator and storage batteries is used to supply the energy, to which is coupled a motor-generator set which operates the transmitting apparatus.

This apparatus is entirely enclosed in a compact cabinet measuring about 18x18x18 inches. On the front of the cabinet is the Oscillion bulb and necessary switches for regulating it; also connection posts for aërial and ground wires. On the side of the cabinet is a small door which gives access to the mechanism inside.

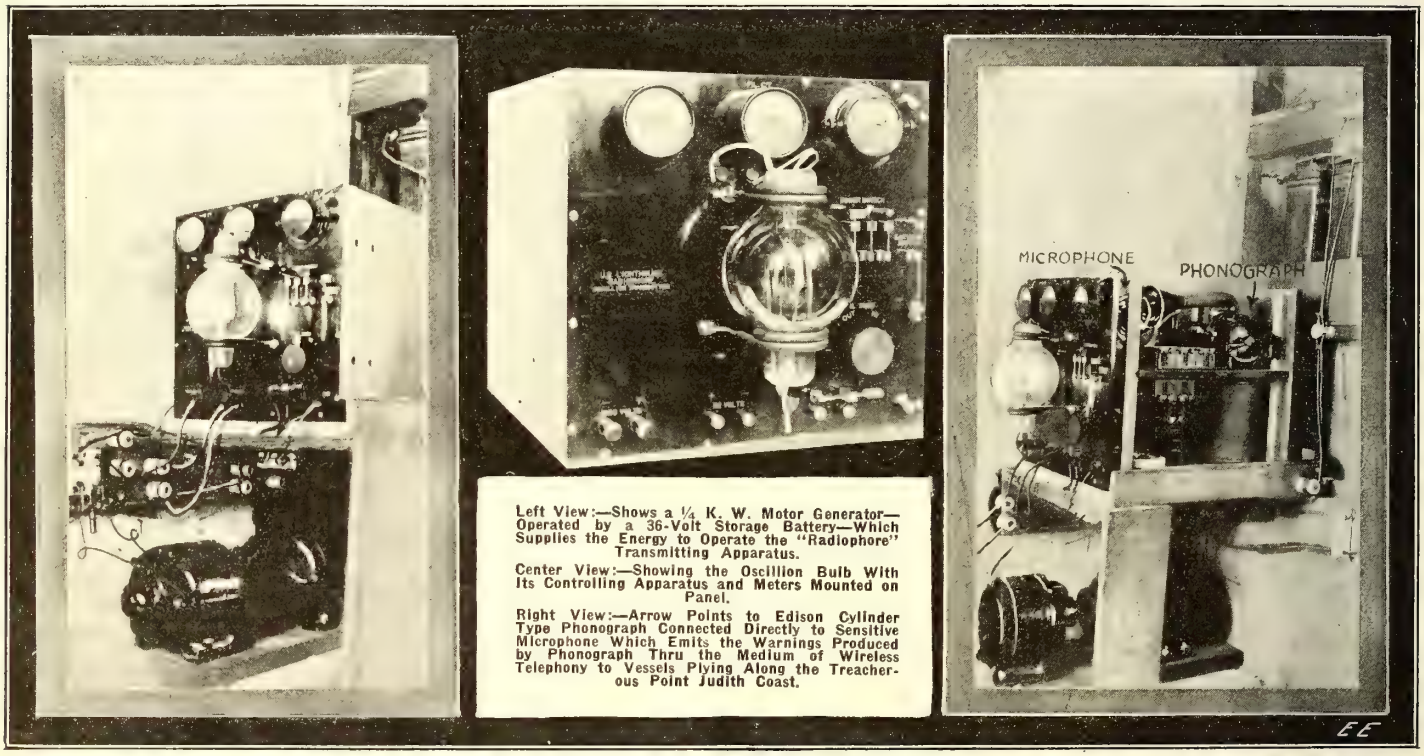
All the working parts are mounted inside the cabinet, including a motor-driven phonograph (see photographs herewith), speaking directly into a microphone. The arrangement of the cylindrical records is such that they repeat automatically, the saffire needle being set back to the beginning each time after it has traveled the length of the record. Each record has an average life of about 60,000 repetitions.

In the circuit diagram may be seen the relative layout of the various horns, microphones, and the Oscillion bulb generator of the radio frequency oscillations used to propagate the vocal message.

Several other modifications of the underlying principles may also be utilized as described in Dr. de Forest's patent. The transmitting apparatus is so arranged that speech can be sent out from the large fog horns, as also musical notes, bell signals, et cetera; on the same prearranged schedule as the radio signals. In this scheme the phonograph with records containing speech, is coupled to a microphonic arrangement and the speech is intensified by means of audion amplifiers and the sound waves sent out thru the fog horns, thereby enabling the captain or other officer to hear the same by ear, *without* the aid of wireless apparatus.

The one big feature of the Point Judith Light equipment is that when a ship is within a range of eight miles of the lighthouse, it will hear the following words flashed by wireless every five seconds: "Point Judith Light;" and after every

(*Continued on page* 462)



Left View:—Shows a ¼ K. W. Motor Generator—Operated by a 36-Volt Storage Battery—Which Supplies the Energy to Operate the "Radiophore" Transmitting Apparatus.

Center View:—Showing the Oscillion Bulb With Its Controlling Apparatus and Meters Mounted on Panel.

Right View:—Arrow Points to Edison Cylinder Type Phonograph Connected Directly to Sensitive Microphone Which Emits the Warnings Produced by Phonograph Thru the Medium of Wireless Telephony to Vessels Plying Along the Treacherous Point Judith Coast.

In September "Radio Amateur News"

Grand Opera by Wireless. By H. Gernsback.

Guarding the Ether During the War. By P. H. Boucheron.

Construction of an Audion "B" Storage Battery. By Herbert Webb.

Static Eliminator of Considerable Merit. By Edgar Terrain Johnstone.

Wireless Telegraphy with the Canadians at the Front. By J. W. Caucor.

The Double Deck Receiver.

A. B. C. of Wireless Reception. By H. K. Dunn.

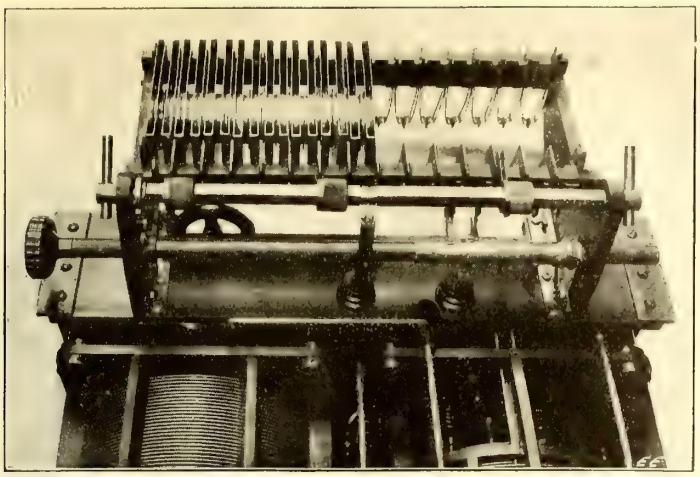
The Latest Design Antenna Switch. By E. T. Jones

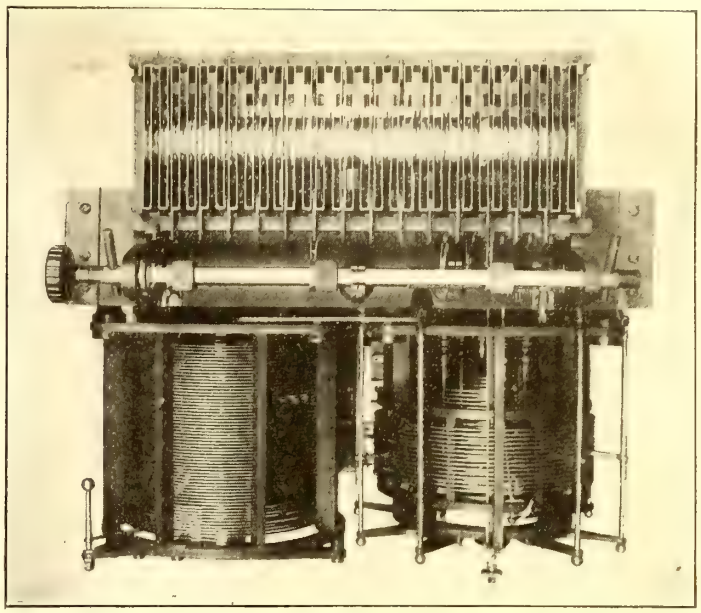
The Lure of Radio. By Eugene Dynner.

A Pocket Size Receiver. By J. E. Aiken.

Value of the Radio Compass. By L. A. Pollock.

Junior Radio Course—Lesson 1. By E. T. Jones.





Two Views of the Navy Type Quenched Gap Used on New 1 K. W. Panel Radio Transmitter. The view at the Left Shows the Quenched Gap With Several of the Units Removed While the View at the Right Shows a Top View of the Panel and Quenched Gap, With All of the Gap Units in Place. The Long Rod Placed at the Side of the Gap and Provided With a Large Insulated Knob at One End, Controls a Power-changing Switch, Which Switches In or Out of Circuit More or Less of the Gaps, as Required for Various Transmitting Powers.

New 1 K.W. Quenched Gap Transmitter

By Lester F. Ryan

THE 1 K. W. panel radio set as is described in the following article, is identically the same in principle and operation to the one described in the July issue of the ELECTRICAL EXPERIMENTER, except for the spark gap. The panel consists of two bakelite-dilecto pieces, the upper panel having the hot wire ammeter, wave changing device and the spark gap mounted upon it. The lower has the volt and ammeter control switches and automatic starter mounted upon it. The voltmeter is of the double scale type. The motor-generator is of the Crocker-Wheeler type, and is driven counter clockwise from the motor end by direct current at 120 volts. It is rated at 2 1/10 horsepower and 1.25 K. V. A. or 1000 watts, at 80 per cent power factor. It is a 500 cycle machine and has 15 field poles. The motor field is controlled by a Ward Leonard 18 point rheostat. This varies the frequency between wide limits. The automatic starter consists of five parts, two solenoids, and two contact discs and plunger, also a common resistance box.

The transformer used with this set is of the closed core dry-type and is rated at 1000 watts, 500 cycles and 150 volts at the primary winding terminals. The ratio of transformation is 38 to 1. It is insulated to stand electric stresses of 30,000 volts and will stand a 50 per cent overload.

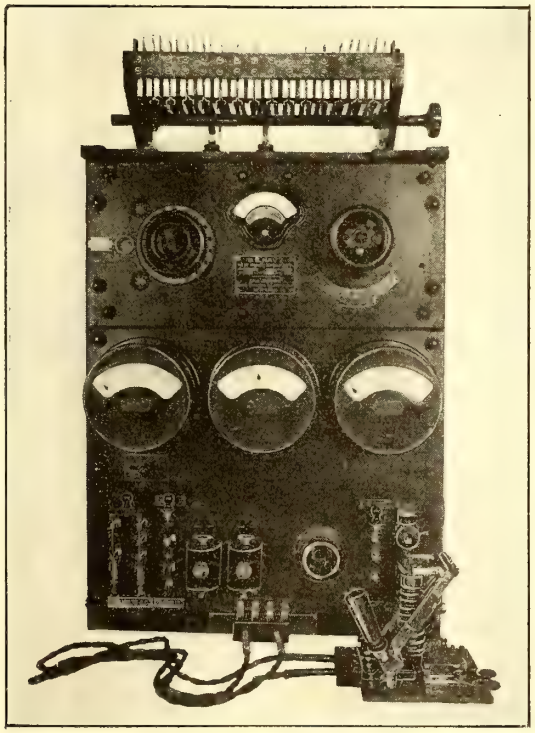
The condensers used are of the Dubilier type of .004 microfarad capacity each, connected in parallel. They are made of selected mica and tested for 100 per cent overload which is more than is ever used.

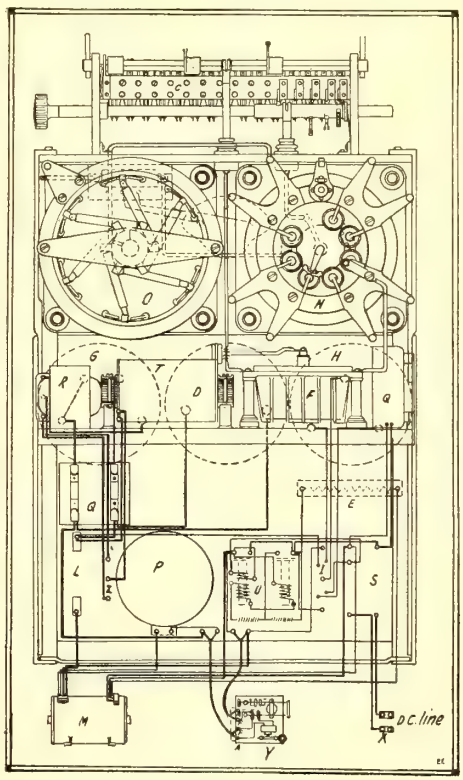
The spark gap which is used with this set is mounted on the top of the panel as shown in figure. The gap consists of a *gap holder* and *power changer*. The gap is horizontal and has a row of fifteen pockets; each pocket accommodates a gap unit as shown in photos. When a gap unit is inserted in a pocket it separates two leaf springs. The pressure of these springs against the gap insures perfect contact. The springs come together as a gap is removed and in so doing bridge the break in the gap holder circuit.

A switching mechanism is also associated with this holder. It consists of two shafts, one above the other and parallel to the row of gap pockets. Each shaft is provided with switch jaws which engage knife blades fitted to the gap holding pockets as shown in figure. The top switch shaft is used for the changing of power. Each movement of its handle inserts or removes gap units in groups. The switch jaws slide over this shaft so that the operator may vary the number of the gaps in a group at will. The three positions of this switch are *Low, Intermediate and High.*

The second and lower switch shaft allows five gaps to be inserted one at a time. The switch engages knife blades projecting from the rear of the first five gap pockets as will be seen. This

(*Continued on page* 471)





Front and Rear Views of 1 Kilowatt Quenched Gap, Panel Radio Transmitter. This Set Has Been Extensively Adapted by the United States Navy and Has Given Excellent Satisfaction. The Quenched Gap Units Are Easily Replaced at a Moment's Notice and Can Be Quickly Repaired When Necessary. The Gap Plates Are Separated by Thin Fish Paper Gaskets. The Set is Noiseless in Operation.

Valves

By PROF. A. U. DION, G.R.I.D., D.C., A.C., H.F.C., T.S.F., etc., and MR. LETIT LEAK, E.M.F., O.T., etc. (Local Plumber)

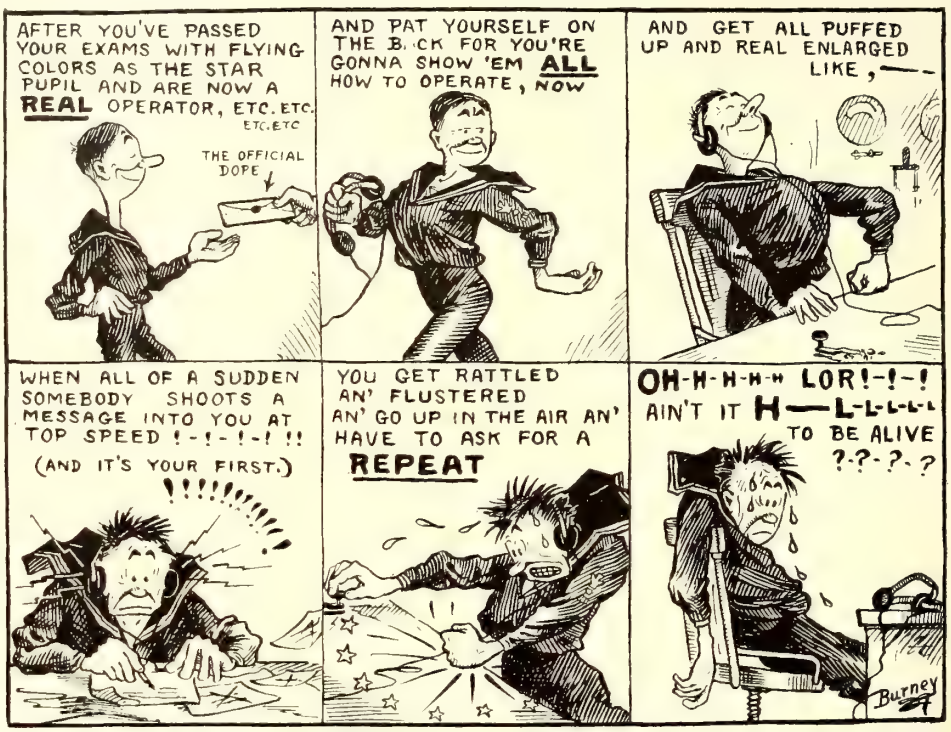
Introduction

In this little article I have tried to set down a few facts and fancies regarding the valve as used in the practice of wireless telegraphy.

They are the direct result of information collected whilst acting in the capacity of W/T operator in one of Britain's aërial dreadnoughts, although much of the advanced technical matter is the result of Mr. Letit Leak's untiring research, and to this gentleman I publicly extend my heartfelt thanks for his invaluable assistance in compiling this treatise.

Author's Note

Thru long association I had come to look upon the W/T valve as the only valve in the wide, wide world, so vividly were its advantages and merits imprest upon me at Cramwell College. I am assured by Mr. Letit Leak, however, that this is quite a fallacy. He tells me that there are H.P. and L.P. steam valves, gas valves, ball valves, and bi-valves, not to mention innumerable others, besides the common or garden dot-and-dash variety.



"Learning the Code" Is Right—First You "Think" You Learn It—Then You Really Learn It All Over Again, As Mr. H. B. Burney Here Illustrates In His Own High Frequency Style.

Valves W/T may be placed in four categories:

(1) The Round Valve (deriving its name from the inventor, not from its shape).

(2) The Hard Valve (has slightly longer life than the soft valve when exposed to the tender mercies of the new operator thirsting for knowledge).

(3) The Soft Valve (so called because it is satisfied with fewer volts than the foregoing instance, and therefore does not require so many ration books).

(4) The "Q" Valve (better known as the "Hush, Hush" valve). By simple proportion it will readily be seen that 31,967 such valves would receive signals from the planet Jupiter.

All four types are much of a muchness in general principle, differing only in detail.

Taking them collectively, a valve consists of a chunk of vacuum surrounded by a layer of glass. A most essential part is the small tip generally found on top of the vacuum. Its precise use has yet to be determined, but Mr. Letit Leak assures me it is a most important *point*. I do not intend to trouble my readers with smaller details, but, in passing, it is imperative to direct attention to a fundamental necessity, which valve manufacturers dare not overlook—viz., the necessity for placing some small parts within the vacuum. These are:

(1) *The Filament.*—A very fragile piece of tungsten made up of 10^{55} negative electrons. Its function is to illuminate the vacuum in order that the student may see how the other parts work.

(2) *The Grid.*—Consists of a number of holes joined together by small pieces of metal. Acts as a shade over filament to protect student's eyes.

(3) *The Sheath.*—A sheet of metal enclosing both the filament and the grid. Prevents small pieces of vacuum, dust or dirt from falling on the filament and affecting its lighting capabilities.

At the bottom of the valve are a number of tags, generally four, although a few more or less should not worry the student. I was under the impression that these were to form a convenient method of holding the valve without making the glass dirty, but Mr. Letit Leak emphatically insists that these tags exist for the sole purpose of ensuring connection with the internal economy of the valve.

To Test Valves.—Carefully examine, and any cracks in glass bulb should be caulked with shellac to prevent the vacuum getting out.

To Test Filament.—Grasping the valve by the tags previously referred to, bang the valve several times in rapid succession against the edge of a bench (unless an anvil is handier), when it should give forth a clear, bell-like note. Should the filament fail to glow after this test, don't waste more time with it, but get another from the stores.

To Test H.T. Circuit.—Connect up to several thousand volts and forget the exact amount. A faint bluish glow will indicate that the H.T. has successfully run the gauntlet of the vacuum and is looping the loop between the filament and sheath, a process known technically as *oscillation.* Should no blue glow be detected and the valve and student still survive, throw the valve away—it is a dud.

To Test Vacuum.—Knock off small tip mentioned previously, and if vacuum is good a faint hissing noise is heard. When the hissing ceases, it denotes that Nature, which abhors a vacuum, has discovered the escape. It is not advisable to apply this test except as a last resource, owing to the extreme difficulty of re-packing the vacuum thru the small hole thus made in the glass.

From the foregoing remarks the student must draw his own conclusions as to the advantages of valves. Our W/T officer says that their tendency to disappear completely and mysteriously is not so marked as that of the carborundum crystal. He attributes this to the post-war amateur not being possest of sufficient filthy lucre to purchase enough high tension to operate the valve, while the current price of volts is so excessive.

Finally. — Mr. Letit Leak informs me that, owing to the super-sensitive qualities of the valve as a detector, it is probable that Scotland Yard will shortly assume the entire control of the valve industry, and every detective will be fitted with seven valves. Police constables, on the other hand, will only be provided with amplifiers.—*Wireless World.*

DE FOREST DEFENDS HIS 3-ELEMENT AUDION

In the interest of fair play and scientific fact Dr. Lee de Forest, acknowledged among scientists as the inventor of the 3-electrode audion or vacuum tube which has made possible the present development of the radio telephone, has made public an open letter to the Editor of the *London Morning Post,* England, protesting against the reported unfair statement of Dr. J. A. Fleming, British scientist, in connection with his series of Cantor lectures in the theatre of the Royal Society of Arts.

The letter written by Dr. de Forest is based upon an article publisht in the *London Morning Post* of February 25th entitled "The Future Telephone—Imperial Conferences by Wireless" in which the perfection of the three-electrode audion is credited to Marconi. The article reads as follows:

"Dr. J. A. Fleming yesterday concluded his series of Cantor lectures in the theatre of the Royal Society of Arts with an account of the thermonic and crystal detectors, which, as he said, have taken an important part in the war. He described how the radiant point from which wireless messages are sent, could be determined by angles taken from two receiving stations, so that the exact position of ships and Zeppelins could be ascertained, and that means whereby electric oscillations could be detected thru the telephone in an airplane above the sound of the engines. Thermionic detection has been enormously developed, and the audience was interested to hear how these instruments, which are the basis of wireless telephony, arose from the discovery by the lecturer himself of a method of utilizing the curious fact that an ordinary filament lamp when incandescent

(*Continued on page* 460)

Vacuum Valve Construction

By R. H. Shaw

By reading this article carefully any Amateur should be able to construct a vacuum detector which will give excellent results. The completed valves are shown in Figs. 1 and 2 as well as connections for them. Several other connections may be used, but those shown have been found best.

In the construction of the valves an incandescent filament is used to produce the electron flow. For this purpose a miniature incandescent lamp with a carbon filament using about three volts should be used.

Having obtained such a bulb place a very thin strip of copper around it, as shown in Fig. 3. Fasten this plate by means of the nut and bolt (B). The plate connection is also made to this bolt.

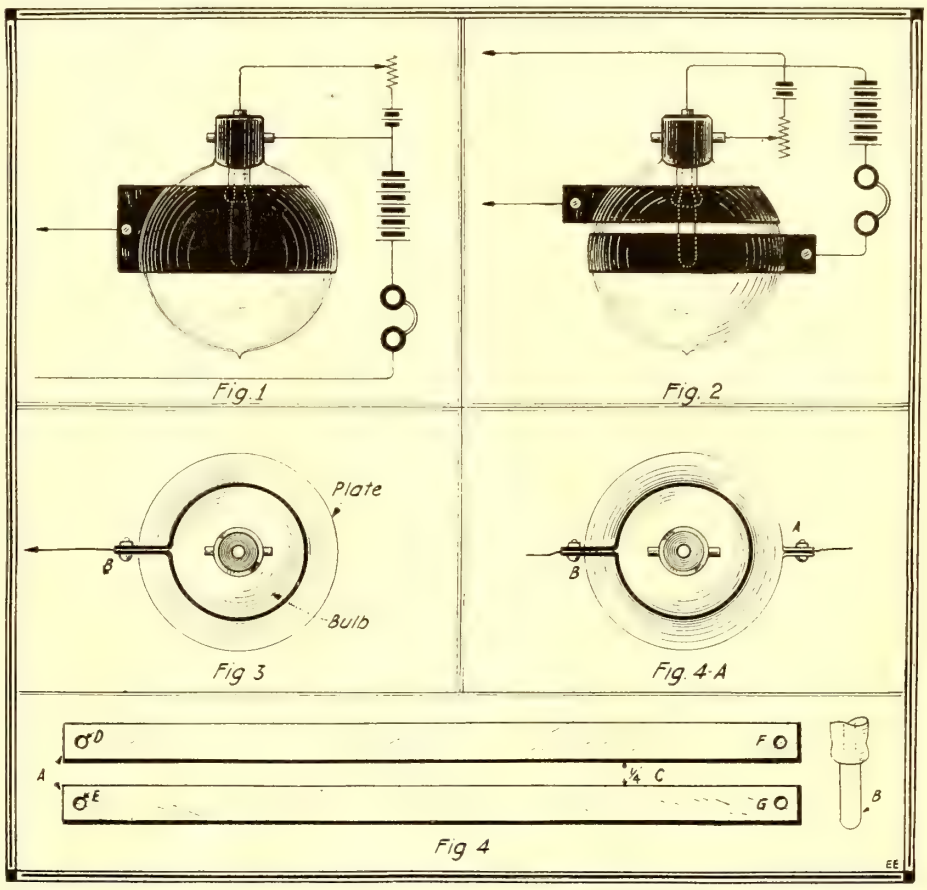
The valve is now ready for use and is connected up as shown in Fig. 1. Adjust the filament to a very high brilliancy, being careful not to burn it out. Do not touch the filament adjustment having once adjusted it, but use the "B" battery potential until the incoming signal is heard loudest in the 'phones.

In Fig. 2 is shown a second type of detector. This differs from the one just described in that its plate is divided. A lamp of the same kind used in the above detector is used for this one.

The construction of the plate for this valve is shown in Fig. 4. A thin strip of copper long enough to go completely around the bulb as shown is first cut (A). This plate should be a little wider than the filament (B). Having cut the strip to the right dimensions a piece one-quarter of an inch wide is cut out (C), Fig. 4. The holes D, E, F, G are next drilled. The two plates are then fastened around the lamp and secured to the bolts (A and B), Fig. 4-A. The plate connections are also made to these bolts.

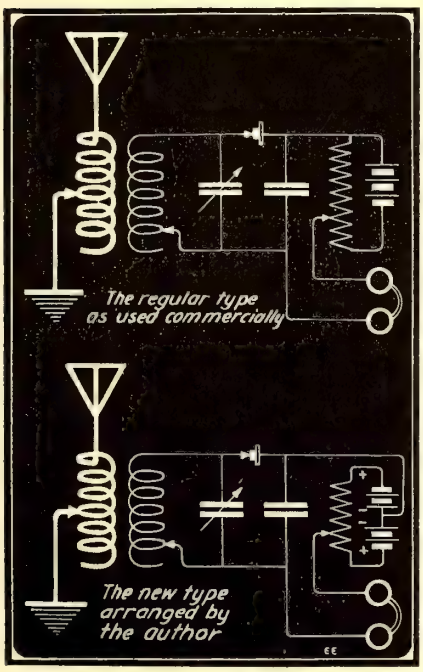
The valve is now completed and is connected as shown in Fig. 2. This valve is adjusted the same as the other one. An "A" battery of six volts and a "B" battery of fifty volts should be used with these valves.

The theory of operation of these valves is: As the glass becomes heated it allows the electrons being discharged from the filament to flow thru it and make connection with the plate on the outside of the lamp. The circuit from the filament to the plate is thus completed. It is therefore advisable to use a lamp containing a carbon filament as it produces more heat than a tungsten filament. The valves described herein are fully protected with patents and must not be manufactured for sale.



Home-Made Audion Designs for Two and Three Electrode Units. Made from Ordinary Single Filament Auto Head Lamps, Purchasable in Any Auto Supply Shop.

The Potentiometer—How to Use It



Above—the Old Way, and Below—the Improved Hook-Up for Obtaining + or — Current from a Potentiometer Circuit Without Switches

There has been very little said in print in regard to the use of this very important and effective instrument as a regulator of battery current which aids some types of crystals decidedly in their functioning.

In the majority of cases upon visiting the ordinary and even the advanced class of Amateur or Experimental stations, I have found that probably one in a hundred made use of this very necessary piece of apparatus. Once used, no one will do without it, owing to the following facts:

1. There is absolutely no carborundum which is not greatly increased in sensitiveness by its aid.

2. I have found upon investigation that there is not a piece of silicon which does not function better, to a greater or lesser degree, according to the kind used, by the aid of minute battery current and a potentiometer for regulation.

Even tho some experimenters do make use of a potentiometer they do not in all cases thoroly understand its operation and correct use in order to derive best results.

As a general rule potentiometers with a critical point of adjustment should be employed. Such a potentiometer would be one wound with fine wire and an over-all high resistance. This affords greater life to the battery shunted across it and allows one to hold point of adjustment at a greater length of time due to the fact that with large wire the battery dies out more rapidly and then it is necessary to readjust the potentiometer to allow the same amount of battery current to flow thru the detector.

A sliding contact potentiometer, if well constructed, should be used instead of the switch contact point arrangement, owing to the fact that it is impossible to arrive at an exact or critical point of adjustment with the latter.

Another point of great interest in connection with this apparatus is that the right polarity must be maintained, and in order to do this with the commercial form of potentiometer, it is necessary to first connect the detector or battery and "adjust"; if no increase in signal strength is found, it is then necessary to transpose either the battery or detector leads. To overcome such annoying procedures as just mentioned the author has arranged the following circuit for the potentiometer, which makes it unnecessary to change the leads of the battery or detector.

The instrument is termed a "duplex polarity potentiometer," and works in the following way: As will be seen from the diagram, the potentiometer is shunted by two batteries opposing each other; therefore no current will flow when the potentiometer slider is in the exact center of the instrument or windings of the same. If it is moved above center one set of polarities is had, and if moved below another set is obtained.

Contributed by E. T. JONES.

The How and Why of Radio Apparatus

By H. WINFIELD SECOR

NO. 12, RADIO ANTENNA CONSTRUCTION

From time to time we will describe one particular instrument used in either the radio transmitting or receiving set, explaining just how it works and why. We have received so many requests from new readers for such explanations that we have decided to publish this matter in serial form. In the course of several issues all of the principal transmitting and receiving apparatus will have been covered. The subject for the twelfth paper is "Radio Antenna Construction."



Here We See Two Earnest Radio Amateurs Preparing the Antenna. The Insulators Must Be Tied or Wired on Very Firmly to Withstand Wind Storms. The Spreaders and Metal Fittings Should Be Thoroly Painted.

TYPES OF AËRIALS.

THERE are various types of antennae adapted to the amateur and experimental requirements. Among the usual types of antennae with which Radio Amateurs are familiar are the "T" and inverted "L". The so-called umbrella aërial is quite familiar to some workers in experimental radio, but is seldom used except in more or less elaborate stations where experiments are carried on for *directive* effects. A typical form of inverted "L" aërial and the proper connections for the wires composing it, is shown at Fig. 1 in the accompanying diagram. Fig. 2 shows an approved form of "T" aërial. The "T" form of aërial has a smaller amount of inductance than the inverted "L" type, its mean length being the length of the lead-in and rattails, plus one-half the length of the flat top. Hence, under certain conditions, as for instance, where two tall trees or other elevations may happen to be available, the whole may have to be exceptionally long for the requirements in question, then the inductance may be reduced by using a "T" connection, thus giving a lower operating range of wave lengths for the whole antenna. The inverted "L" type aërial is fairly *directive* in its activity, and Fig. 3 shows the maximum directive effects both for transmitting and receiving. As Fig. 3 shows, where there are two inverted "L" antennae in use at two stations working with each other, such as in trans-Atlantic radio telegraphy, then the two inverted "L" aërials should point away from each other. In other words, maximum transmission or reception takes place *in a direction opposite to the free end* of this antenna, as the arrows indicate. Also, the longest distance station you wish to receive from should be in a direction opposite to that in which the free end of the aërial points, or in a direction pointing away from the knee.

There are two new forms of antennae, which will warrant considerable experimentation on the part of the Radio Amateur Fraternity, as they possess many very desirable features. They materially reduce the construction labor and expense, not to mention the danger in windstorms from the destruction of masts, etc., and furthermore these new aërials can be used during thunder-storms, which has never been the case with the best of overhead antennae. The aërials of which we speak are the *surface* and *underground* antennae.

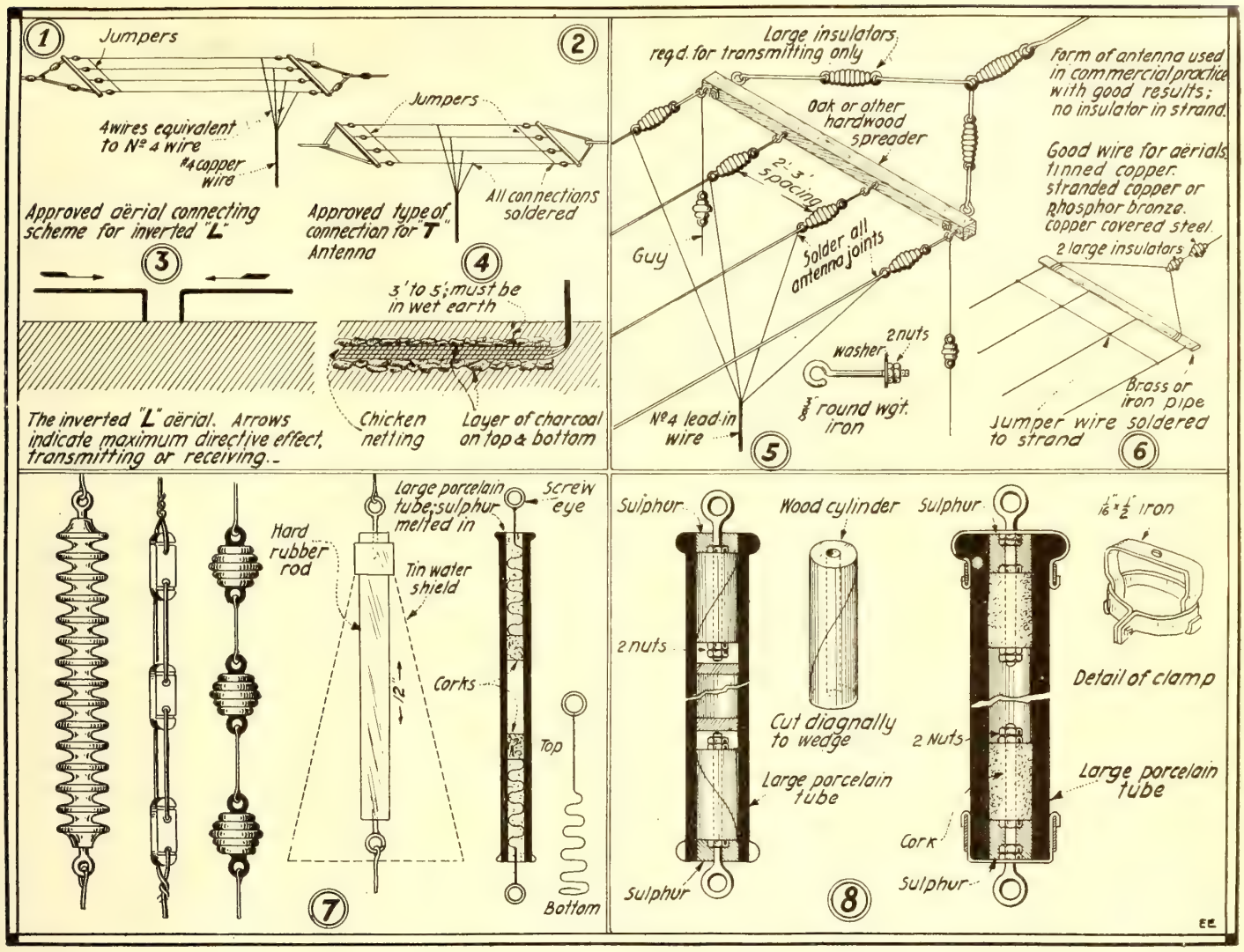
Not very much has been said in print concerning the *surface* antennae, which is formed of several insulated wires laid on the ground and then connected to the apparatus, which apparatus may or may not be connected to the usual ground. But very excellent work has been accomplisht indeed with these aërials by Dr. Taylor, of the University of North Dakota. Messages have been received over distances of several thousand miles with aërials of this type.

The other form of ground aërial, namely the *underground and underwater antennae,* devised by Dr. James Harris Rogers, of Hyattsville, Md., possesses many very meritorious and heretofore unobtainable features, such, for instance, as permitting the reception of radio messages right thru heavy thunder-storms, when the static in regular elevated antennae was so severe that sparks would jump clear across the aërial switch, eight to ten inches long.

In the present article we will deal more with the construction of the *elevated antennae,* as it will undoubtedly be used for a considerable time by Radio Amateurs and Experimenters, owing principally to the fact that it is rather difficult for amateurs to construct a sufficiently well-insulated Rogers underground or Taylor surface antennae, which will hold the charge of several thousand volts from a transmitting set, without breaking down the insulation to earth and thus destroying its efficiency. We would refer the reader to the original article on the Rogers underground antennae by the writer in the March, 1919, issue, and for those who reside in cities or other congested districts and cannot run a long wire in a trench and bury it without being arrested by an ever present "blue-coat," the student so situated will find much consolation in a later article prepared by the writer in collaboration with Dr. Rogers, entitled "The Rogers Underground Aërial for Amateurs," which appeared in the June, 1919, issue, and wherein various forms of spiral antennae which can be used in the operating room or else buried in wells, brooks or down in the cellar, were described. Two other articles in this direction should be carefully studied by the student, the first being "Loop Antennae and Direction Finders for Amateur Use," which appeared in the August number of the *Radio Amateur News,* and the second article, "Concentrated or Loop Aërials," by Prof. Lloyd M. Knoll, A.M., appearing in the August, 1919, issue



Up Goes the Antenna—the Radio Amateur's Heart Now Beats With Joy, for Soon He Will Be Listening to the Etheric Messages from Stations Hundreds and Even Thousands of Miles Away.



Many Practical Hints on Radio Antenna Design and Construction Are Here Illustrated and Described in the Text. Data Are Given for Calculating the Wave Length of a Given Size of Aerial, as Well as Direct Reading Graphs. See Cut Below.

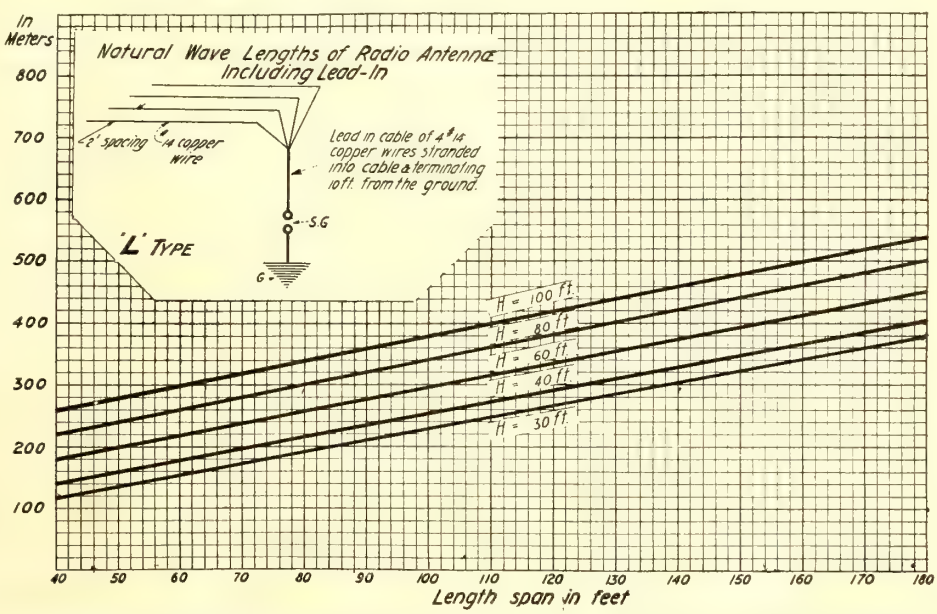
of the ELECTRICAL EXPERIMENTER Magazine.

WAVE LENGTH OF ANTENNAE.

Undoubtedly the first question that the Radio Experimenter will ask in relation to the antenna which he intends to buid is: "What will the wave length of my antenna be?" In the first place, and altho it might seem almost paradoxical to make such a statement, it may be said that radio experimental stations use antennae of all sizes. You may find that the owner of one station is interested, as a great many are, in receiving or trying to receive signals from the high-power European stations, such as Nauen, Germany; Lyons, France; Rome, Italy; or Carnarvon, Wales, England. Therefore, when such is the case, you will probably be surprised to see an aërial, either underground, surface or elevated, ranging away from the station for a distance of possibly 1,000 to 4,000 feet!

These high power stations are using wave lengths almost beyond the dreams of our most eminent radio experts of pre-war days. Wave lengths used by these stations in various parts of the world, including the United States, run up to 10,000, 12,000, 15,000 and 20,000 meters quite frequently.

Before going further, we should consider most probably the size of antenna required in a Radio Amateur station, where a *transmitting set is to be used*. If the new rules for Radio Amateur stations, when they are opened shortly by the Department of Commerce or by the Navy Department, follow those of pre-war days, then the majority of the transmitting stations, in view of the fact that they will be able to transmit over the state border line, will have to be *licensed*. Whether they are licensed or not, however, the transmitting wave length must not exceed 200 meters under the old rule. Unless an inefficient, energy-wasting *series condenser* is to be used in the ground lead in the aërial oscillatory circuit, then, in order to radiate a wave length not exceeding 200 meters in length, the antennae to be employed can hardly exceed 80 feet in length for the flat-top, with an altitude of 50 to 60 feet, (*Cont. on page* 462)



Direct Reading Wave Length Graphic Chart for Various Lengths of Four-Wire Antennae. What Is the Natural Wave Length of an Inverted "L" Aerial 100 Ft. High, 120 Ft. Long? At 120 on Lower Scale, Look up Line Till It Meets Diagonal Marked H = 100 Ft. Follow Horizontal Line to Left, Giving 420 Meters as Wave Length in This Case.

Eccentric Antennae

By EUGENE DYNNER

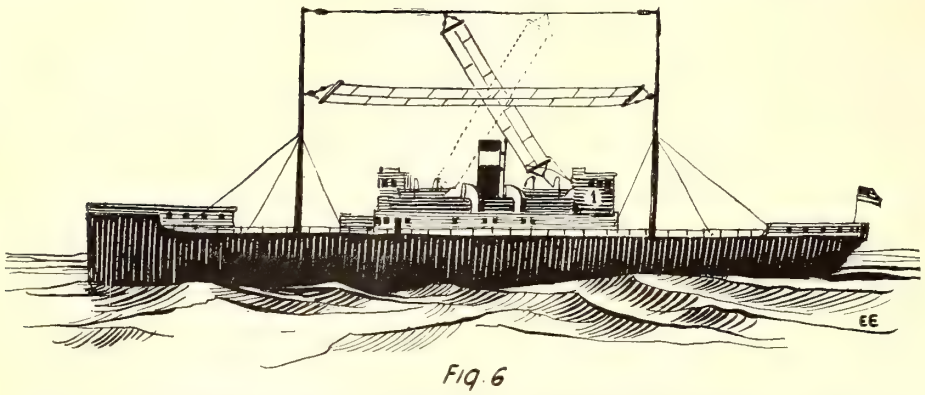


Fig. 6

Novel Form of Eccentric Antenna Tried Out on Ship-Board by the Writer. This Aerial, as May Be Seen, Is of the Cross-Connected Type. With This Form of Antenna, There Was Approximately 50 Per Cent Increase in Strength of Signals Over a 1,500 Mile Range.

SOME time ago experiments were made to develop an antenna which should give the maximum efficiency in reception of radiotelegraphic signals without necessitating the use of expensive apparatus. The first distinctive aërial developed was the one depicted in Fig. 1. This antenna consists of three wires which are connected together at intervals in length twice the width of the spaces between the wires, and measured in such fashion that one of the rectangles formed ends at the center of the adjacent one.

The receiving transformer used was of a special design, consisting of one stationary and three movable coils (Fig. 5). Coil 1 is a primary into which secondary No. 3 may be moved. Coils 2 and 3 also form a primary and secondary which may be brought closer to primary No. 1 or drawn further away. No taps are taken off, there being a double variometer action. A plain galena detector gave excellent results. The entire apparatus was connected as per Fig. 4. Condensers 5 and 6 are of .001 mfd., and condenser No. 7 may be a smaller one.

Using antenna No. 1 with this hook-up, there was an increase in efficiency of about 40 per cent. With coil 2 eliminated and 4 slid inside of 3, a decrease in wavelength resulted and the efficiency was increased about 5 per cent. when an audion was substituted for galena. Efficiency is calculated from results obtained by the use of an ordinary well-built loose-coupler with possibilities for variations by single turns. To test efficiency a device described several years ago in the ELECTRICAL EXPERIMENTER was employed.

With the loose-coupler in circuit and antenna No. 1, it was found that somewhat sharper tuning was accomplisht and signals were louder than those received with the ordinary type antenna.

Antenna No. 2 was found to cause a waste of energy, until the distance between wires 1 and 2, 2 and 3, etc., were separated at least 15 feet. This cage-like contrivance was 150 feet long. Even when this proportion was establisht the increase of efficiency over antenna No. 1 was less than 5 per cent., working under the same conditions.

This Flat-Type Cross-Connected Aerial Showed an Increase of 40 Per Cent in Efficiency When Used With the Receiving Coupler Described

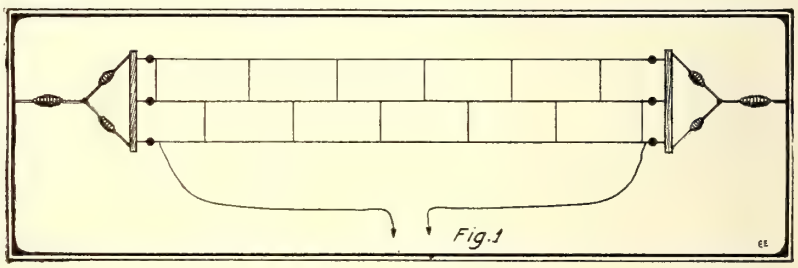


Fig. 1

A composite antenna and "ground" was built, No. 3, which gave excellent results. This arrangement, however, was found most efficient where the capacity of the two bodies was different. Putting the ground above the antenna gave a slight decrease in loudness of signals with broader tuning.

With the antenna depicted in Fig. 6, there was approximately 50 per cent. increase in strength of signals over 1,500 miles away—in direction opposite upper end of vertical antenna—was obtained. Addition of another section of antenna built in direction opposite to first one, gave the same strength in both directions.

In all cases the leads as indicated on diagrams were found most satisfactory. Substitution of single wires for three wire antennae gave practically the same results where the sections were over 300 feet in length, and reception was from stations using wavelengths of over 2,000 meters. For shorter waves the three-wire arrangement was found best.

The United States Navy is using extensively a type of aërial that has been developed in England, and which is used on all her battleships and destroyers. It is termed the "Barrel" type on account of its shape, which is cylindrical. On American battleships, it is anywhere from 75 to 150 feet long. On the smaller type of boat, the aërial must necessarily be much smaller. It consists of six wires arranged in barrel formation and supported every eight feet by three pieces of light bamboo, crost in the shape of a six pointed star. These pieces of bamboo may be of any length, thereby giving the aërial any diameter desired. The diameter is usually determined by the length. On our battleships the diameter of the barrel is anywhere from one to two feet. It may, however, be decreased to six inches for a very small antenna.

For the wire composing the aërial, the United States uses its standard phosphor bronze wire. This wire has been found to be the most efficient in every way. It does not corrode, neither does it rust nor deteriorate in other ways, as the usual kinds of wire do. One big trouble heretofore has been corrosion of the wire in the aërial, due to the action on it of the gases from the smoke stack directly below.

The English government, with whom this type of antenna originated, uses an entirely different kind of wire. They use ordinary copper wire of about No. 12 or 14 B. and S. gage. The bare copper wire is treated with a coat of black enamel, which is made from a specially prepared formula. The enamel coat does not detract from

(*Continued on page* 470)

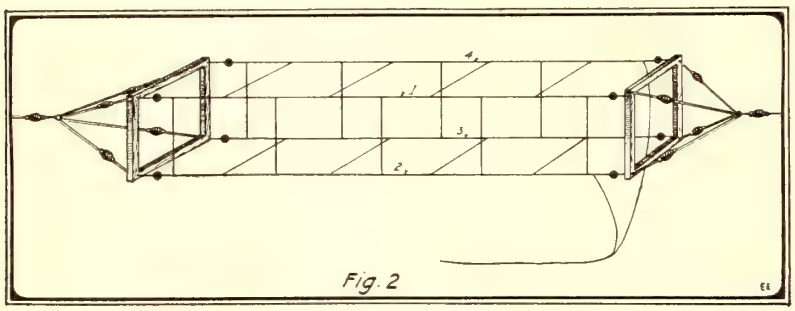


Fig. 2

One Form of Cross-Connected Antenna Tried Out by the Writer With Gratifying Results. The Individual Wires Are of Course Carefully Insulated as Shown.

Novel Composite Antenna and "Ground"—This Design Gave Excellent Results, Says the Author. Placing the "Ground" Above the Antenna Gave Slightly Lower Efficiency.

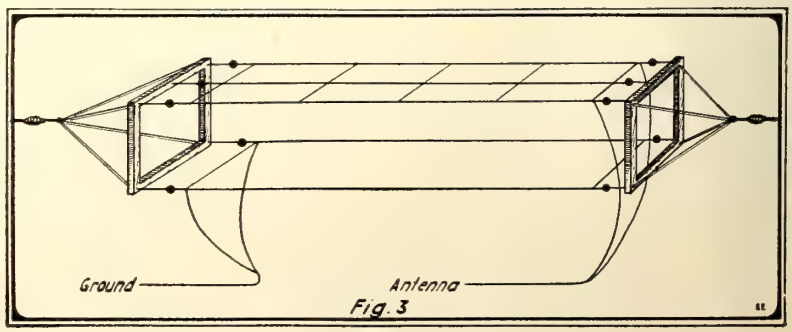
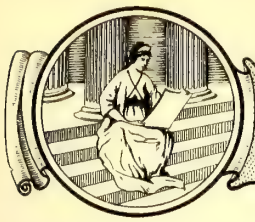


Fig. 3



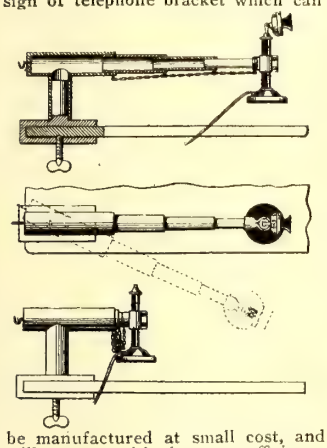
LATEST PATENTS



Telephone Bracket.

(No. 1,288,611, issued to Edward T. Jones.)

This represents a very simple design of telephone bracket which can

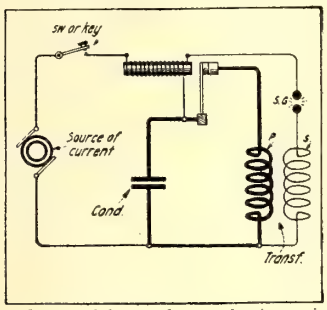


be manufactured at small cost, and still operate with the same efficiency as some of the more expensive and elaborate telephone devices of this character now on the market. The device comprises a series of telescoping metal tubes, which slide into one another when the bracket is to be collapsed, in the manner apparent. A chain is fastened to the successive telescoping sections so that they cannot be put out of alignment or beyond their limit.

Electric Igniter.

(No. 1,307,854, issued to William and Philip Dubilier.)

An electromagnet interrupter is used in conjunction with a condenser

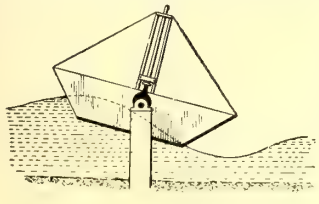


and a special transformer having primary and secondary windings, the primary of which is connected with the interrupter and condenser in such a way that this circuit becomes a tuned oscillator whenever the vibrator is in action. This circuit, in conjunction with a magnetic interrupter, is used to throw a spark across the gap shown, the line current maintaining an arc across the gap.

Wave Motor.

(No. 1,307,095, issued to William Gregersen.)

A surf or wave motor in which the float or body shown is made in the form of a boat pivotally supported, so as to rock with the rise and fall of the wave, and thereby operate a mechanism arranged to rotate a shaft in a continuous circulatory fashion. It is understood that two or more of these wave motor members may be used of course at one location, so as to give a much steadier rotative

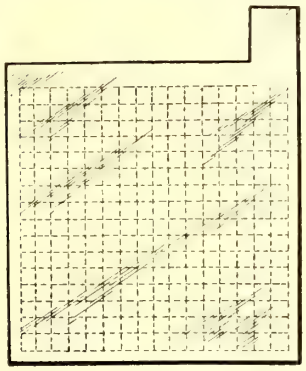


power to the main power shaft, and also to increase the amount of power developed in any instance. The rising and falling float is provided with suitable arms, connected with a set of pawl wheels and ratchets.

Storage Battery.

(No. 1,306,214, issued to Richard J. Crowley.)

A clever scheme providing for a new departure in the manufacture of storage battery plates or grids, having an active agent consisting of lead oxid and aluminum sulfate, and a method of producing a battery plate or grid paste of this compound. One object is to provide a battery element which will permit charging and discharging at a rapid rate without injury to the plates; providing a higher voltage at a heavy discharge and having a greater capacity in ampere-hours than other

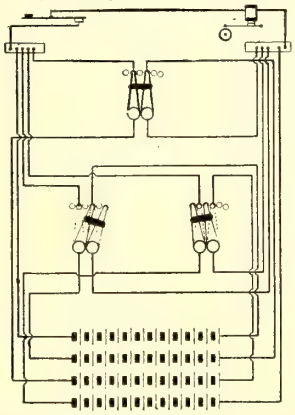


lead cells. Positive elements so made are said not to disintegrate as rapidly as peroxid of lead positives. The electrolyte used may be composed of sulfuric acid and water, but better still it is formed with an acid sulfate of aluminum. This is adaptable for transportation as a solid and only requires the addition of distilled water to form an electrolyte.

Battery Switch.

(No. 1,306,147, issued to Simon B. Hess.)

One of the principal objects of this invention is to provide a battery switching system by means of which large ampere-hour capacity may be obtained for using dry cells. Further, by the switching scheme here provided, it is possible to change the voltage of the battery system at any time without changing the original battery installation in any way. Again, it is possible to connect in

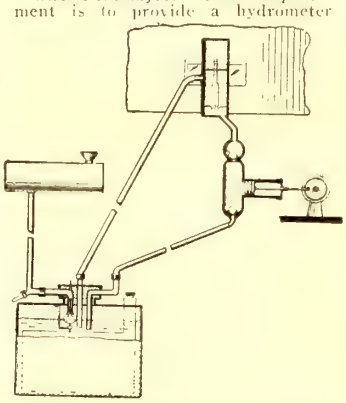


circuit fresh cells for exhausted ones without disturbing the circuit. When the battery system gives out entirely, and becomes no longer possible of manipulation adequate to increase the voltage, anyone not acquainted with the art will be enabled to readily replace old with the necessary new battery cells, and again make the system operative, owing to the simplified connection scheme shown.

Sight Storage Battery Tester.

(No. 1,308,223, issued to Ernest Camp.)

One of the objects of this improvement is to provide a hydrometer

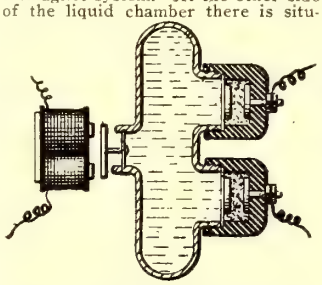


chamber having a connection to the storage battery cell, providing a means whereby the liquid electrolyte may be drawn into the hydrometer chamber, so that the electrolyte may be tested. The testing chamber may be placed upon the dash panel of the car so that the condition of the battery may be examined at any time. A further idea provides a means whereby distilled water may be supplied in small amounts from time to time.

Water Telephone Relay.

(No. 1,306,248, issued to Edward E. Clement.)

At one side of the liquid chamber shown there is placed a diafram actuated by a telephone receiver electromagnet system. At the other side of the liquid chamber there is situ-

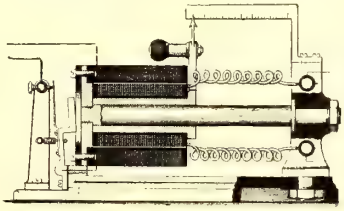


ated one or more microphones. When an incoming sound current passes thru the receiver, it actuates the diafram and corresponding vibrations are transmitted thru the liquid, which may be water.

Induction Coil.

(No. 1,307,093, issued to Benjamin Fulton Gardner.)

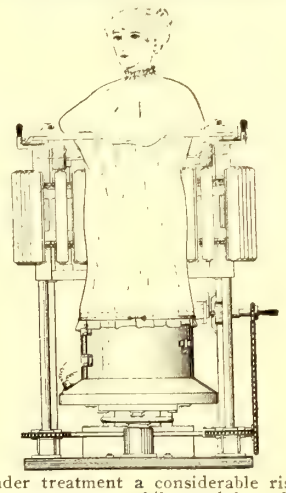
A reversible transformer for the purpose of stepping down or up either alternating current or direct current. There are two coils wound about an iron core and fitted with a vibrator. The outer coil is wound with fine wire and the inner coil is wound with coarse wire, the inner coil being movable along the iron core. A scale is provided so that the strength of the current may be watched as the regulating coil is moved along the core. The device can be connected to any lamp socket.



Electrical Reduction Apparatus.

(No. 1,305,439, issued to William E. Brennan.)

Those having a corpulent form, whether male or female, will be interested in this reducing apparatus invented by Mr. Brennan. One of the principal features of this apparatus lies in the use of an electric heating cell at the base of the structure, in order to give the person

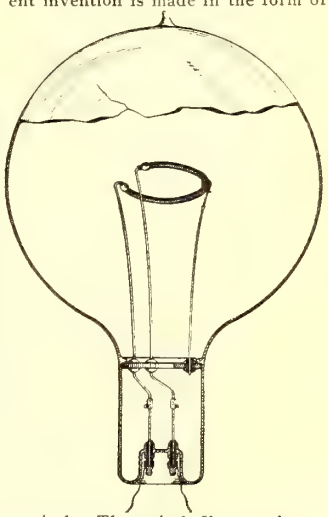


under treatment a considerable rise in temperature while applying the massaging action by means of rotating wooden bars, shown in the illustration. As the inventor points out, any treatment of this nature for reducing the size or weight of a person is much more effective, and the results are more quickly and easily obtained, where the body is heated as well as massaged.

Improved Tungsten Lamp.

(No. 1,306,259, issued to Frederick G. Keyes.)

An improved design for tungsten lamps of high candlepower and suitable for operation on low voltage and high ampereage, in contradistinction to the usual form of high-voltage lamp. One of the features of this lamp resides in the mode of securing proper sealing of the lead wires and the anchors supporting the tungsten filament, which in the present invention is made in the form of



a spiral. The spiral filament is attached at its end to two lead wires made of copper sheathed with iron, the copper being utilized for its good conducting qualities, and the iron being employed for its rigidity, to prevent bending or distortion of the copper wire under the influence of the high temperature developed within the globe.



WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

The Editors desire to call to the attention of all owners of "Electrical and Chemical Laboratories" the fact that hereafter the MONTHLY PRIZE WILL BE $5.00 CASH, instead of $3.00. ALSO $2.00 CASH WILL BE PAID TO EACH "HONORABLE MENTION" ENTRY PUBLISHT. We have not received any "Laboratory Photographs" of late. So "go to it" and send us your photo, together with that of your laboratory. If they are particularly good we may list some new and bigger prizes. So get busy, Boys!!! It's up to you. Here's a way to earn some greatly wanted laboratory apparatus at no cost whatever. Don't be afraid to send in too many photos, Boys.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER—STANLEY C. REED

HEREWITH are three photographs of my electrical laboratory. I am sixteen years of age and have had my laboratory two years. I have a 6-volt storage battery, two Tesla coils, spark coils, a dynamo and a number of small motors.

I have a fairly complete wireless "Demonstrating Set" with seven-foot aërials, about ten feet apart. The receiving set consists of a coherer outfit and a detector set with a 75 ohm receiver.

I find the study of magnetism very interesting. I have made many magnets, compasses, galvanoscopes, galvanometers and similar instruments. Also my laboratory contains a chemical department in which I test soils, water, and perform other interesting experiments. In my experimental work I am guided by a library of thirty-five scientific books and the ELECTRICAL EXPERIMENTER.—Stanley C. Reed, Lennon, Mich.

HONORABLE MENTION—THEODORE FREDRICK $2.00 PRIZE PAID EACH "HONORABLE MENTION"

HEREWITH I present four pictures of my chemical laboratory, which is very complete, containing all apparatus used in general chemistry. I spend a great deal of my time in qualitative analysis including analysis of foodstuffs, and most everything else. My laboratory contains an electrical rectifier which I have constructed from an article publisht in the ELECTRICAL EXPERIMENTER. I use this in working experiments in electrolysis, such as making potassium chlorat, sodium hydroxid, etc. I have constructed an electric furnace with which I perform experiments in making alloys and castings. My chemicals number about two hundred and fifty, including salts of most of the metals, and I have about one hundred and seventy-five pieces of apparatus. I have also constructed a large Oudin coil, the top of which can be seen under one of the tables. I have performed a great many interesting experiments in high frequency such as described in this magazine.—Theodore Fredrick, 924 Chicago Avenue, Evanston, Ill.



Science in Slang

By EMERSON EASTERLING

"I'M sure glad that station is up and going," remarked Stokes as we motored in from the power plant site.

"I saw a bunch of stuff in the cement houses," put in Punk, "but I'll be flopped if I can make it all out."

"It's more or less a long story," returned Jazz Stokes, "but I'll make it short as possible and still get you birds out of the dark on the subject.



We All Know that Tommy Edison Lost a Lot of Sleep Fiddling Around Over a New Kind of Illumination—the Electric Light. We Used Direct Current then But Nick Tesla Stept in and Gave us "Altering"—Excuse us —Alternating Current.

"We all know that Tommy Edison lost a lot of sleep fiddling around over a new kind of illumination—the electric light—back some years ago. Well, the next thing to do was to make it possible for the neighbors to have the product of his perspiration and inspiration, so he sticks up the primitive central station in the Knickerbocker Burg. The result is that one thing leads to another and now we have 'em all over the sphere.

"Back in the old days they used direct current. Then it was that Nick Tesla steps in and gets disgusted with the layout, kicks out the old stuff and pulls a new one on us. The stunt takes the form of *alternating current.* Nick gets his visionation working and pictures to himself—O, well, anyway he constructs a generator that fools the polarity indicator, and makes it possible for the generator to be farther away from the consumer and yet not have to strain itself to get the juice to the destination."

"How is all this?" asked Bender.

"It's this way," said Stokes, "this alternating current stuff was a new one on the public. The armature in the generator passes thru consecutively opposite magnetic fields and the current therefore goes shooting one way, croaks, and goes flopping back the other way. The speed and number of poles has to do with the frequency of the current.

"Here we put Mike Faraday's induction stuff to some real use. Mike found that if a current be made to pass thru (or over, which way he had it) a wire and another wire be placed parallel, a sort of sympathetic flow will present itself in the second wire; in the other direction. By winding many layers of wire around an iron core—for the iron core makes an easier path for the magnetic flux; the inductive flow is resultant from the induced magnetic field set up by the primary current—of both wires the result is found to be better than to lay the wires stretched out straight. It can be easily seen that the more concentrated flux would act more efficiently than the sparse flux that would course around the extended wires.

"It was found also that if the secondary be wound with smaller wire—more wire being used to make up the mass—that the voltage would be higher in the secondary. If the secondary be wound with larger wire the effect was found to be opposite. All this stuff worked out mathematically to a jot."

The Altering of the Alternating Current

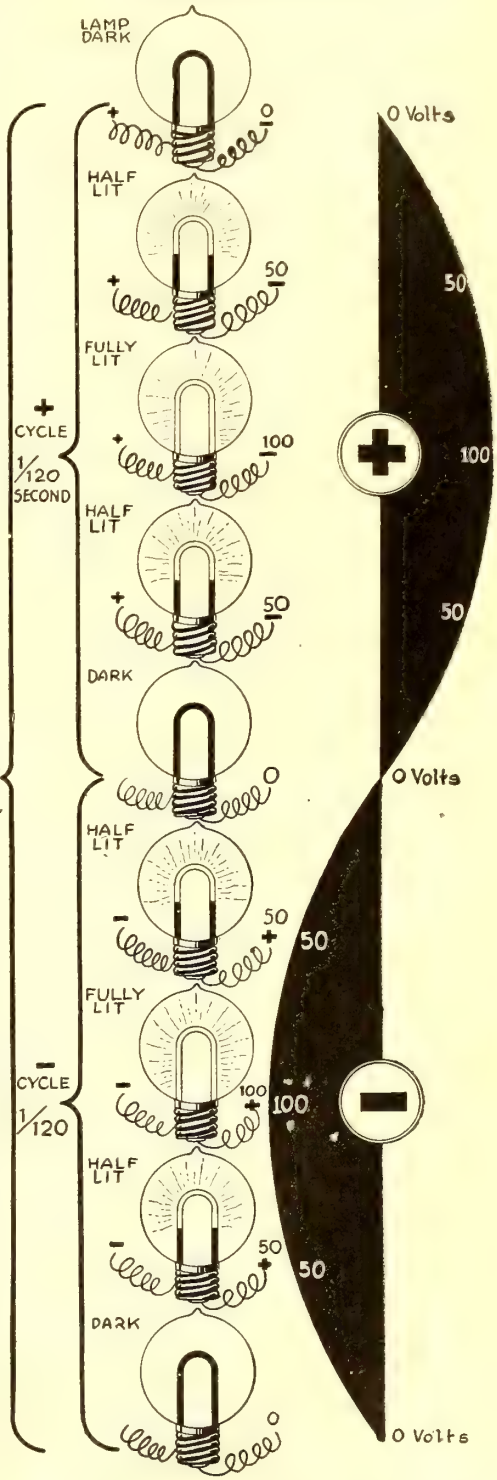
"That all sounds like real spiel," sang out Bender. "But how is it that if the alternating current flops back and forth from positive to negative so many times a second, as you say it does, that we do not perceive any flicker in the incandescent gas bottles, better known as incandescent lamps?"

"Well, as I was going to say," continued Stokes, "several important things happen in producing radiant light from an incandescent lamp after the manner of Tommy Edison's invention. Probably the best way to understand just what happens in the incandescent lamp and why you do not see the flicker when the current pulsation does a one-step, and changes from positive to negative in the twinkling of an eye, is best shown by a drawing." Stokes then took a pencil and pad from his pocket and continued: "Here on the right we have an undulating line known as a *sine wave curve,* and which represents the rise and fall of a single phase alternating current thru two alternations, *or one cycle.* The current at a given instant starts from zero and rises to 50 volts, then 100 volts or 110, whatever it may be, maximum positive value; immediately afterward the positive current impulse starts down hill toward zero again, doing it very smoothly, yet with great speed. The juice makes a complete rise and fall thru *one alternation* or one-half cycle, in 1/120th of a second. Then it passes thru the *dead* or no-current point, also called the zero point, and starts to increase in strength, but in the *negative* (opposite) direction. These negative current pulses, running thru 1/120th second, pass thru the successive rise and fall potentials as you will see, reaching the end once more—this is called *one* cycle by electricians. A cycle comprises two alternations, or a complete reversal from positive to negative. By drawing the various degrees of illumination in the incandescent lamp at different stages thru the cycle, you will at once see how the filament rises from a *dark* condition at the start of a given cycle, increases in temperature and luminosity as the voltage increases thru the *positive* alternation, and finally becomes *dark* again as the current passes thru the first zero point. As the *negative* alternation starts to increase in potential in the next 1/120th second, the filament temperature again rises to a maximum with a consequent full luminosity, and then falls thru successive stages of brilliance until it becomes *dark* once more, as the current passes thru the second zero point at the end of a cycle. This action keeps up repeatedly."

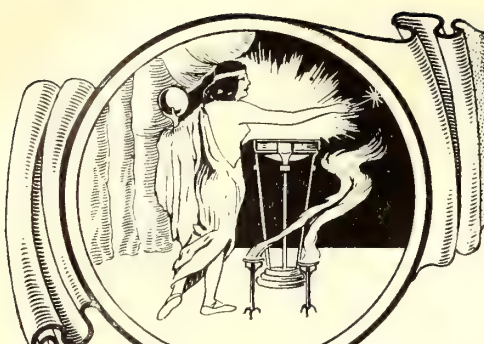
"Yes, that is all very fine," interrupted Bender, "but I don't understand yet, why it is that we do not see the lamp passing thru the dark periods in the cycles. One one-hundred twentieth second is not very fast, and the human eye is supposed to be one of the most wonderful high speed mechanisms in all Nature."

"I was coming to that," bawled Stokes, "if you would have allowed me another minute to catch my breath. Apparently you have forgotten some of your physics, Bender, and on second thought you undoubtedly will agree with me, if you will stop to remember that due to the *retention* of the 'image' on the rod and cone layer of the light sensitive portion of the eye, there is a peculiar action which takes place, causing the image thrown on this element of the eye to be retained for a short but quite appreciable period. Thus it is that

(*Continued on page 444*)



How an Incandescent Lamp Lights Up and Passes Thru the Half Cycle "Dark" Periods When Supplied with "Alternating Current." The "Dark" Periods Are so Short in Time "Duration" that the Eye Does Not Notice Any Flicker.



THE ORACLE

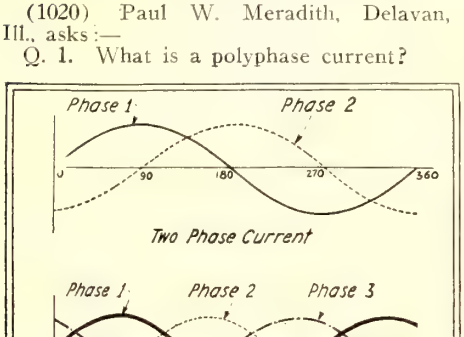
The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, **a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.**

WHAT IS A POLYPHASE CURRENT?

(1020) Paul W. Meradith, Delavan, Ill., asks:—

Q. 1. What is a polyphase current?



Graphic Curves Showing Difference Between Two and Three Phase Currents. A Polyphase Current is One Comprising three or More Alternating Currents, Spaced Apart on the Time Axis in a Regular and Definite Ratio, Such as Here Illustrated.

A. 1. We must say that this is a very broad subject. You will do very well to consult your library and look up some good works on A.C. current. A very simple explanation, and one which you can readily understand is given in the book entitled, "Alternating Currents—Theory, Practice and Diagrams," by Horstmann & Tousley; also another very excellent work is that entitled "Alternating Currents," by Branch.

We give you herewith illustration showing the relation of the three distinct currents making up a three-phase polyphase system. The three-phase current may be transmitted by six wires or three wires, this system being the usual one in everyday practise. A polyphase current is one composed of two or more distinct, single-phase currents co-acting in a circuit in a certain particular relation to each other. In a two-phase system there are two alternating currents generated in two distinct windings in the alternating-current dynamo; one of these currents is 90 degrees ahead of the other. In a three-phase system there are, as the graph herewith shows, three separate alternating currents generated in three distinct windings on the rotor or stator, as the case may be, of the alternator, and each of these currents is 120 degrees ahead of the other. When one of these polyphase currents enters the windings of an A.C. motor, it sets up a rotating magnetic field of constantly changing polarity, as may readily be imagined, and this drags around the rotor, due to the fact that north and south magnet poles are induced in the iron poles of the rotor, which are repelled and attracted by the suddenly changing north and south magnetic poles of the stator in exactly the same manner as in a direct-current motor.

Your understanding on the subject of D.C. motors most probably makes clear the fact that if it were not for the commutator and brushes connected with the armature or rotor circuit of the D.C. motor, that it could never rotate, and the sole function of the commutator and brushes on such a machine is to suddenly change the polarity of the magnetic poles or fields surrounding the armature, as these poles approach the respective north and south poles of the stationary field.

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New stations, both commercial, government, and private. Owners of private or amateur stations will find a special contest for these photos on another page of this issue. And don't send us plate or film "negatives"; send unmounted or mounted "prints", preferably a light and dark one. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation.

Address photos to—Editor "Odd Photos", Electrical Experimenter, 233 Fulton Street, New York City.

ONE-INCH SPARK COIL.

(1021) D—— Brothers, East Lynn, Mass., writes:—

Q. 1. Asking for data on spark coil and underground antennae.

A. 1. Regarding data which you request on underground wireless, we would refer you to the June 1919 issue of the ELECTRICAL EXPERIMENTER wherein you will find a special article by H. W. Secor.

For size of coil which you wish to use with four cells of dry battery, we recommend the following:—

Core about 8 inches long, 1 inch in diameter, properly insulated with a fibre tube having about two to three layers of No. 14 D.C.C. magnet wire wound on same. Over these two or three layers of empire cloth and another insulating tube on top of this, wind about No. 38 S.C.C. magnet wire so as to make the coil about 4 inches in diameter when complete. The coil when operated will give about 1 inch spark.

For information on the construction of spark coils, we would recommend a very excellent book, namely: "Design and Construction of Induction Coils," by Collins, $3.25 prepaid.

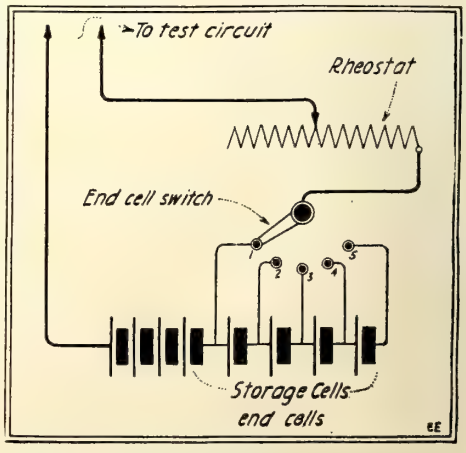
CONSTANT POTENTIAL TESTING CURRENT

(1022)) Oliver V. Austin, Ellisville, Miss., wants to know:—

Q. 1. How can I obtain an absolutely constant testing current from a storage battery?

A. 1. Would say that there is no ordinary method available, to our best knowledge, for maintaining a constant potential from such a source, except by means of a rheostat in the circuit, and also by the provision of a so-called *end-cell switch.*

An end-cell switch is a multi-point switch, connected at the end of the series of cells, and so arranged that as the voltage falls from the battery that other cells one by one can be switched in the circuit, and then the final graduations of potential are compensated for by means of a finely adjustable rheostat connected in series with the battery, as here illustrated.



Method of Obtaining Constant Potential Current from a Storage Battery by Means of an End Cell Switch.

Why Electrical Workers Are Needed.



Consider for a moment what part electricity plays in every-day life, in the comfort, convenience, pleasure and even health of the whole civilized world.

Think of having to ride in horse cars again—

of writing a letter every time you now phone—

of waiting days for what the telegraph does in a few minutes—

of no automobiles or moving picture shows—

Electricity takes millions to and from work. Without it the automobile and airplane would be impossible—the telephone and telegraph would be useless. All the civilized world relies on it for light, heat, transportation and communication. In a thousand ways electricity is used in factories, offices and in the homes.

Electricity is almost as essential as the air we breathe. Business would be almost at a standstill if deprived of its energy.

To say that electricity is still in its infancy is no exaggeration. Every day brings into practical use some new method of controlling it, some new device or appliance for using it. In industrial work there are still scores of operations where electricity will be utilized sooner or later. The day is coming when the railroads will entirely replace steam with electricity. Doctors, dentists and scientists are only beginning to realize the possibilities af electrical energy.

These facts merely touch the high spots, yet they prove beyond a doubt that electricity plays a vital part in business, in our individual lives, and that there is unlimited scope for those who make electricity their life work.

The electrical worker provides other men light to work by, the telephone and telegraph to convey their orders, the power to run their machines and transport their goods. He supplies power in the homes to operate washing machines, vacuum cleaners; for ironing, heating and ventilating. In short, it is the electrical worker who makes it possible for the world to live more comfortably, to enjoy more pleasures and to do a bigger, more profitable business.

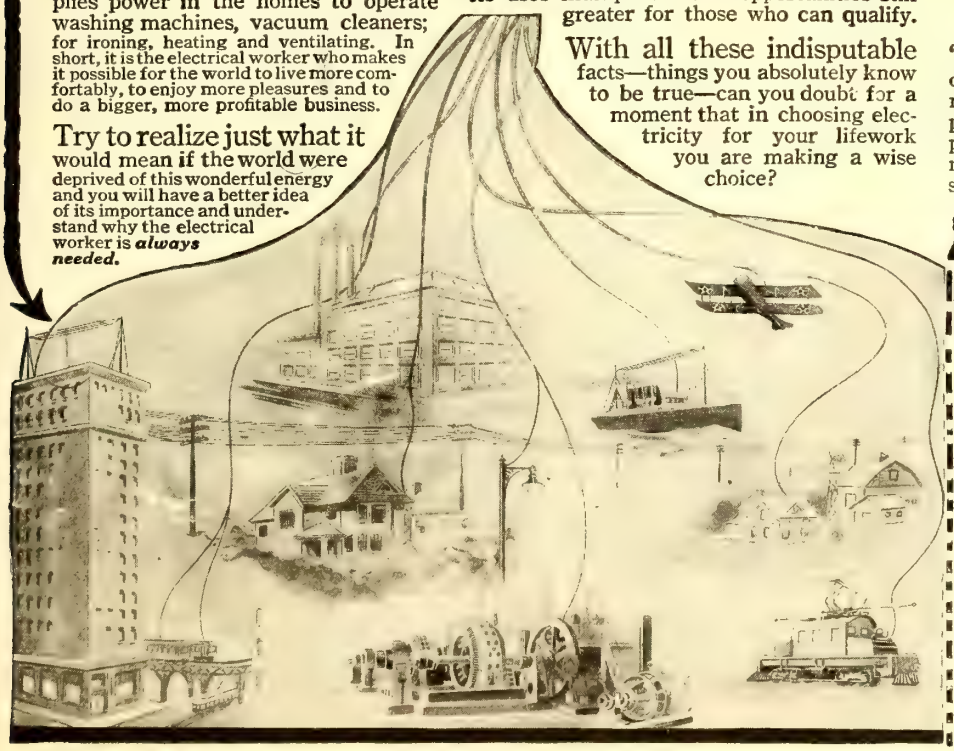
Try to realize just what it would mean if the world were deprived of this wonderful energy and you will have a better idea of its importance and understand why the electrical worker is *always needed.*

What Electricity Offers You

Once you have mastered the A-B-C of electricity you are confronted with unlimited opportunities for advancement. You can specialize in extending and perfecting the wonders already accomplished in the field. You may take up those branches of electrical and mechanical work which cover the design and manufacture of electrical apparatus or start in to qualify for a well-paid position in the designing, construction, operating or consulting branches of the electrical engineering profession, and to fit yourself eventually for a position as Distribution, Operating, Testing, Erecting or Designing Engineer.

In the automobile, airplane, telephone and telegraph lines there is also great scope for the trained electrician. Many wonders of electricity have yet to be unfolded—its uses multiplied—and opportunities still greater for those who can qualify.

With all these indisputable facts—things you absolutely know to be true—can you doubt for a moment that in choosing electricity for your lifework you are making a wise choice?



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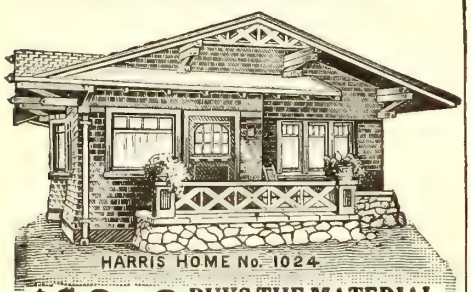
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Experimental Mechanics

By Samuel D. Cohen

(*Continued from page* 423)

favor with all users of reamers. The eccentrically relieved reamer is purely a finishing reamer, and cannot be used with advantage to remove any considerable amount of metal. When hand reamers are used merely for the purpose of removing stock, or simply for enlarging holes, the flat relief will undoubtedly prove to be superior to the eccentric. The primary use of straight hand reamers, however, is for producing holes true to size and smoothly finished, removing meanwhile but a small amount of stock. For this purpose nothing excels the eccentric relief. That there are a number of different classes of reliefs required, according to the use to be made of the reamer, is best proved by the fact that while some manufacturers of tools relieve their reamers eccentrically, intending them to be used as finishing reamers, some of their customers place them in a grinding machine and replace the eccentric relief with a flat one, because they find this relief better for their purpose, viz., simply enlarging holes irrespective of the highest requirements of accuracy and smoothness.

A regular cutter and reamer grinder is often used for grinding reamer teeth. See Fig. 5. Another method is to utilize an electric grinder held in the tool post of a lathe, while the reamer is held between the lathe centers. The most economical and best results are obtained when using a grinding machine, made for this purpose. The sharpening or backing off of reamers in a lathe is unsatisfactory and should never be resorted to unless no other means are at hand. Sometimes it happens that a large reamer must be sharpened, the diameter of which is either too long or too short for the capacity of a grinder. In such a case the electric grinder used in a lathe will prove satisfactory. Of course, from the experimenter's point of view, the only means at hand for him to grind his reamers will be the lathe and electric grinder.

The amount of clearance that a reamer tooth should have depends largely upon the class of reamer and its size. A suitable clearance for reamer teeth, exprest in degrees (the face of the tooth being radial), is not a fixt number, but varies for different diameters, and the smaller the reamer the greater the angle of clearance should be. Hence, if the cutter and reamer grinder are set to grind the right amount of clearance on a large reamer, a smaller reamer would not have a suitable clearance at that setting.

(*To be continued*)

How the R-34 Crost the Atlantic

(*Continued from page* 404)

fying audion and sending outfit he has been able to send and receive a distance of 1,200 miles by actual test, he being off the coast of the Azores at the time, communicating with the British Air Ministry at London. The auxiliary outfit is capable of sending 800 miles. In addition to this there is an ordinary spark coil outfit, utilizing but a small amount of current, which has covered a range of 300 miles. This seems rather unique, inasmuch as it is seldom that small spark coil outfits ever cover such a great distance. But according to Lieut. Durrant, it is a fact, and is recorded in the ship's "log." In addition to these outfits there is a "Wireless Telephone" instrument device, which can be connected to the auxiliary wireless outfit, and when so connected, forms a part of this auxiliary outfit, by means of which wireless telephonic communications have been sent and received while in flight.

In back of the Radio Room is the engine room of the forward gondola. This, like the other gondolas, contains a high-powered gasoline engine, which, however, is greatly geared down, the power of each motor being about 275 H.P. An oiler and a mechanic are in charge of these engines constantly, both day and night. Amidships are two gondolas, each of them containing an engine and its respective propeller. The rear gondola has two such engines geared to a single propeller so that either one or both may be operated at the same time. Energy for electric lights is derived by special dynamos each connected to an engine; these dynamos furnish the light for the respective gondolas, and are connected in such a way as to allow any one of them to furnish the electric current thruout the entire ship if necessary. The energy for the wireless station is derived from the main engine. From each gondola there is an aluminum ladder enclosed in a fabric, which leads up into the interior of the blimp. These ladders connect into a passageway so that men aboard the airship may pass from one gondola into another. In the center of the airship there is a large room 20 feet long by 8 feet wide, in which the crew eat, their meals being cooked over the exhaust pipe of the engines. Strange as it may seem the men had bacon and eggs for breakfast on the first day out, cooked as above mentioned on the exhaust pipes of the engine. This shows the terrific amount of heat that these engines, because of their combustion, furnish. Hence each engine has connected with it a very elaborate system of radiators in order to cool it. These radiators are placed above the gondolas as shown in the illustrations.

In the center of the ship there is a runway covered with linoleum, as already mentioned, stretching almost thru the entire length of the keel, i. e., about 600 feet long, and only 9 or 10 inches wide, which the crew use for exercising and for passing from one gondola to another. Should one member attempt to pass the other, either one of them must lean against the aluminum frame-work of the dirigible, so as to allow the other to pass. Should they fail to do this, a drop of about 8,000 feet into the briny deep would result. There is plenty of room to walk upright, the roofs of the gas bags above being about 12 feet from the runway. The gas bags are divided into eighteen separate envelopes, which are inflated with hydrogen, nine of these being equipt with automatic valves so that expanding gases due to changes in temperature may escape. All the bags are incidentally equipt with gages, which register the pressure of gas and are inspected hourly. The hydrogen bags are made of calves' intestines (goldbeater's skin). There are sixteen gasoline tanks attached to the frame-work on either side of the runway, each with a capacity of about 70 gallons, forming a total weight when filled of about 500 lbs. There are forty-nine of these tanks aboard the gondolas and thirty-two in the ship, making a total of eighty-one, more than half of which can be thrown overboard to lighten the craft in case of emergency, which is absolutely necessary inasmuch as there is no way of refilling the

(*Continued on page* 440)



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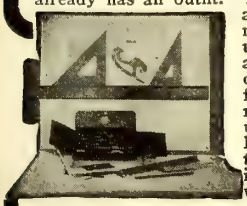
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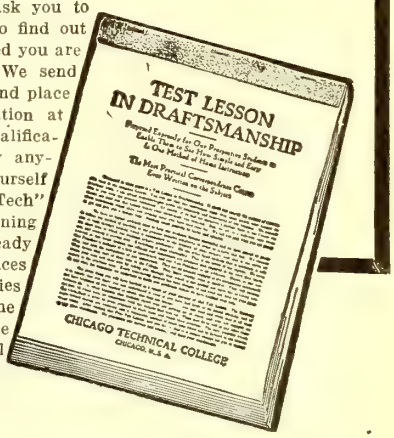
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How the R-34 Crost the Atlantic

(*Continued from page* 438)

bags with hydrogen while at sea. There are three immense drinking water tanks and several water ballast tanks which may be opened to lighten the airship. Everything inside the ship is balanced to perfection, tank for tank, hammock for hammock, and parachutes and life belts for parachutes and life belts on either side. The men eat and sleep in shifts. They sleep in hammocks made of Italian hemp, which are strung from one aluminum strut to another; there are ropes to tie oneself in with. There are ten of these hammocks, three forward, three aft, and two on each side amidships. Two aluminum ladders are connected with the forward and rear gondolas leading between the hydrogen balloonets to the top of the dirigible, where a cockpit opens to the external atmosphere by means of which the observer, taking care not to attempt to stand on the roof while the ship is in motion, takes a "shot" at the sun.

No leather shoes are worn by any of the men around the vessel in order to avoid jarring. Nor are matches allowed inside the envelope at all, everyone using flashlights equipt with miniature electric storage batteries. Inside the ship are found some of the comforts of home, the crew having brought two phonographs to America with them and returning with a third, presented by Mr. Thomas A. Edison. By jabbing a needle into Caruso, they heard him yell all night. In other words, these phonographs were kept going constantly. Lieutenant Durrant asked us not to forget to mention the mascot, a small maltese cat named "Jazz," which he is sure brought them luck on both the journey to America and back home again.

THE AIRSHIP IN MOTION.

The ship is 672 feet long and 150 feet beam at its maximum diameter. The ladders leading to the top are approximately 80 feet high. In order to start the vessel, its moorings are loosened, after which the ship swiftly drifts upward to about 8,000 or 9,000 feet. At this level an equilibrium is establisht and the engines are then started, when the ship proceeds on its course. The speed of the vessel is approximately 49 knots per hour when under full swing with no unfavorable winds, and the men on duty remain at their posts for about four hours, after which they are relieved by another section. For every thousand feet that the dirigible ascends, it loses 1/30th of its volume of gas, and in very heavy foggy weather naturally its normal position would be much nearer to the earth's surface, due to the fact that with a heavier atmosphere it would not be as buoyant.

The ocean viewed from this wonderful craft appears to be a vast blue stretch of prairie, beautifully streaked with green, which is visible thru the rifts in the clouds; every now and then a long white streak forms and rolls along rapidly. Wave motion is not visible at all, but the foam turned up by the wave as it breaks is distinctly noted as the white line of which we have just spoken. On preparing to land, the hydrogen is not allowed to escape, as so many think. The blimp's propellers are kept in constant motion and its rudder is tilted so as to make a nose dive at about a 45 degree angle. Sweeping around the field several times and preparing for a landing place, the vessel comes nearer and nearer to the ground. When all is ready a heavy cable is thrown out from the forward gondola which willing hands immediately grasp, and in addition to this some water ballast is thrown out, giving the landing crew a nice ducking.

While at Mineola, Long Island, the airship was anchored to huge concrete blocks, but because of the terrific resistance such a large body offers to a gust of wind, it broke loose from its moorings, a large hole being torn in its outside envelope. This was repaired in short order, and after that the balloon was held under control by a number of United States soldiers who swung the balloon like a weather vane, so that it continually presented a streamline effect and never broadside to the wind. In this way it was handled for the rest of its stay with no mishap.

An American army portable electric generating station furnished electric current for the searchlights scattered thruout the field, and current for operating the electric gasoline pumps to fill the tanks in the R-34. This outfit represents the latest army type of portable generator, giving about 110 volts and 125 amperes direct current.

Sir William Crookes' Psychical Researches

By Hereward Carrington, Ph. D.

(*Continued from page* 407)

with electricity, and of such a height that it would just fit under the table (see illustrations). Writing of these experiments, Sir William says:

"Mr. Home took the accordion between the thumb and middle finger on one hand at the opposite end to the keys. . . . Having previously opened the brass key myself, and the cage being drawn out from under the table so as just to allow the accordion to be pushed in with its keys downwards, it was pushed back as close as Mr. Home's arm would permit, but without hiding his hand from those next to him. Very soon the accordion was seen by those on each side to be waving about in a somewhat curious manner; then sounds came from it, and finally several notes were played in succession. Whilst this was going on, my assistant looked under the table, and reported that the accordion was expanding and contracting, and at the same time it was seen that the hand of Mr. Home, by which it was held, was quite still—his other hand resting on the table.

"Presently the accordion was seen by those on either side of Mr. Home to move about, oscillating and going round and round the cage, and playing at the same time. Dr. A. B. now looked under the table, and said that Mr. Home's hand appeared quite still, whilst the accordion was moving about, emitting distinct sounds. . . . But the sequel was still more surprising, for the medium then removed his hand altogether from the accordion, taking it quite out of the cage, and placed it in the hand of the person next to him. The instrument then continued to play, no person touching it and no hand being near it."

When Home had hold of one end of the accordion, Sir William Crookes took hold of one of the medium's wrists, and found that *he was not moving a muscle.*

The next experiments were those with a "spring balance." A mahogany board, 36 inches long, was suspended at one end to a balance, supported by a firm tripod stand. See illustration herewith. Any downward pressure upon the board was therefore registered by the spring balance. The other end of the board rested upon a knife-edge fulcrum on a solid table, and directly over the center of the fulcrum was placed a large glass bowl filled with water. Over this, in

(*Continued on page* 442)



"I'll say it is!"

Prince Albert certainly will put some frolic into that pet pipe of yours! To pack that joy'us old jimmy brimful or roll a makin's cigarette and hit'er up a notch or two is just going right over the top with your eyes wide open! What P. A. will do for your taste and tongue you sure ought to know! Like the gentleman from Sparrow's Point you'll call P. A. a good egg! You'll smoke a pipe full and talk a bucket full—Prince Albert is such a great, big bunch of smokesunshine!

You'll quick catch the P. A. cue that it can't bite or parch; that Prince Albert's exclusive patented process frees it from bite and parch! And makes the sky the smoke limit! Give Prince Albert high pressure for flavor and fragrance! Put P. A. through your little old taste-test-mill—and—just let that q-u-a-l-i-t-y percolate into your smokesystem!

You'll say it is, too!

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What's the use of merely existing, when you can improve yourself to such an extent that life will become a pleasure.

You don't know what life is unless you are an athlete.

If you are weak, run down, mentally and physically, if you lack ambition or feel discouraged, if you have suffered from youthful errors, or dissipations of later years, if you are bothered with indigestion, constipation, worry, kidney trouble, or any like ailment, *brace up*, and **START IN ANEW, AND MAKE THE MOST OF YOURSELF.**

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E. E., Sept., 1919.

Sir William Crookes' Psychical Researches

By Hereward Carrington, Ph. D.

(*Continued from page* 440)

turn, but quite detached from it, being separately supported, was a metal cup, perforated, so as to allow the entrance of the water. The board, thus suspended, weighed six pounds.

It will be observed that by placing the fingers in the metal bowl no added weight was imparted to the board, since this would serve only to displace a small amount of water, which would be registered equally on both sides of the fulcrum.

Mr. Home was asked to place his fingers in the metal bowl, in the water, without touching anything, and requested to *will* the emission from his fingers of the "psychic force," in order to register a depression of the opposite end of the board near the spring balance. He did so, his hands and feet being carefuly guarded (all these experiments being in good light). *A pull of about* 5,000 *grains was registered!* In a number of subsequent experiments, even stronger pressures were measured, which results were permanently recorded by means of a needle, making a graphic tracing of the various depressions and oscillations of the board. The manifestation of some kind of "psychic force" thus seemed to be establisht.

These, however, were but the simple, initial experiments undertaken by Sir William Crookes, which proved to him the reality of "psychic phenomena." His subsequent researches were most striking, including such manifestations as the *levitation or floating in space of the medium's body; the elongation of his body; the movements of objects without contact; playing upon musical instruments without any human hand being near him; the handling of red-hot coals without injury to the medium, and finally (with the medium Florence Cook) full-form materializations, which were seen and photographed by Sir William Crookes, and proved by him to be independent beings, separate from the body of the medium.* Sir William thus enumerates the phenomena witnest by himself:

The movement of heavy objects without contact; raps; the alteration of weight of bodies; movements of heavy substances at a distance from the medium; levitations of tables and chairs, without contact; the levitation of human beings; luminous appearances (lights); the appearance of hands; direct writing; phantom forms and faces; various phenomena indicating intelligence other than that of the medium.

Regarding, for instance, *levitation,* Sir William Crookes says:

"On one occasion I witnest a chair, with a lady sitting on it, rise several inches from the ground. On another occasion, to avoid the suspicion of this being in some way performed by herself, the lady knelt on the chair in such manner that its four feet were visible to us. It then rose about three inches, remained suspended for about ten seconds, and then slowly descended. . . . The most striking cases of levitation which I have witnest have been with Mr. Home. On three separate occasions have I seen him raised completely from the floor of the room. Once sitting in an easy chair, once kneeling on his chair, and once standing up. On each occasion I had full opportunity of watching the occurrence as it was taking place. . . . There are at least a hundred recorded instances of Mr. Home's rising from the ground, in the presence of as many separate persons, and I have heard from the lips of the three witnesses to the most striking occurrence of this kind—the Earl of Dunraven, Lord Lindsay and Captain C. Wynne—their own most minute accounts of what took place. To reject the recorded evidence on this subject is to reject all human testimony whatever, for no fact in sacred or profane history is supported by a stronger array of proofs.

"The accumulated testimony establishing Mr. Home's levitations is overwhelming. It is greatly to be desired that some person, whose evidence would be accepted as conclusive by the scientific world—if, indeed, there lives a person whose testimony *in favor* of such phenomena would be unequivocally taken—would seriously and patiently examine these alleged facts. Most of the eye-witnesses to these levitations are now living (at that time), and would, doubtless, be willing to give their evidence. But in a few years such direct evidence will be difficult, if not impossible, to be obtained. . . ."

Other phenomena recorded by Sir William Crookes regarding the mediumship of Home are still more wonderful. For instance, on a number of occasions, *Home took live coals from the fire, held them in his bare hands, and blew on them until the flames licked between his fingers, and the coal could be seen burning with a fierce heat in his hands.* On several occasions Home asked one of his sitters to touch the coal to assure himself it was hot; he did so, with the result that a large blister was at once raised on the hand. On other occasions, however, Home would apparently communicate his "preternatural incombustibility" to one of the sitters. He would say, "*Now,* touch the coal!" and they would be enabled to do so with the same impunity as Home himself. These phenomena—incredible as they may appear—were vouched for by many witnesses, including Sir William himself, and seem to be among the best-attested of Home's phenomena. The only analogy we have is the so-called "fire walking ceremony" performed in India, Japan, the Fiji Islands, etc.—if we leave out of consideration the historic case of Shadrach, Meshach and Abednego!

Doubtless the most striking tests undertaken by Sir William Crookes, however, were those made with the medium, Florence Cook. These manifestations took place in Sir William's own home—usually in his laboratory—and were of the order of *full form materialization.* Florence Cook, the medium, would enter the cabinet, and apparently go into a state of deep trance. The room being in complete darkness, a white-robed spirit form, claiming the name of "Katie King," would emerge from the cabinet and be seen by the sitters—at times carrying on a conversation with them. Naturally, the question at once comes into the mind: Was fraud possible in this case? Was a confederate employed, or could the medium herself have played the part of the materialized spirit?

It may be taken as certain that no confederate was employed. The tests were conducted, as stated, in Sir William Crookes' own laboratory, and the doors were securely locked before the séance began. No; if any fraud was possible at these times, the medium herself was responsible for it. Could the medium have played the part of "Katie King"?

Writing of this, Sir William says:

". . . Katie is half a head taller than Miss Cook, and looks a big woman in comparison with her. In the breadth of her face she differs essentially in size from her medium, and the photographs show several other points of difference. . . .

"I have the most absolute certainty that

(*Continued on page* 444)



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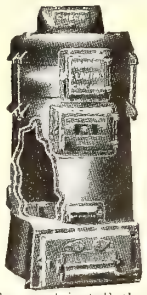
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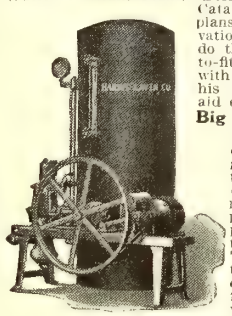
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Sir William Crookes' Psychical Researches

By Hereward Carrington, Ph. D.

(*Continued from page* 442)

Miss Cook and Katie are two separate individuals, so far as their bodies are concerned. Several little marks on Miss Cook's face are absent on Katie's. Miss Cook's hair is so dark a brown as almost to appear black; a lock of Katie's, which is now before me, and which she allowed me to cut from her luxuriant tresses, having first traced it up to the scalp and satisfied myself that it actually grew there, is a rich golden auburn. . . .

"One evening I timed Katie's pulse. It beat steadily at 75, whilst Miss Cook's pulse a little time after was going at its usual rate of 90. On applying my ear to Katie's chest, I could hear a heart beating rhythmically inside, and pulsating even more steadily than did Miss Cook's heart when she allowed me to try a similar experiment after the séance. Tested in the same way, Katie's lungs were found to be sounder than the medium's, for at the time I tried my experiment Miss Cook was under medical treatment for a severe cough. . . . ."

Sir William Crookes also took a number of flashlight photographs of Katie—one showing her standing beside him, and one showing Miss Cook, entranced, in the cabinet, with Katie, the materialized spirit, beside her. These phenomena, incredible as they may appear, were nevertheless seen and testified to by a large number of responsible people, and were observed by Crookes himself for many weeks consecutively, and tested in every way possible. These phenomena are among the most extraordinary in the whole history of spiritualism—the most incredible, *and the best attested!* What are we to think of them? That is the question which has been asked for the past half century, and which still remains unanswered! They are the most startling manifestations which Sir William Crookes reported, and will remain forever associated with his name.

In the next issue, "Apparatus Used in Exposing Fake Spiritualists." Another interesting discussion by Dr. Carrington.

Science in Slang

By Emerson Easterling

(*Continued from page* 435)

the eye tends to retain an impression of the filament at full or nearly full luminosity, while the current passes thru zero and the temperature of the filament proper decreases rapidly toward zero. Hence, before the image of the illuminated filament thrown on the eye is lost, insofar as its effect on the optic nerve is concerned, the current and filament temperature has past safely thru the zero point of the style, and started to rise again on the reversed current pulse of the cycle, as I showed you previously.

"As high voltage currents transmit with more efficiency and low voltage currents are more conducive to longevity when placed within reach of the uninitiated consumer, it was found that alternating current would have to neither be partial to the transmission nor the consumer, so the juice peddlers stick in the A. C. generators and hang pots (transformers) to step up the juice for better transmission, and then step her down for the consumers' better health, disregarding the undertakers' scowls."

"That is a pot," Bender said, pointing to a cast iron object on an electric light pole, and looking over at Jazz to see if he was going to censure the statement.

"Yes," replied Punk, "I have noticed them on a number of telegraph poles."

"There is a funny thing," laughed Stokes, "to the general public a pole is a pole—whether telephone, telegraph, light, or power. There is as much difference as there is in nigger, chink, white, or Eskimo. One of the most apparent differences would be found out if you should happen to try to tap in on a high tension transmission line to get the Tia Juana results."

"How is the stuff worked?" asked "Bonehead" Florey. "How is the juice sent from the station where the stuff is manufactured to the kitchen range or cigar lighter?"

"The stuff is first stept up, as I said, then it is stept down somewhat by a substation, generally in the outskirts of the village that the juice is being pumped into. The idea is that 4,000 volts is less likely to cause a massacre if the lines blow down than 66,000, 33,000, 20,000, or the like; so they step it down. Four thousand will transmit the distances from most substations with more efficiency than would the higher voltages—they figure that the line loss is more desirable than the life loss. Some companies step the voltage down to 2,300 again, or direct from the sub-station. Laws, ideas, and convenience have to do with the voltage.

"Then again, the *three phase* effect that the A. C. made possible has put that form of service over the direct current way in practically all power work. The three phase motors have first place in efficiency, you know."

"What is three phase?" asked Bender.

"In alternating currents we have *single phase* currents. The working of the current is generally described on paper by drawing a straight horizontal line representing zero—no current. All above the line is current in one direction, say positive. All below the line negative. The vertical distance from the line represents the height of the voltage. The voltage in a single phase current under ideal conditions would describe a continuous reversed curve, a semi-circle above the line and a semi-circle below the line. It will be seen then that the potential raises from zero to the maximum and to zero, thence to maximum in the other direction. You see the effective voltage is not the maximum voltage, for part of the time there is no flow in the circuit, and part of the time there is more than is recorded on the voltmeter. I guess that explains the single phase.

"Then in actual practise we have *two* and ***three phase*** alternating currents. In the two phase when one circuit is dead, the other is making an impression on the line. In the three phase each wave comes up just as the other is dying and keeps up the 'racket' in a much better manner than is possible for the intermittent single phase, or the two phase."

"And a volt is the pressure on the circuit. An ampere is the rate of flow. The volts times the amperes equals the watts. One thousand watts equals one kilowatt," rambled on Punk. Then turning to Stokes, "Isn't that right?"

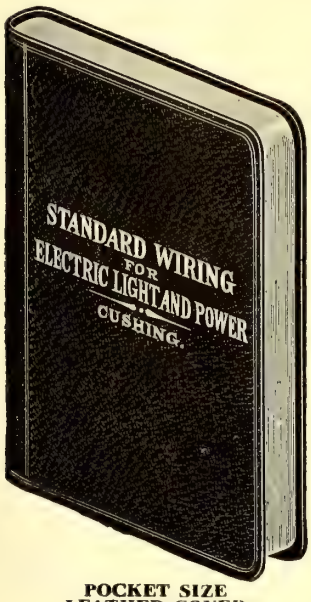
"Right," responded Jazz, "and the juice peddlers stick you up so much per kilowatt——"

"Yes," interrupted Bender, "too much."

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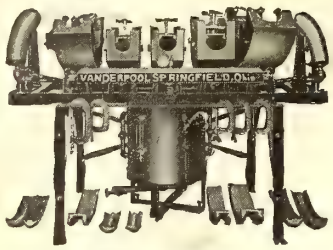
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Speeding Up the Airship

(*Continued from page* 397)

equally light gas, which we do not know of as yet.

On its first visit to the United States, the R-34 proved beyond controversy that the natural element of the dirigible is the air. As long as an airship remains from 300 to 500 feet above the surface of the earth it is comparatively safe, and at this level it will be possible for it to ride out any storm. The airship in this instance is not any different from the steamship, which can ride out any storm, as long as it is in the open ocean. What the steamship fears is the proximity of land or reefs, which usually spell its doom.

The future airship will not land its passengers by coming down to earth, any more than the steamship lands its passengers by climbing upon dry land. The airship will be fastened to earth by means of long thin steel cables from 200 to 500 feet long, and only one or two of these cables are needed; they will probably be attached to either the center or the nose of the airship. The passengers will then be landed by means of a landing passenger and freight elevator built into the airship, as described in our article in the July issue. This idea is also depicted in the above illustration, which shows the portable elevator built into the airship.

Making a Machine for Telegraphing Pictures

By Leroy J. Leishman

(*Continued from page* 421)

of its shaft by about 4 inches. The width of the base should be 8 or 9 inches. It is inadvisable to make these bases from metal, as short-circuits are too liable to occur. Wood is good enough.

Five holes are to be bored in each base as indicated in Fig. 2. A and B are for binding posts. C should be a small hole to accommodate a piece of annunciator or magnet wire. D and E should be large enough for two flexible cords such as that used for light drops. Do not bore E until the machine is practically completed for reason that will be apparent later.

The uprights A (Fig. 1) that support the cylinders must be made of metal. They can be triangular shaped, and should have half an inch of the lower edge turned up to a right angle for affixing to the base (see B, Fig. 1). From this angle to the hole which is to be bored at the top for the cylinder shaft the distance must be at least a half inch more than the radius of the cylinder. The holes in these *must be bored exactly the same distance from the bottom, so that the cylinder will be supported absolutely level.*

The cylinder should be mounted close to the opposite edge of the base to that near which the holes were bored for the binding posts. The binding posts are at the back of the machine, and the cylinder at the front. Mount the cylinder and shaft so that the cylinder comes about 3 inches from the end of the base, leaving about 1 inch between the end of the rod and the other end of the base. One support should be placed against the cylinder and the other about 1 inch from the end of the shaft (see F and G, Fig. 2). Screw the supports in place so that the cylinder is parallel to the edges of the base, and then place the cylinder rod thru the holes provided for the purpose. If Meccano or Erector material is used, collars can be obtained for keeping the cylinder and other parts in place.

Now get a cold-rolled steel rod about 3 inches longer than the cylinder and about ¼ inch in diameter. Have this threaded within a half inch of one end and an inch of the other. No particular pitch is essential, as the progress of the carriage can be governed by other means. The unthreaded ends must now be turned down to the same size as the cylinder rod, so that the same make of gears or pulleys will fit. Then secure a rod about a half inch shorter than the threaded shaft. This rod can be of the same diameter and material as the cylinder shaft.

The height of the supports for these will vary with the material at your disposal for the carriages, which can be made from ordinary telegraph sounders by soldering an extra piece on the end of the arm where the spring is attached. This piece can be the same width and thickness as the original arm of the sounder, but must be at least 3/16 inch square. The length will be dependent upon the diameter of your cylinder and the way the sounder is mounted on its own base. Hold the sounder level and at the same height as the cylinder rod, keeping the end of the sounder with which we are concerned toward the cylinder and the base of the sounder at least ½ inch behind the cylinder. The addition to the arm must be long enough to extend about ⅛ inch beyond an imaginary line perpendicular to the base of the whole machine and extending thru the center of the cylinder when the carriage is held in this position. The phonograph needle, to be placed in the end of this extension arm, will then touch the cylinder right at the top. Drill a hole the size of a steel graphophone needle down thru this extension arm about ¼ inch from the end, when measured from the top, and slightly less than 3/16 when measured from the bottom, so that the needle will set at an angle of thirty or forty degrees. As the needles must be changed, a thumb screw (H, Fig. 2) should be placed in the right side of this arm to hold the needle in place. A Victor or Columbia graphophone thumb screw is satisfactory, and most phonograph repair shops have taps to thread holes to fit.

If you do not have two sounders—one for each machine—the essentials for making the carriage are merely the needle arm, the fulcrum, a pair of electro-magnets, a bar for the magnets to attract, a coiled spring, and a stop to prevent the arm from moving too far up or down.

Under the front of the carriage, near each side, some sort of threaded half-nut arrangement must be provided. It is satisfactory to use a couple of pieces of tin with the edges turned down and slotted approximately to fit the screw or threaded shaft. Place one at each side. Under the back of the carriage two screw eyes can be used for the guide rod to pass thru.

The height of the uprights or supports C (Fig. 1) for the guide rod D and threaded shaft E can now be determined. They should hold these rods at a height which will support the carriage so that the end of the phonograph needle in the end of the arm will touch the cylinder when the arm is in its downward position. These supports can be made of metal, like those for the cylinders, or else from wood. Separate supports can be made for the screw and rod, or else double supports with two holes. *The screw and rod must be absolutely parallel, otherwise the carriage will catch or bind.* They must also be parallel to the cylinder, but not necessarily in the same plane. This means that great care must be taken in boring the holes in the uprights so that the screw and rod will be not only the proper distance from each other, but absolutely the same distance from the base thruout. Be sure, therefore,

(*Continued on page* 448)

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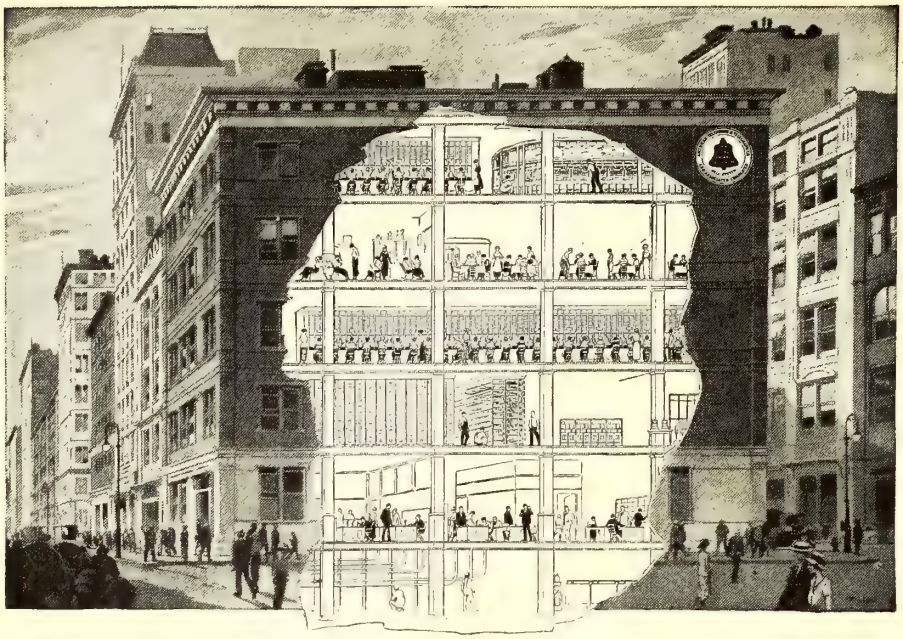
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Making a Machine for Telegraphing Pictures

By Leroy J. Leishman

(*Continued from page* 446)

that the rod and threaded shaft are straight. Mount these so that the rods extend the same distance beyond each end of the cylinder, and so that the front of the mounted carriage comes about ¼ inch behind the cylinder with the needle at the top of the cylinder directly above its center.

The only place in the whole set of machines where pulleys can be used instead of gears is in connecting the threaded shaft and the cylinder. The pulley I (Fig. 2) for the screw must be larger than the one on the cylinder rod, the exact size depending on the pitch of the threads and how dark or light you may desire the telegraphed pictures to be. The cylinder should make from 60 to 120 turns while the carriage travels 1 inch. After the pulleys are placed on the rods and lined up, put on a cord, elastic band or spiral spring for a belt.

It is essential that the cylinders of both machines turn as true as possible. If they do not do this, bend the rods till they are as perfect as you can make them.

Hole E (Fig. 2) should now be bored about a half inch behind the guide rod D (Fig. 1) and J (Fig. 2), and midway between its two ends.

After both machines are this far completed, they may be wired. Get a piece of flexible fixture cord and cut two pieces about 2 feet long. Peel the ends and scrape the strands of wire till they shine. Inasmuch as it is difficult to tell which one of the wires you want after they are drawn thru the base, it is best to twist both ends of one of the wires in such a way that it will be recognized from the other. Put a pair of these wires thru hole E in the base of one machine, and use the other pair in like manner for the other instrument. Attach one wire to the terminal of the magnet windings on the carriage, and also ground it so that it is electrically connected to the metal arm bearing the phonograph needle. Connect the other end of the same wire to one of the binding posts. The other wire should be connected to the other side of the carriage magnet windings, so that a current in both wires will energize the magnets and lift up the needle. The remaining unconnected end of these wires should be drawn thru hole D (Fig. 2), where it is to be connected to the right side of a two-way battery switch G (Fig. 1). The slack in this wire should be pulled above the base to give the carriage plenty of play. A piece of magnet or annunciator wire should lead from the left contact of this switch thru hole C, and be grounded to the support of the cylinder rod. The main terminal of the battery switch must be connected to the other binding post at the back of the base. Both machines must be connected the same way.

Now suppose we examine these circuits. First turn the battery switch to the contact at the left—the position used when "sending." The current now comes from the binding post to the switch, thru the right contact to the upright and thru the rod to the cylinder, thence thru the needle down one of the flexible wires to the other binding post. When the switch is thrown to the right or "receiving" position, the current passes to the carriage magnets.

Excepting for the gear connections, the machines themselves are now completed, but as no picture can be transmitted unless the cylinders run in *synchronism*, I shall presently explain three ways to synchronize them before showing how to prepare and transmit a picture.

(*Part II will appear in the October issue*)

Popular Astronomy

By Isabel M. Lewis

(*Continued from page* 400.)

his weight would be zero. Continuing from the center to the surface thru the same shaft the weight would increase progressively until the surface value of 150 lbs. was restored.

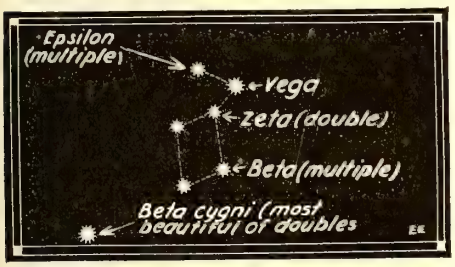
WEIGHT ABOVE SURFACE OF EARTH.

If, on the other hand, it were possible for a man to ascend above the earth's atmosphere he would still be subject to the attraction of the earth (see diagram IV), but the force would *decrease* inversely as the square of his distance from the earth's center, so at a distance of two radii, or 8,000 miles from the earth's center, a man weighing 150 lbs. at the surface would weigh only one-fourth as much as at the surface of the earth, or 37½ lbs. At a distance of six radii, or 24,000 miles, from the earth's center, he would weigh 4⅙ lbs., and at a distance of about 12¼ radii, or 50,000 miles, his weight would be only one pound. If the distance should be increased to four times this amount, or 200,000 miles, his weight would be decreased to one-sixteenth of his weight (at 50,000 miles)—or one ounce.

ASTRONOMICAL QUESTIONS AND ANSWERS.

Question 1. What is the sidereal system and sidereal time?

Answer 1. (a) The terms sidereal system, stellar system, and sidereal universe, are all synonymous and refer to the organized system of the stars in which our solar system is a single unit. The stars do not move in a haphazard manner but are governed by some definite law and purpose



and organized into some great system. To this system belongs the Milky Way as well as practically all the stars, both visual and telescopic, the great irregular gaseous nebulae, the globular star clusters and loosely formed moving star clusters, such as the Hyades and Pleiades groups. It is not yet known whether the spiral nebulae are subordinate units in the sidereal system to which our sun and his satellites belong, or whether they are external systems or external universes independent of our own sidereal system and units along with it in some vaster system.

Answer 1. (b) Sidereal time is "star" time as distinguished from solar time or "sun" time. A sidereal day is the interval between two successive passages of the meridian across the same star. The sidereal time of any place on the earth is zero when the meridian of that place crosses the vernal equinox (point of intersection of the celestial equator and the ecliptic), which is chosen instead of a star as the point of reference for sidereal time. A "solar" day is the interval between two successive passages of the same meridian across the center



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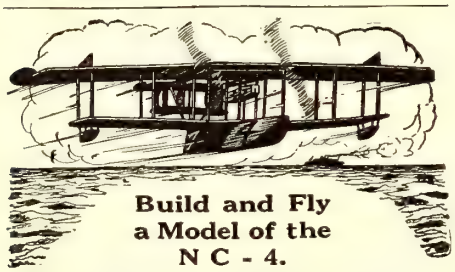
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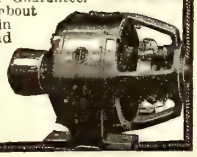
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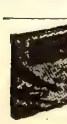


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of the sun. As the sun appears to move eastward among the stars about one degree a day the solar day is longer than the sidereal day by about four minutes, the time that is required for the meridian of the place to turn thru an angle of one degree and "overtake" the sun. Since the sidereal day is four minutes shorter than the solar day the stars appear to rise four minutes earlier and to come to the meridian four minutes earlier each successive evening.

Question 2. Please name and locate a few double and multiple stars.



Answer 2. An interesting multiple star is Epsilon Lyrae, now visible in the constellation Lyra about 2° N. E. of Vega (on the meridian 9 p. m. Aug. 30). The two wider components are 207 seconds of arc apart and can be distinguished as separate objects by persons with exceptionally fine eyesight. Each of these components is itself a double star and can be separated with a three-inch telescope. Beta Lyrae, about 6° S. E. of Vega, is not only an interesting multiple star but also a remarkable variable with a period of nearly thirteen days and a range of one magnitude.

There are several interesting doubles in addition in this constellation, which is a fine field for a three-inch telescope.

Beta Cygni, about fifteen degrees to the southeast at bottom of Northern Cross is a most beautiful double.

In the constellation Delphinus, known as Job's Coffin, are two fine doubles, Gamma and Alpha. This constellation is a small diamond-shaped group of stars about 30° to the southeast of Lyra.

In the constellation Scorpio (in southern skies in August west of meridian in the early evening) are three interesting doubles, Sigma, Beta and Nu. Sigma is the star just north of Antares, the brilliant red star in this constellation. Antares also has a greenish companion, but it takes a four-inch telescope to separate it. Nu and Beta are about ten degrees northwest of Antares.

200,000 Horse-power in One Hour

(*Continued from page 409*)

will go out of its way or take a roundabout course. However, it notifies the system operator; subsequently these warnings either discoutinue, or the rapidity of the signals increases as the storm approaches or dies out. With this storm, however, it was different; it approached with hurricane velocity, and when about one-half to one hour away the bell strikes every minute.

This now became a positive signal that the storm was about to break, and that within a very short time. The fires in the boiler room, which have been banked up to the present time, are now let loose and coaled up. Within a short time "steam is up" in the boilers. The system operator now, by means of telephone or other forms of annunciators, directs the starting of the gigantic reserve generators, so that everything will be in readiness should the storm break. Now the auxiliaries are started. The system operator is warned by the bell ringing continuously, and the device, which



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has finished its overtime work, is now short-circuited. There is no further need of warning. The city becomes enveloped in darkness equal to that of night. Suddenly the storm breaks and together with a downpour of rain comes the click of so many light sockets and the pull of so many chains, and we think no more of it. The "juice" is there and we have light.

We never realize how those fellows up at Waterside station have to work in order to supply this demand. There is the crashing of many huge switches, as extra feeders are put into operation, and finally as a last resort powerful storage batteries are thrown into the circuit so as to supply the city with its increasing demand for electricity—and this has been done with no inconvenience and without bravado. Thanks to the Edison service, New Yorkers were able to work at their offices as late as desired, while the house and theater lights blazed forth by the hundred thousand.

Electric Cookery—A Snap!

By Grace T. Hadley

(*Continued from page* 412)

oven switches on *High* for fifteen minutes in advance. Bake paste fifteen or twenty minutes on *High* heat.

Quick Coffee Cake.—Turn oven switches to *High* before preparing cake. Sift together twice one pint of flour with one-third cup of sugar, three heaping teaspoons of baking powder, one-half teaspoon each of salt and cinnamon. Mix to a soft dough with one cup of milk stirred into a well-beaten egg. Add four tablespoons of melted butter and spread in a buttered shallow pan. Sprinkle over with granulated sugar mixed with cinnamon. Bake on lower grate from twenty to twenty-five minutes, turning switches to *Medium* for last ten minutes of baking.

Date Muffins.—Cream three tablespoons of butter with three of sugar and add two well-beaten yolks of eggs, then three-fourths of a cup of milk and two cups of pastry flour sifted with three scant teaspoons of baking powder. Beat well and add the stiffly beaten whites of the eggs and a cup of dates cut into small pieces. Turn oven switches to *High* twenty minutes in advance and muffins should bake in from twelve to fifteen minutes with switches left on *High*.

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The modern electric range is really a triumph in beauty of design and workmanship. Clear white enamel walls and oven door panel, bright nickel trimmings make this type of range a source of pride and joy to the particular housewife. There is so much labor saved. There are no black bottomed pans and pots to be washed, hence there is a great saving in the matter of cleaning up after the cookery process. The easy control and perfect regulation of the heat establishes dependable temperature conditions. Best of all is the satisfaction of doing good cookery in the most modern way.

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A Dinner Prepared in Automatic Electric Range.

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"Heads Win!"

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There are men like Jesse G. Vincent, who rose from a toolmaker's apprentice to inventor of the Liberty Motor; men like Joseph G. Tynan, the laborer who became the world's greatest ship builder; men like Robert E. Ramsay, the clerk who became editor of Advertising and Selling. There are carpenters' helpers who became architects, bookkeepers who became general managers, men and boys who rose from nothing at all to responsible positions at splendid salaries.

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Can you still go on, putting in your days at the same grind, getting the same pay envelope with the same insufficient sum, keeping up the constant fight against a soaring cost of living, when a little grit on your part could be the means of changing your whole life?

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All we ask is the chance to prove it. That's fair, isn't it? Then mark and mail this coupon. There's no obligation, and not a penny of cost. But it may be the most important step you ever took in your life. Take it *now!*

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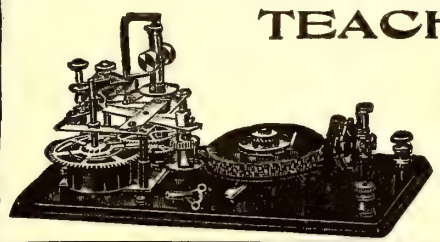
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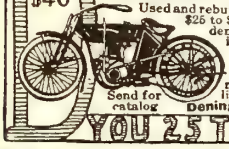
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Carrots, spinach, turnips, in three-cluster utensil. Current on fifteen minutes. Wattage 213.

Food cooks in both ovens one and a half hours.

Make coffee in electric percolator, four cups; 167 watts.

Princess Pudding.—Two-third cup butter, one cup sugar, one large cup flour, three eggs, one-half teaspoon baking powder, small glass cider. Rub to smooth cream butter and sugar, add eggs one at a time, beating few minutes after each addition; add flour sifted with baking powder and cider; put into mold well buttered, set in sauce pan in some boiling water; steam thus one and a half hours; turn out on dish carefully; serve with lemon sauce.

Tapioca and Cocoanut Pudding.—One cup tapioca soaked overnight, one quart milk, yolks four eggs, whites of two, one cup sugar, two tablespoons grated cocoanut; bake one-half hour. Make frosting of whites of two eggs, three tablespoons sugar, two tablespoons grated cocoanut; spread over pudding when baked. Set in oven until light brown.

DINNER

Asparagus Soup
Pseudo Roast Chicken
Carrots Espagnole
Baked Tomatoes or Potatoes
Salad
Fruit Tarts Whipt Cream
Demitasse

Pseudo Roast Chicken.—To avoid cold storage chicken and yet have it tender, try the "pseudo roast." Take the cleaned fowl, place it in kettle of water already heated to boiling. Simmer gently in boiler oven, current low, until chicken meat becomes tender; twenty minutes before mealtime baste chicken with butter and place in oven, current on *High* until golden brown.

Carrots Espagnole.—Boil and mash thru a colander two or three bunches of carrots; beat into them melted butter, pepper, salt and cayenne or paprika; add two eggs well beaten and grated cheese to taste; bake in mold and serve turned out on a hot dish; garnish with parsley. It should be as light as a souffle. Cook carrots in boiler oven. Bake tarts, tomatoes or potatoes, chicken and carrots espagnole in large oven.

Electric luncheon to Northwestern Electric Equipment Co. by Edison Electric Appliance Co., Hotpoint Division, January 10, 1919. Menu for forty-five guests:

Celery Olives
Chicken Soup Wafers
Roast Beef, Meat Sauce
Potatoes and Peas in Cream
Sweet Corn in Ramekins
Raisin Bread Sweet Rolls
Head Lettuce Salad
Plum Pudding, Hard Sauce
Coffee Cheese Straws
Van Dyke Cigars

Prepared on electric range by Miss Bell, of the Minn. Gen. Elec. Co.

10 cans soup	469	watts
18 lbs. roast beef	2,325	"
1½ pks. potatoes	1,188	"
2 cans peas, 5 cans corn	300	"
6 loaves bread	1,000	"
5 doz. rolls	700	"
50 portions pudding	1,275	"
70 cups coffee	525	"

At 4 cents per kilowatt-hour, this generous repast was prepared entirely at a cost of 31 cents per person. The operation was in charge of Miss Bell, of the Minn. Gen. Elec. Co., with one assistant, and not only were they on the job only ninety minutes, but the task found them just as sweet and clean as tho they had never seen a kitchen.

Total wattage was 7,782, or 172.9 per person. How was it done? By utilization of one great essential in successful range operation—stored oven heat. Of four surface burners only three were used to a current consumption of 2,682 watts.



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In his announcement recently Dr. Duncan, who has just returned from the East, where he studied the use of radium at Johns Hopkins, Harvard and Cornell cancer research institutes, stated that the Los Angeles institute will use more radium and radium therapathic equipment than can be found in all the other territory west of the Atlantic Coast. The building "L" will cover an area 65x38 and 50x36 feet. In addition to its offices and elaborately-equipt laboratories, it will have a large number of beds for patients who find it necessary to remain at the institute for a time.

"The purpose of this institution," said Dr. Duncan, "is to provide unexcelled facilities for radium therapy, and the study and treatment of neoplastic disease. The benefits to be derived will be available to all requiring such treatment, and a fee consistent with the financial condition of the patient will be charged. Any profits earned above those required for the proper maintenance and equipment of the institution will be devoted to scientific and research work."

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(*Continued from page* 401)

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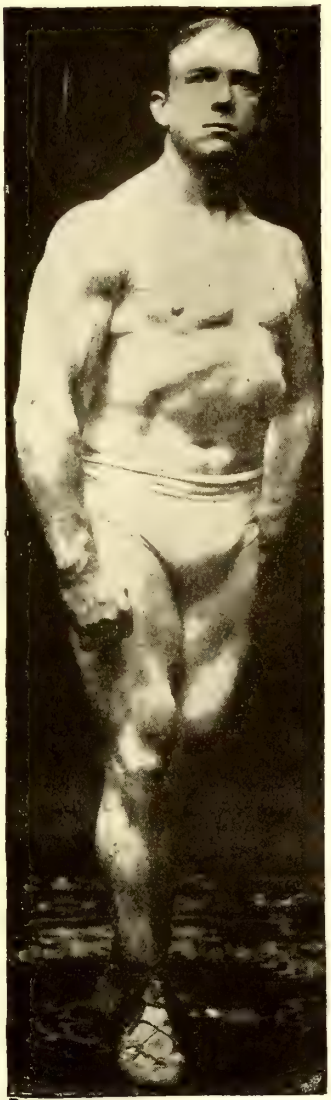
The entire control of this turbine, together with all the others in the power house, is centered at an electric switchboard located in a room in the upper part of the power house. Here, by merely operating a few dozen small keys, resembling telegraph keys, the operator starts and stops the turbines in accordance with the demands of the transportation system, directs the current into various circuits as required, makes special connections to meet emergencies, and in other ways keeps New York constantly on the move. The responsibilities connected with this work can hardly be over-estimated, since a single error might tie up half of the city's elevated, subway, and surface lines.

In addition to this human control, a system of governors has been devised for the large turbine that automatically takes care of almost every possible contingency. In consequence, the machine practically runs itself and one of the things that strikes a visitor is the fact that workmen are rarely seen on the power house floor.

For the technical reader the following details will be of interest. Superheated steam enters the *high pressure* element at 205 lbs. pressure and dividing into two portions is exhausted into the *low pressure* elements at 15 lbs. pressure. From the low pressure elements it goes into the *condensers* in which a 29-inch vacuum is maintained; 826,000 lbs. of steam are used per hour for the maximum load, and the water rate is below 11 pounds of steam per kilowatt-hour. The generators are each rated at 20,000 KW continuously and 23,500 KW for two hours. Three-phase, 25-cycle current at 11,000 volts is delivered to the substations. The floor space occupied by the entire turbine is only 52x50 feet and its height is about 20 feet.

Photos Courtesy Westinghouse Elec. & Mfg. Co.

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You married men come across to yourself—get the pep and ginger and tingle of life into you. You are not living for yourself alone; you need dash, spirit, the enterprise you used to have. Regain and maintain your vigor; I'll show you how.

You business men—overworked, did you say? You are not doing half as much as you ought with your experience. Never mind, there is a way to get back your aggressiveness, to be right in the fight and enjoy it. You can double your percentage of real worth as a man, and enjoy life as you ought to be able to do.

You young man—think of your future—how about it—are you fit for marriage—are you qualified—do you feel it in your soul—are others sliding by you doing more—getting more than you are? I know what is dragging you down, what is keeping you down, and it is time, high time, that you **Stop.** No one can abuse nature and succeed; others tried it and failed miserably. Do you want to be a failure, or even worse than a failure? Then come to me; I have helped thousands; physically, mentally, morally. I will help you; I will make you the kind of young man that is a credit to any community— will make you so that your progress in any undertaking will be easier. Just be frank and above board—tell me your troubles. I will guide, direct and point the way; the natural way for you to achieve what I have said—Nature's way. You can stop the drain on your system, you can be free from bad habit, gain muscular tissue, be strong, virile, erect in carriage, courageous and likeable to all you meet. Let me be your guide, your teacher. I have pupils all over the world, learning a system of Health, Strength, moral courage building, known as

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..Rupture	..Torpid Liver	..Despondency
..Lumbago	..Indigestion	..Round Shoulders
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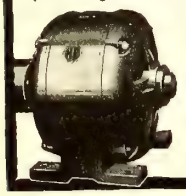
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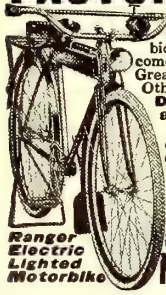
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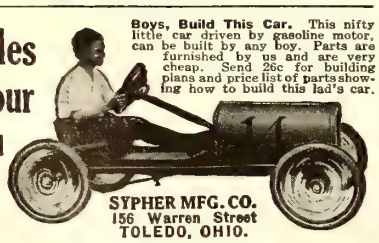
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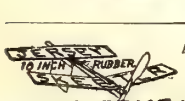
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Under-Water Surveying by Reflected Sound Waves

By H. Winfield Secor

(*Continued from page* 405)

to the greater sound conducting properties here presented, the velocity of sound wave propagation thru water being about 4,700 feet per second, or somewhat over four times the velocity of sound traveling thru air. Otherwise the sound waves in water behave much the same as they do in air, giving all the echo, reflection and diffraction effects and other well-known phenomena with which we are all familiar.

AUDIBLE AND INAUDIBLE SOUND WAVES.

Mr. Ries has spent a great deal of time on research in the physics of sound wave propagation and reception, and one of his startling statements was the fact that in time of war or for certain other reasons (where multiplex or selective communication might be required in a constricted body of water), it then becomes possible to apply his sound surveying and detecting system by means of *inaudible* sound waves, i.e., sound waves pitched either above or below the normal register of the human ear. The human ear normally does not detect the presence of sound waves at below eight vibrations per second nor higher than sixteen to seventeen thousand per second, altho among radio operators it is common to "hear" at a higher limit of audibility—30,000 vibrations per second. The buzz of the beetle's wings is in the neighborhood of 16,000 to 17,000 vibrations per second, and this is about as high a sound as the average ear will note, unless specially trained. This particular detail is unusually interesting to us, for if audible sound waves have to be relied on to detect an enemy submarine for instance in war time, then the enemy might hear the sound waves.

By means of specially sensitive apparatus well known to engineers and physicists, it is possible by several distinct means to thus utilize for the purpose of solving the location of a distant object under water, by sound wave triangulation *sounds above the audibility of the ordinary ear.* Mr. Ries has devised apparatus which will not only detect such sound waves at two points on the base of a triangle, but also record them.

As Mr. Ries pointed out, it is a simple yet not commonly known fact of everyday physics that a sound that is inaudible to one person may be audible to another person, all depending upon the structure of the outer ear and the thinness and elasticity of the diafram in every case. It has been proven by scientists that there are a perfect multitude of sounds surrounding us all the time of which we have no cognizance, simply because our ears do not ordinarily respond to these abnormal frequency sounds. For example, there are certain insects which make sounds inaudible to ordinary persons, and thus it is believed that they carry on communication between one another. Furthermore, simply because we do not hear a sound, such as produced by Mr. Ries's 20,000 to 30,000 cycle surveyors, while listening at the receiver connected to a submerged microphone, is not a reason why our ears would not under proper conditions pick up and interpret that sound to the brain. If the form of the outer ear, i.e., the shell of the ear, were properly formed with regard to its length and angle, quite possibly the diaframs of our ears would respond. Therefore, it becomes apparent that to hear a certain sound is certainly a case of ultra-mechanics, or building a sufficiently sensitive apparatus to hear a certain sound or range of sounds.

(*Continued on page* 457)



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Developing an Idea*

By Nelson Hall

NEARLY every one at some time gets an idea that he would like to develop if he knew it was worth while. That is if the field is not already covered or paralleled. It is always a burning question with inventors to know what has or is being done along the line of his idea. In these days when improvements are being made so fast that the patent office issues over a hundred patents a day, it is not uncommon to find, much to the inventor's distress, that some one has covered his cherished idea with a patent or come near enough to be an interference. Realizing the time and money spent in developing, the litigation involved in interference or overlapping of claims, and the disappointment that comes from an invention which has little or no market value, the following information is being offered to those who are developing ideas.

When an idea occurs give it some time and attention. Lay it out in the mind as much as possible, make rough sketches until a clear mental picture is formed. Building models or samples is always very instructive and aids much in producing a working article. At any rate think it out so it can be drawn or some one can be directed to draw it or build it if it is a construction, or go thru the sequence of operations if it is compounding or manipulating drugs or chemicals.

When the conception is developed sufficiently that it can be seen thru all the operations and the parts are in fair proportions, make a complete assembly drawing showing very clearly the new parts, improvements and the novelty. Also write a brief concise but lucid description to accompany the drawing, and take these before a notary public and have one or more of your friends who understand the drawing and description sufficiently to identify them sign as witnesses. If a model has been made photographs of it should accompany the drawing and description. This is much stronger evidence, because it shows that work has actually been done in developing. By these papers and the date affixed by the notary public a record is made that will be taken in court should it ever be needed. Very often the date of conception is of the utmost importance in establishing the priority of claims.

Do not conclude that such documents make it unnecessary to take out a patent, for such is not the case. Should any one secure a patent on the same idea, tho your conception antedated his, it would cost a lawsuit to establish your claims. If too much time had elapsed from the time of the witnessing *the court would consider yours an abandoned idea* unless you could produce evidence of your developing. One should not delay taking out a patent. He should file his application as soon as he knows the idea will work, can be manufactured and marketed. But before one decides how well his idea will work, how suitable it will be for manufacturing and how well the buying public will receive it, some very careful thinking technically and painstaking sounding among manufacturers, prospective users, and salesmen are required.

Every one meets people in several walks of life during each twenty-four hours of the day, and some of these may have just the information desired. By a little artful juggling of words the conversation can usually be shifted to the desired topic and run something like this if, let us say, a tire iron is the idea under consideration:

"I just saw (in mind or the mental picture which was worked out in getting the idea into a working form) a man repairing a tire with a very unique tool. The way he rolled that four and a quarter over the rim beat anything I ever saw, and when it came to replacing it was just as easy."

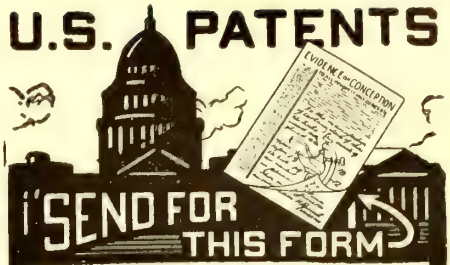
"What kind of tool was it? I have seen several and have a very good one with my car."

"It was about eighteen inches long with a peculiar shaped hook at one end that slipt under the tire and hooked on the rim, giving an unusual amount of leverage. I understand that it is new and is going to be put on the market soon."

By carrying the conversation further an opinion can be formed whether or not this man who is a user of a car and a prospec-

* Owing to the fact that this special article by Mr. Hall is running this month, the usual "Patent Advice" Questions and Answers will appear next month.

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tive buyer feels the need of a new tire iron. Sounding out several such men gives a fair idea of how keenly the public feel the want. This is very essential, from a financial point of view. It is possible for an invention to work perfectly, be a good manufacturing proposition and still not be received favorably by the public.

Often the original patents have expired before the public realized the merits of the invention. This was the case with the typewriter. Offices needed the typewriter, but there were no operators, and it was only after a long and tedious delay of developing operators, educating the public, and perfecting the machines that they became universally adopted in practice. Many of the original experimenters were dead before typewriters found their way from the inventor's shop.

Parallel with this is the modern steam turbine. Mr. Parsons' original patents expired before the turbine was considered seriously as a prime mover by the engineering profession. Mr. Parsons received his returns not from his patents but from his advanced knowledge gleaned from the experimental work which became a priceless asset in his later engineering practice. All this goes to show how important it is for the inventor to realize the condition of the public's wants. Many an inventor has been obliged to abandon an improvement because he could not stay in the game until the public realized its merits. Financial backers are liable to lose interest and withdraw their support if they have "come in" expecting a quick turnover, and it takes several seasons instead. Inventors are prone to be too optimistic about the public's receptivity of their invention and to paint such glowing pictures of success that their organization is sorely disappointed with the volume of business and the financial headway made in a given time.

If one meets a salesman he can adjust the conversation to get an idea of the selling capacity of the article. Will the article be *bought* or *sold?* It has been said there are no life insurance policies bought—they are all sold, and sold by personal solicitation of salesmen. One can describe the article and the plan he has for selling as if he were considering taking an agency himself and ask the salesman for his opinion. "Knights of the Grip" are always ready to pass an opinion, pick up a side line, or while the time away in conversation, so he will tell of any similar article that he may have seen and how it was marketed. If he is favorably imprest, remember him for the future selling force. He may cite to you several ways of marketing this from cases that have come under his observation. It is a very good plan for the inventor to have a feasible selling plan worked out before trying to interest capital.

From a manufacturer one can get some idea of the probable cost of production, necessary equipment, etc. The cost of manufacture is always more or less a stumbling block, but it is one of the three great questions that investors always ask. These are: What does it cost to manufacture, what does it sell for, and how long will it take to get it going? One can, if he likes, submit the whole article to a manufacturer and have him bid on it. But it is preferable to see what the cost of standard parts will be from a trade catalog, get bids on the other parts from screw machine works, stamping concerns, or others specializing in making parts. They will bid on the part in any quantity named from a blue print.

There is a type of man that one is bound to find in his travels, namely, the man with a lot of ideas. He will quickly commence: "I'll tell you what I would like to see and what I would buy if I could find it. I believe it can be done. It's a wonder to me some one has not done it already."

Such a man is often wide awake—he sees

(*Continued on page* 473)

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Under-Water Surveying by Reflected Sound Waves

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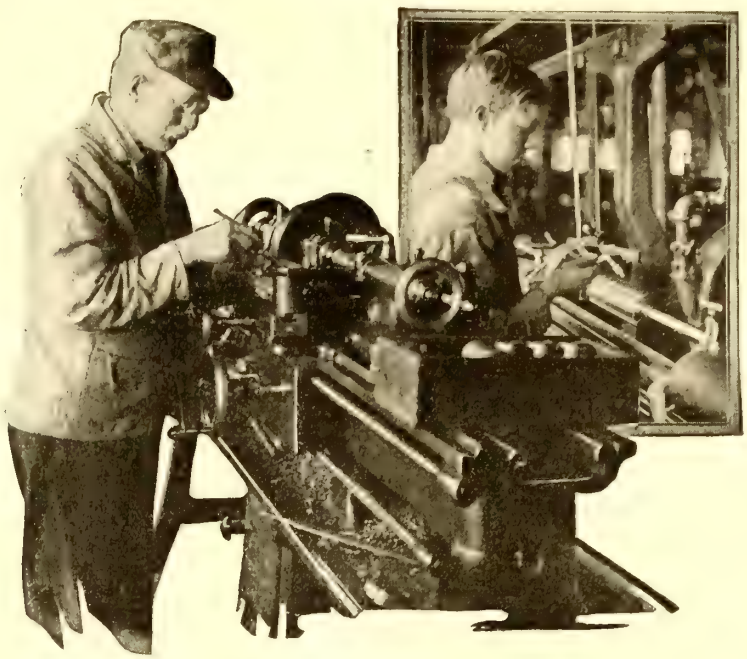
(*Continued from page* 454)

We remember one scientific investigator who could hear sounds as high as 38,000 cycles per second.

As Mr. Ries demonstrated, it is very remarkable how accurately a sound can be located, such as a blast from a whistle, if two short curved horns about one and one-half or two feet long are held tightly against the two ears, as shown in one of the accompanying illustrations. Should someone sound a whistle quite a distance away and you then swing your head from side to side, you will quickly ascertain that there is one certain position which will be found to be at right angles to the direction from which the sound emanated, in which a *maximum response* will be heard. It is possible that this method could be used to make a simple *range-finder* for military or other requirements. A very beautiful principle of pure physics was further mentioned at this juncture, and one that probably not one person in ten thousand ever thinks about. It deals with *sight* instead of sound, and the principle of triangulation is clearly illustrated thereby. Mr. Ries said: "Show me a good artist or draftsman and I will show you *the man who possesses abnormally separated eye-balls.*" This does not mean the eye-balls are divergent or convergent as in stigmatism, but that two normally straight eyeballs, having the most accurate observation possibilities, of extreme importance in all perspective drawing and painting, was here enhanced by the fact that the possessor of such a pair of eyes had a *longer base* for his triangulation of sight on a given object than the average man, or one whose eye-balls were spaced abnormally close. This fact is brought out pointedly by referring to the accompanying illustrations. If you are familiar with the laws of simple geometry and trigonometry, or else with the operation of the range finders now in use by the Army and Navy gunners, you will see that the reasoning is correct, and of momentous import indeed.

Mr. Ries's Under-Water Sound Detector.

There are two general methods by which Mr. Ries's highly perfected system of surveying may be carried out by means of sound waves. In the first method it may be applied in charting or surveying a given body of water and ascertaining the formation and character of bottom. In this case it is only necessary to provide at the receiving or measuring station a beam of known length on the extreme ends of which are placed two of the improved sub-aqueous microphones with balanced diaframs, perfected by the inventor. A sound projecting horn is sounded at pre-arranged intervals, and readings are taken as the apparatus is moved from point to point. In order to measure the range quickly, the two pivoted microphones are connected by means of gearing or rods with a calibrated dial placed in the center of the beam supporting the microphone sound detector. This dial moves proportionately to the movement of the microphone, and always gives the appropriate reading for identical angular positions of the microphones. The diaframs of Mr. Ries's subsea microphones are accurately balanced against the water pressure by comprest air, the pressure of which is automatically varied to a nicety in proportion to the pressure of the water, which, of course, increases as the depth of submergence is increased. The horns fitted on to the front of the microphones may also be attuned to a certain frequency.



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Where it is not possible to utilize a distant direct source of sound, as in measuring the distance of an iceberg, etc., then *reflected sound signals are used*. As afore-mentioned, a powerful siren or bell is now placed midway between the two microphones, and this is operated in the following manner: By means of an automatic *double contact switch* when the siren or submarine bell is sounded, to send out the *originating* sound signal, the circuits of the receiving microphones are automatically disconnected so that the powerful sounds being transmitted are not picked up, which would prove confusing, if for no other reason. After the signal has been sent out for a few seconds, the switch is thrown to "receiving," and the microphone circuits are re-connected. By this time the sound has died away at the transmitting station, and is being propagated toward the distant point from which the reflection is sought. After a few seconds, and during which time the pivoted beam supporting the two microphones is swung back and forth continually, a sound will be heard which is the echo, if there has been a reflection of the sound, and of course, if there is no reflection or echo, then no sound will be heard. The distance which the echo has traveled can be checked by a stop watch or other chronometer, dividing the time elapsed in seconds before the echo is heard, by two, and then multiplying this value by 4,700, which gives the range in feet. This is not necessary, however, as the automatic range reading scale connected to the two pivoted microphones is calibrated to give both the distance and position directly, once the beam has been swung so as to be at right angles to the point of the original sound, or in the present case the point from which the echo was reflected.

One of the accompanying views shows a diagram of Mr. Ries's *differential sound receiver* for this purpose, and its operation is very ingenious indeed. A differentially wound telephone receiver is used, provided with two windings or coils, one of the receiver coils connecting thru an induction coil as shown to one microphone, while the second receiver connects thru another induction coil and shunt circuit to the second microphone. What happens when a sound is received, is interesting. No sound is heard at all in the receiver, for the following reason:—When the microphones have been properly focust and the sounds localized and picked up in each microphone unit are equal in strength, then the currents passing thru the induction coil circuit to the two differential windings in the telephone receiver are arranged so that they neutralize one another, and as a consequence no sound is given forth by the receiver diafram.

An exceedingly important and timely application of Mr. Ries' invention is that brought about by the World War that is now happily ended, namely, the location and recovery of many of the numerous and costly warships and merchant vessels sunk by submarines, mines, etc., amounting, according to recent estimates,* to more than 18,000,000 tons out of a total world tonnage in 1914 of 42,000,000 tons. Among the original purposes which Mr. Ries had in view in devising his apparatus was the location and salvage of vessels and the preliminary study and charting of their position and condition, *from the surface*, by means of the reflected sound waves which were brought to a focus upon and caused to travel in exploration along the entire exposed part of the vessel, and also over the ground on which she lay. In this manner not only the exact depth and position of the ship is ascertained without the use of a diver, but every part of the ship is plotted as the survey proceeds. A three-funneled steamship, for example, with the widely separated sound receiver horns brought to *a spot focus* upon it, will give

* See article in "Sci. Amer.", July 19, 1919.

Young's Elements of Astronomy (Revised)



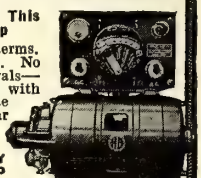
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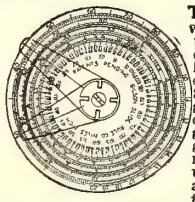
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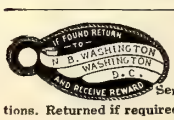
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three characteristic echoes as the pivoted exploring arm is moved.

Ries Balanced-Flame Sound Detector.

In this case two manometric flames, as shown in the accompanying illustration, are separated by an opaque partition inside of a ventilated glass bell or other cover. The two flames are adjusted to burn with equal brilliancy, and pneumatic comprest air tubes provided with appropriate needle tips are placed at the side of either flame. These two pneumatic tube systems, which are used to cause either of the flames to vary or quiver, are suitably connected to the two receiving microphone-telephones. While the microphones in this case are being focust, there will be a fluctuation of the flames until the beam is accurately focust and the sounds of the telephones are of equal strength, when the flames will become balanced, and each will burn with equal brilliancy and shape.

An interesting experiment, which the reader may like to conduct, is that of causing a focust sound wave to be propagated across a room, and then listening for the focust ray. This will demonstrate one of the principles on which Mr. Ries's invention works. To perform this experiment, all you need is a common garden variety of watch, such as a dollar Ingersoll, which gives a good healthy tick, and this may be placed in a parabolic or other reflector, or even a china oatmeal bowl.

Experimental Under-Water Signaling System.

All that is required for making this experiment is a water-tight tin box, in which is mounted a small buzzer. This buzzer may be soldered to the inside of the metal box, which may be a cocoa tin. The two wires carrying battery current to the buzzer are carried out thru the top of the container thru a piece of small rubber tubing. Where the rubber tube enters the box the joint may be tightly sealed by the liberal application of hot sealing wax. The lid of the box may be sealed tight by thoroly waxing with paraffin.

The receiver is of the microphone type, and any electrical experimenter will be able to make this device very easily with a little ingenuity. There are several ways in which it may be done. The first requisite is a sensitive carbon microphone. A Skinderviken microphone button, which is complete in itself, may be used, attaching it firmly to a ferrotype (iron) diafram about 2¾ inches in diameter. It is best to place solder over the nut on the water side of the diafram to keep the inner chamber of the receptor thoroly water-tight. The receptor may be mounted on a piece of pipe or a metal rod, so as to be suspended over the stern of a rowboat or launch, and provided with a handle so that the microphone and its attached metal horn can be swung in different directions. One side of the circuit may be completed thru the metal suspension of the microphone apparatus, and the other side of the circuit thru an insulated wire leading up above the water thru a rubber tube. All joints around the microphone should, of course, be made water-tight, but this is not very much trouble where a simple experimental apparatus is under consideration. The microphone diafram should be fitted with substantial rubber gaskets on front and back, and then the base of the horn and the rear casing of the microphone thoroly bolted together to form a compact whole by means of a number of small stove bolts or machine screws and nuts placed around the perifery of the chamber, as shown in the drawing. This is due to Christian Berger.

An ordinary 75-ohm telephone receiver, or a pair of them, are connected up with a dry cell or two in circuit with the microphone at the receiving station. All is then ready to try out the transmission of sound signals thru water.

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"Audions on A. C." Correction

In the article entitled "Operate Your Audions on A. C.," by Elliott A. White, published in the July issue of the ELECTRICAL EXPERIMENTER, page 234, an error occurred in the statement of the formula in the center column of page 234. The multiplying factor in the numerator of the equation should have read 6.25 instead of .625. Also the second line at the top of column three should have read 1 ampere instead of 0.5 ampere.

We are pleased to add the following information contributed by Mr. White since the publication of the original article, and which we believe our Radio friends will be very glad to procure, especially in view of the high technical standing of the author, who was formerly Radio instructor at the *Carnegie Institute of Technology*. The additional information follows:

"If the tubes of the rectifier are of the high internal impedance type, they must pass at least as much current as is required by the plate circuit of the receiving tubes; and if the tubes of the rectifier are of the low internal impedance type (such as the G. E. Co.'s *Tungar* tube), a current-limiting resistance should be inserted in the lead from the middle of the transformer windings T3 T4, to protect the tubes. As the filaments of these tubes require only 2 volts, but a correspondingly heavy current, the transformer windings T5 T6 would have to be wound for 2 volts with heavy wire. There is another simple way of connecting the rectifier to the transformer, whereby all the windings are in series and the plates in parallel, but to avoid confusion this method is not given. Any connection or design adopted by the experimenter is satisfactory, so long as it is adapted to the kind of tubes used, whether they are transmitter tubes, receiver tubes, commercial tubes, or home-made ones."

TRENCH USE OF TELEPHONE WIRE.

Telephone wire is the *sine qua non* of the trenches. It is used to hang pictures on the walls of the dugouts, to mend cots and to make them. Men who have been "over there" have said that frequently soldiers have stopt in their pursuit of the Hun to gather bits of telephone wire lying along the blood-soaked fields of No Man's Land.

De Forest Defends His Three-Electrode Audion

(*Continued from page 428*)

gave off torrents of negative electricity. This discovery was made before anything was known of electrons, but Dr. Fleming had persisted in his efforts, directed towards rectifying alternating high frequency currents, and eventually by an exceedingly pretty contrivance, was able so to control and study the current as to suppress all the oscillations in one direction by the Fleming valve. This was improved on later by Mr. Marconi, and the present three-electrode valve, with its contrivances for audio-magnification, three times repeated, was finally evolved. Two currents being coupled and exalting each other made an exceedingly sensitive detector, and the lecturer remarked that this might be tested by placing the receiver and the transmitter of a telephone together, when all the little noises in the room were picked up and a whistling sound produced. Thus, with the modulation of the waves to the human voice, the problem of radio-telephony was solved, and great developments were to be expected.

"Conversation with ships would be practicable, as man to man in the same room, and also Trans-Atlantic telephony. The Premiers of the Dominions would, he anticipated, be able to take part in a cabinet meeting in London by vocal intercourse, tho their bodies were thousands of miles away."

The protest of Dr. de Forest is contained in the following letter:

Editor of *Morning Post*,
London, England.
Sir:

I have just read the paragraph in your issue of February 25th entitled "The Future Telephone," a resume of a Cantor lecture by Prof. Fleming. Prof. Fleming's lectures have usually been so clear and instructive that I am astonished to see him now quoted as having made statements widely at variance with well known facts. In the recent testimony before Mr. Justice Spencer in the unsuccessful attempt before his court by the Marconi Company experts to prolong the "Fleming valve" patent it was admitted by the Marconi experts (Prof. Fleming himself being present at the trial) that the Fleming valve did not amplify, that it only rectified the weak currents received in wireless signalling.

As a matter of fact, well known to radio engineers, the true Fleming valve has itself been of exceedingly small value in the modern wireless art. And Fleming did not improve it. It is a three-electrode vacuum tube, called by myself, shortly after its invention, the "Audion," which, if I may say it in all modesty, has brought about all those wonderful advances in radio signalling.

The Audion and not the Valve made possible the trancontinental wire telephony —the Audion and not the Fleming Valve, used as an oscillator at the transmitter, and as detector, and then amplifier at the receiver stations made possible transoceanic radio telephone in 1915, and again this year between New Brunswick, N. J., and the S. S. *"George Washington"* in Brest Harbor.

I cannot believe that a scientist of Prof. Fleming's standing would knowingly lend his name to any deliberate attempt to mislead the public in stating, or artfully inferring that Marconi improved the Fleming valve and produced the three-electrode device. Neither do I believe that a paper of the standing of the *London Morning Post* would knowingly lend its columns to any unfairness or pettiness in withholding the credit due an American inventor, altho there always has been and there still is plenty of evidence to show such an unfair and petty attitude on the part of certain British interests, especially in the United States. Marconi had no more to do with inventing a three-electrode device or Audion than the Kaiser, altho both have made good use of it, since an American produced it and demonstrated its limitless possibilities.

In the interest of fair play and scientific fact, I ask you to publish this communication. (Signed) LEE DE FOREST.

CORRECTION NOTICE.

Courtesy for the photographs used in illustrating article entitled "Airplane Antenna Reels" on page 324 of the August issue, should have been given to Emil J. Simon, Inc.

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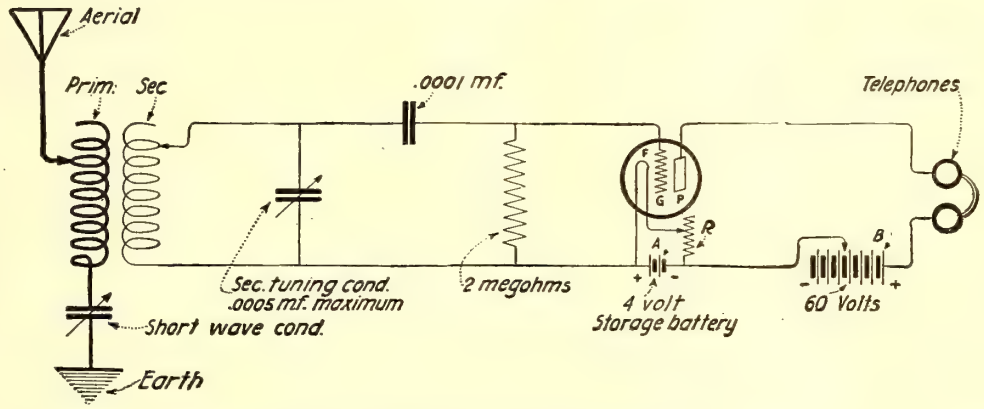
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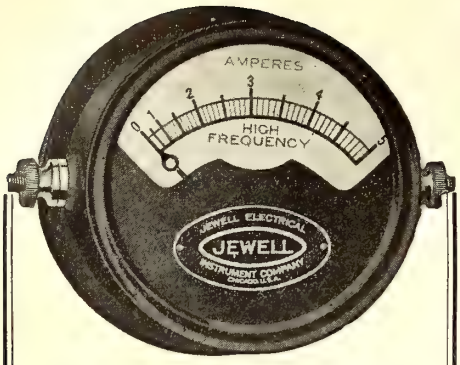
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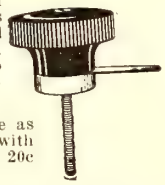
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The "Fog Warning" Radio Telephone

(*Continued from page* 426)

third repetition the warning, "You are getting closer, keep off!" is sent out with a limit of range of about two miles. These signals are sent out during fog, mist, rain, and falling snow.

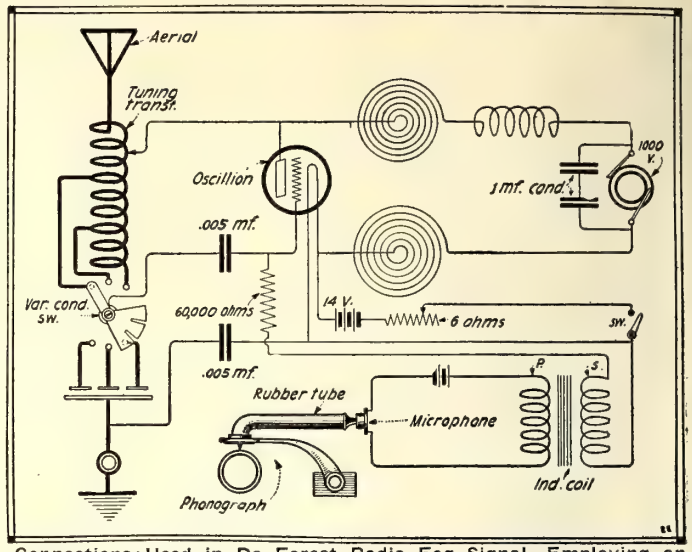
When sent out by *radio* the signals can be heard with any suitable or well-known wireless telegraphic telephonic receiving apparatus which may be employed to receive, detect, or reproduce the emitted or radiated signals. Crystal detectors may be used. The signals are sent out now on a first wave length of 600 meters.

If the transmitting and receiving apparatus is equipt for graduated strength musical note signals, these will be received by a ship at sea; for instance, suppose the ship receives the note corresponding to the Middle "C"; then it will be known that the lighthouse is four miles away.

If both the middle "C" and the "E" and "G," are detected at the receiving station, the distance is two miles, and if all four notes are heard, then the distance away is one mile or less, and so on for any other pre-arrangement and adjustment of the sounding apparatus.

This invention is bound to be a great help to all mariners and the system is a direct innovation over any that have heretofore been tried. Doubtless many disasters and wrecks will be avoided and in general to make navigation safer.

Every important lighthouse and lightship on the U. S. coasts will be fitted with this new Radiophone "fog signal."



Connections Used in De Forest Radio Fog Signal, Employing an Oscillion Bulb to Generate the Transmitting Oscillatory Current.

EMIL J. SIMON WINS CANADIAN LAWSUIT.

The Marconi Wireless Telegraph Company of Canada, Limited, the plaintiff in a Canadian radio patent suit, recently released and discharged the American Wireless firm of Emil J. Simon from and against all claims and demands set forth in the Statement of Claims, and further stated in their disclaimer that it will not institute any other proceedings against the defendant, Emil J. Simon, in respect thereof. This notice was dated Montreal, June 7th, 1919.

A competent English authority says that English central station managers realize that lighting is fast becoming the small end of the electric central station's income, and power and appliances are to be the main sources of revenue in the future.

The How & Why of Radio Apparatus

By H. Winfield Secor

(*Continued from page* 431)

comprising a four-wire inverted "L" aërial, the wires being spaced about 2½ feet apart.

However, where long distances are wanted, it becomes necessary to use longer aërials.* The reason for this is that, to gain the highest maximum results in any radio transmitting or receiving circuit, the antennae oscillatory circuit down to earth should be able to vibrate at a frequency approximating its natural period. Hence, it is seen that for this reason, it is necessary to use a long aërial, having in consequence a long-wave *natural period* in order to pick up efficiently such wave lengths as 12,000 or 15,000 meters. This is not the whole story, either, for another important factor is that the longer the aërial, the more energy will be picked up from the rapidly moving etheric wave front, as it passes across the antenna wires. This may be compared for analogy to the electromagnetic field. In a dynamo or motor you will recollect that the longer the wire, the more magnetic flux it will intercept in its rotation in the field, with a consequent greater potential produced in the moving conductor. In the case of radio transmission, the conductor is stationary, while the electrostatic field moves and thus cuts the wire, inducing an electric current in the wire. It is this induced current which operates the detector in the receiving set.

*See "Calculation and Measurement of Inductance"—in the September, 1917, issue of this journal.

As a guide to the young radio designer, the accompanying graph chart is given, which shows the natural wave lengths of four-wire antennae of various heights and lengths. These values were computed from data given by Dr. Louis Cohen. A common rule for calculating approximately the wave length in meters of a simple antenna system, without any coils or other apparatus connected with it, is to multiply the length of the flat-top, plus the length of lead-in wire to earth, in meters by 4.5. This rule applies to inverted "L" type aërials. It is also applicable to "T" type antennae, but here the length of wire considered in meters is the lead-in length to earth, plus *one-half the length of the flat-top.* The factor 4.5 varies under different conditions, as, for instance, where metal roofs may change the natural capacity of the antenna. But it serves very well for approximation, and has been very extensively used.

Mathematical Calculation of Antennae Wave Lengths.

In a previous paper the writer had the following to say in regard to the wave length of radio antenna and the value of tuning inductances in the aërial oscillatory circuit.

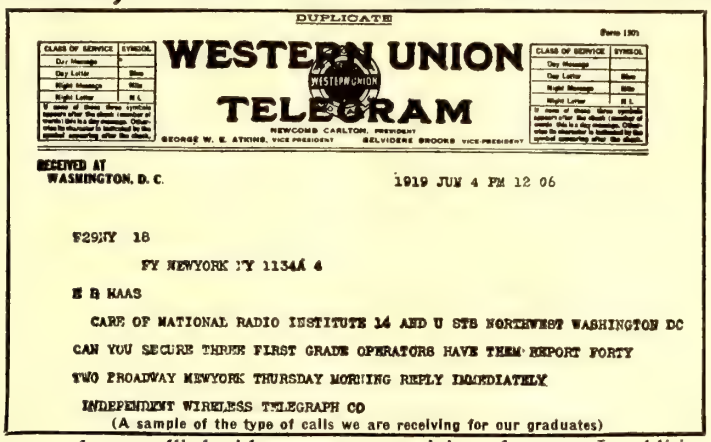
Having theroly discust the methods of both calculating and measuring the inductance of coils, we are now in a position to continue with the design of the most im-

(*Continued on page* 464)

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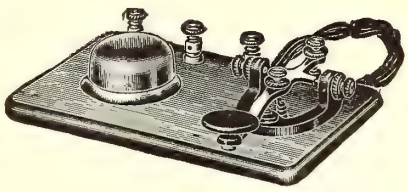
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Wireless Receiving Ban Raised

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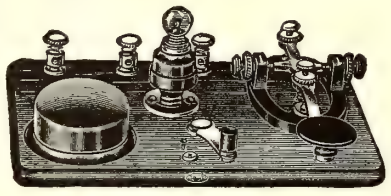
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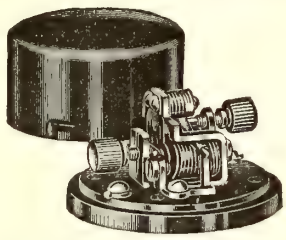
This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.



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The How & Why of Radio Apparatus

By H. Winfield Secor

(Continued from page 462)

portant type of inductance coils used in radio work. We will confine ourselves to the types of coil which are mostly used, namely—loading inductances, loose couplers, variometers and transmitting oscillation transformers.

Before we delve into the actual design of these coils, however, let us first consider the fundamental facts necessary for the design. Since the inductance is employed in building up the proper oscillating condition of the circuit and consequently the wave length, we can express this relation by the following formulæ:

We have first the formula expressing the wave length, *W.L.*, of the open (antennae) oscillatory circuit, thru the primary, L_o, of a loose coupler, loading or tuning coil.

$$W.L. = A\sqrt{L \times C}\ ; \qquad (1)$$

where:—

A = a variable, ranging from 38.15 to 59.6 for short wave length. (See curves for various values of "*A*" in article cited below in February, 1917, issue.)

L = total inductance in centimeters of aërial, including lead-in and loose coupler, tuning coil or loading coil.

C = capacity in micro-farads of aërial, including lead-in.

Those interested in this subject should refer to the excellent article on "The Design of Large Radio Receiving Transformers," by C. S. Ballantine, in the February, 1917, issue of this journal, page 732. The variable factor, 59.6, appearing in the usual wave length formulæ was there discust at length, with a graph giving the different values of this function for various wave lengths and aërial inductance to localized inductance ratios.

Considering long wave lengths (10,000 meters and higher) and the design of large loose couplers we are safe in using the expression:

$$W.L. = 59.6\ \sqrt{L \times C}\ ;$$

where:—

L = inductance of loose coupler primary and loading coil (if used); the inductance of the antennae being neglected, owing to its small value compared to the inductance of the loose coupler (or loading coil).

C = Capacity of antennæ, including lead-in.

For designing short wave apparatus we shall call L_o the value of the loose coupler (or tuning coil) primary inductance. Then we have:

$$L_o = \frac{\lambda^2}{3552 \times C} - L\ ; \qquad (2)$$

here:—

L_o = inductance of load (loose coupler, tuner, etc.), in centimeters.

λ = maximum wave length to be tuned to.

L = inductance of antenna and lead-in in centimeters.

C = capacity of antenna and lead-in in micro-farads. (See tables herewith for these values.)

For long wave apparatus, let L_o represent the loading coil inductance, plus the inductance of the loose coupler primary (or tuner, if used). Then we have the formula:

$$L_o = \frac{\lambda^2}{3552 \times C}\ ; \qquad (3)$$

with all values the same as in formula No. 2.

The following tables will be found useful in applying the above equations to the design of loose couplers, etc.:

TABLE "A"

Cap. in M.F., Including Lead-in, of 4 Wire Inverted "L" Aerials. Wires Spaced 3 Ft. Apart

Height	Length of Flat-top in Feet			
	60	80	100	120
40....	.00033	.00042	.00051	.00060
50....	.00035	.00043	.00050	.00058
60....	.00036	.00044	.00051	.00059
70....	.00037	.00045	.00052	.00059
80....	.00039	.00046	.00053	.00060
90....	.00040	.00048	.00055	.00061
100....	.00042	.00049	.00056	.00062

TABLE "B"

Inductance in Cms., Including Lead-in, of 4 Wire Inverted "L" Aerials

Height	Length of Flat-top in Feet			
	60	80	100	120
40....	35,000	41,100	47,200	53,310
60....	48,800	55,460	62,090	68,700
80....	62,400	69,320	76,300	83,300
100....	76,260	83,500	90,750	98,020

It is possible to determine approximately the inductance required to produce a desired wave length when the capacity of the total oscillating system is known. When using any of the above formulæ, it should be remembered that they include the *total value* of the unit. Thus, the capacity factor includes the antenna, and condenser capacity, each of which must be determined separately and the capacity of the antenna must be obtained by actual calculation, formula for deriving this quantity having been given on page 732 of the February, 1917, issue of this journal, as well as a table of the capacities of a four wire antennæ of different lengths and heights.

The first step in the design of an inductive tuner (having determined the wave length) is the actual size of the instrument, and from this to find the approximate dimensions of the winding tubes to be used. Having these on hand, and knowing the maximum inductance of the primary by equations (2 or 3), we can immediately determine the number of turns that the primary coil will require to obtain the wave length sought, by solving equation (3) of (Part 1, March, 1917, issue) for *N*.

The inductance of the secondary winding should be such that its wave length should correspond very nearly to the antenna circuit, and that of the primary. If this condition is to be obtained, then we have an ideal condition of maximum efficiency and great care must be exercised in bringing about this ideal condition. The value of the secondary inductance must therefore be in the neighborhood of the primary (unless it is to be shunted by a variable capacity), but in practise it is made somewhat larger than that of the primary. It is customary in coupler design to allow one-half inch difference in size of diameters between the primary and secondary tubes and therefore the diameter of the secondary can readily be determined The number of turns required is deduced from equation given in the September, 1917, issue.

Details of Aërial Construction.

When it comes to discussing details of amateur aërial construction, one could almost write an encyclopedia of several volumes, for in traveling about the country, it is amazing to note the many different ideas followed in building antennæ. This is so for many reasons, not simply because one Radio Amateur wishes to have something different from his fellow Amateur across the street, but in a great majority of cases his pocketbook controls the design. And so it is that instead of using beautifully molded ten-inch Electrose insulators on his aërial, you may perchance bunk into one of the greatest freaks of modern times, a real dyed-in-the-wool Amateur antenna—constructed from about six kinds of wire, including some good old iron hay-baling wire, and a variety of insulators that would win first prize in any freak photo contest, made from miscellaneous odds and ends,

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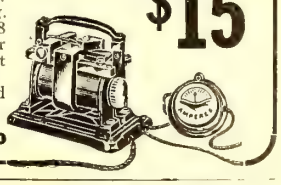
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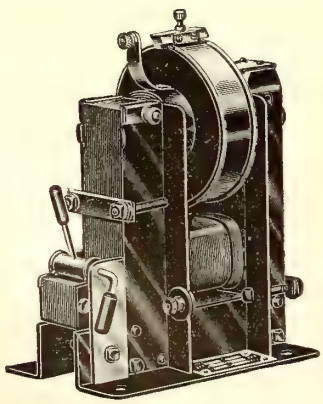
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including beer—excuse us, *near-beer*—bottles, porcelain cleats, waxed wooden rods, pieces of crockery and other choice bits of "backyard junk."

So it is seen that there is a wide latitude in ideas, and good ones, too, in many cases, let it be said, for building an experimental wireless antenna of fair efficiency. Your average Radio Amateur does not care so much about the "looks" of his antenna as he does about the fact as to whether or not he can sit down in his little coop with his apparatus about 10 P. M. and hear "Carnarvon" calling one of his Britannic Majesty's cruisers lying off the Canadian coast! That's the life that cheers.

Figs. 5 and 6 show several practical and approved developments in aërial design, which are not only efficient, but simple as well, in their application. Fig. 5 shows a typical elevated aërial spreader, which may consist of a length of stout bamboo, or a very good spreader is composed of cypress or oak sparring, about two inches square. The best shape for the spar is to make it about four inches broad at the center, so as to give it greater strength against bending. For ordinary work the Amateur usually winds several turns of wire around the spreader, and then fastens his insulators to it. A good construction, however, is afforded at very small cost by having a blacksmith (or else you can make them yourself) bend up a few eye-bolts, as shown in Fig. 5. These may be made from ⅜ inch round, wrought-iron bar, threaded at one end and provided with a washer and a nut or two. The iron and wood work on the aërial should be thoroly painted, of course, before erection, so as to withstand the weather. A heavy red or white lead paint is advised. If the antenna is to be used for "Receiving" only, four insulators are placed at both ends of the flat-top at the spreaders. Where the very highest efficiency is desired, extra insulators may be placed in the suspension ropes holding the spreader, as shown at X. This is the standard of aërial construction, but a much simpler form which has been extensively used in commercial practice, on ship stations particularly, is that shown in Fig. 6. Here no insulators are used in the flat-top part of the aërial proper, but they are placed in the main suspension ropes, as shown at X. This insulating scheme effectually insulates the aërial, of course, and a piece of brass or iron pipe may very well serve as a spreader, connecting the wires of the flat-top to the pipe, by winding the ends of the wires around it. It is the best practice to run a jumper wire across the strands, soldering this thoroly at the joints. This applies to the free end of the antenna; no jumper wire being required at the opposite end, where the lead-in rattails are led off. In any case all joints in the aërial circuit thru which radio frequency energy has to pass, *should be carefully soldered,* or else a very good design of clamp should be used, packing the cleaned wire joint with tin-foil before tightening the clamp. The jumper and rattail connections for inverted "L" and "T" type aërials are clearly shown in Figs. 1 and 2.

Kind of Wire to Use in Aërials.

"What kind of wire should I use for constructing my aërial?" "How many feet long?" and "What altitude?" are questions frequently repeated, and these are not simple ones, either. However, the Radio Experimental fraternity may count itself lucky in the respect that the size of wire for the antenna is pretty well standardized. For Amateur antennæ, it is common to use a wire corresponding in size to No. 14 B. & S. gage solid conductor. Where stranded cable is used, and which possesses a much lower *high frequency* resistance than a solid conductor of equal diameter (owing to its greater surface area, which

is the only part of the conductor traversed by the radio frequency currents), then a seven-strand cable is commonly employed. Seven strands of No. 22 or 24 wire constitute a common size of cable for experimental work, while a heavier cable is used in building commercial and Government stations. There are several kinds of wire in use for aërial construction. Aluminum wire was used previously, but it is very difficult to make a good soldered joint with aluminum wire, and for several other reasons it has not been used very much in latter-day practice. A very good wire for amateur work is a plain solid copper conductor, No. 14 B. & S. gage, or heavier, which may or may not be tinned. A good stranded cable for this work is one comprising seven strands of tinned copper wire. Another standard cable is a seven-strand one composed of phosphor bronze stock, which is of course very strong and suitable for the extra long spans. Still another form of wire in use for experimental aërial construction is copper-clad steel wire, which possesses greater tensile strength than any other equal size electrical conductor. The radio-frequency currents pass thru the outer copper jacket. Plain iron wire alone has been used, but is not very satisfactory.

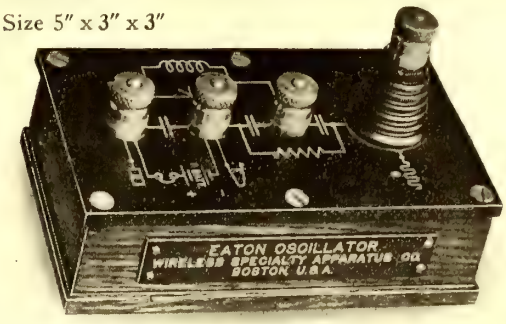
Grounding Connections.

The matter of grounding antennæ, especially of the elevated type, is very important, markedly so in the case of *thunder-storms*. Also the *Fire Underwriters'* rules have to be carefully heeded in this respect, which apply to every building on which *fire insurance* is carried. The safest method to follow in any event, for your own protection, as well as keeping in conformity with the Fire Underwriters' rules, covers the following recommendations for the *grounding of radio antennæ*.

These regulations call for a ground wire connected to a first-class ground plate or pipe running down to damp earth, or to the street side of water mains in cities, this ground wire being composed of No. 4 B. & S. gage solid copper conductor. The ground wire connects to a grounding switch rated at 600 volts and 100 amperes. The regulations do not specify what size of lead-in conductors should be used, but it is apparent and obvious that if you intend to conduct a heavy static surge or induced charge from a thunder-storm down to earth thru this massive switch and ground wire, that you certainly would not make a lead-in of No. 14 gage wire, like so many amateurs have been wont to do in past years. The right way to do this is to construct the lead-in wire of No. 4 B. & S. gage solid copper conductor or its equivalent in cross-sectional area, such as by employing two or more wires of smaller size stranded together. Good Radio Engineering practice calls for rattail leads brought down from each strand of the aërial to be of equal cross-sectional area to the aërial strands proper, and then bunching these rattail leads into the lead-in joint at the bottom of the fan-tail construction. All of these joints, as aforementioned, should be SOLDERED. The rattail leads should be brought into an aërial connector of some kind before being soldered, so as not to depend upon the solder alone for mechanical strength or electrical conduction.

The *Fire Underwriters'* rules further stipulate that this lightning ground and switch should be placed on the exterior of the building in all cases, and furthermore, that this *ground* which has just been described in detail, should be separate from the station ground. It is the usual practice in experimental radio stations to place the aërial grounding switch either on the window-sill or on the side of the window, and, of course, it should be covered with a metal or other box, so as to protect it from rain

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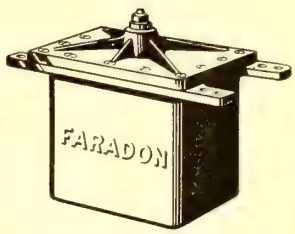
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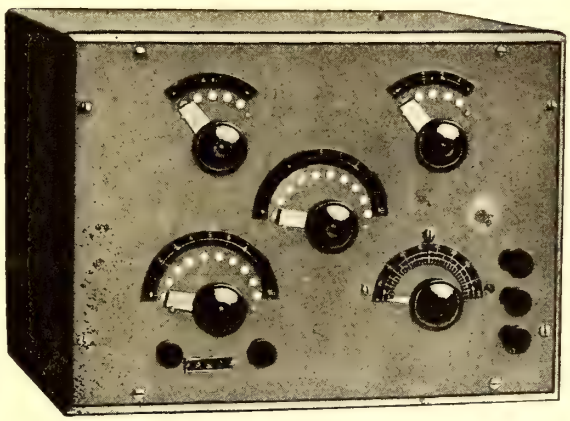


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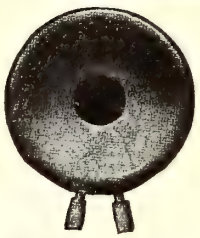
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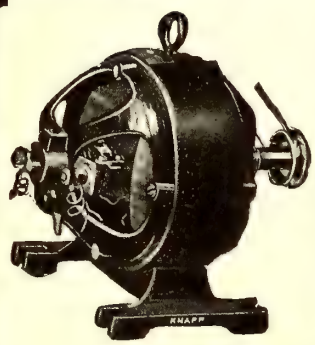
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and snow. In running the ground wire down the side of a building, it need not be insulated and bare copper wire is generally employed. Fig. 4 shows one form of efficient ground for lightning protection or for the regular station grounding purposes. This ground is composed of a piece of galvanized chicken wire buried from three to five feet in the earth between two layers of charcoal. The depth to which the ground plate is buried will depend upon how dry the top soil is. *The ground plate must be placed in wet earth,* no matter if it has to be buried twenty feet deep, unless some provision is made to keep the earth in this vicinity moist, such as by daily watering, or else by allowing a waste pipe from some water system to empty over the spot.

Types of Masts.

When it comes to masts or towers for supporting the elevated type of antenna, there are many different styles. One of the latest events in radio is the "Tree Aërial," as devised by Maj.-Gen. George O. Squier, which was described in detail, with special drawings, in the July, 1919, issue of the ELECTRICAL EXPERIMENTER.

This represents one form of natural elevation for supporting aërials or aërial conductors at a considerable altitude, and another one is the balloon or box kite. The average Radio Amateur does not care so much about details on the construction of radio masts, for in practically all cases he will follow his own intuition in making use of whatever material and facilities he may happen to have on hand. For example, some antenna masts used in the past have been of the latticed wood form of construction, while others of the iron pipe type have been erected to considerable heights. We remember one mast of iron pipe construction in the vicinity of New York City which rose to a height of 110 feet. For safety's sake, such a mast should not be constructed with too small a pipe at the base, and for altitudes of 75 to 100 feet, the first and second base sections of the mast should comprise standard heavy wrought iron pipe not less than 3 to 3½ inches in diameter. Needless to say, the iron pipe should be either galvanized or else thoroly painted before erection, and very carefully guyed by stranded steel cables attached ⅓, 2/3 the altitude and at the top. Long guy wires should be split up into sections not exceeding 20 feet, by means of strain insulators.

Aërial Insulators.

Various forms of commercial and home-made aërial insulators are shown in Figs. 7 and 8. Fig. 7 illustrates the commercial, fluted type of molded Electrose insulator, as well as the Electrose ball insulator. Where greater efficiency is desired, several of these insulators are connected in series to give a high resistance. Porcelain cleats are often used in constructing small experimental antennæ, and serve the purpose quite well. Another detail shown in Fig. 7 is an aërial insulator made from a piece of hard rubber, polished or unpolished (Bakelite is best), the two ends of which have threaded screw eyes as indicated. A tin or galvanized iron water shield is made to clamp at one end of this hard rubber insulator in order to ward off rain, and thus keep the insulator in a better working condition during inclement weather. It is absolutely impossible to obtain any long distance results for *transmitting* or *receiving* with rain pouring down on the insulators; for a considerable amount of the energy induced in the aërial conductors will leak to earth thru the water covering the insulators. The commercial radio companies have overcome this difficulty by placing cable shields on the antenna insulators in this fashion in a great many instances, and undoubtedly will use more of them as this fact is better appre-

ciated. Figs. 7 and 8 show novel ideas for constructing antenna insulators from porcelain tubes. Of course, the small tubes are not of much use, generally speaking, but the large size tubes, measuring about 12 inches long by 1½ inches in diameter, are cheaply purchased, and make very good insulators. Of course, the main question here is "How can the screw-eyes be securely anchored?" and several suggestions are given in the drawing herewith. In one case the screw-eyes have their lower ends twisted spirally with the largest diameter at the base, so as to hold firmly in molten sulfur; or the screw-eye may be held by slotted wooden blocks cut so as to expand and wedge against one another inside the tube. Fig. 8 shows a detail drawing for making a pair of brass or iron clamps which will make a very substantial aërial insulator from any stout porcelain tube.

THE HOW AND WHY OF RADIO APPARATUS.

Series to Date.

No. 1. *The Induction Coil, Page* 493, *November,* 1916.

No. 2. *The Transformer, Page* 656, *January,* 1917.

No. 3. *Condensers, Page* 735, *February,* 1917.

No. 4. *Spark Gap, Page* 113, *June,* 1917.

No. 5. *Radio Transmitting Inductances, Page* 537, *December,* 1917.

No. 6. *Radio Receiving Tuners, Page* 685, *February,* 1918.

No. 7. *Radio Receiving Condensers, Page* 766, *March,* 1918.

No. 8. *Detectors, Page* 30, *May,* 1918.

No. 9. *Telephone Receivers, Page* 176, *July,* 1918.

No. 10. *Radio Amplifiers, Page* 472, *November,* 1918.

No. 11. *How to Make and Use a Direct-Reading Wave Meter and Decremeter, Page* 874, *April,* 1919.

Radio men everywhere will undoubtedly like to obtain the complete set of these specially prepared papers on the "How and Why of Radio Apparatus." Also the following three important and timely papers on the "Calculation and Measurement of Inductance," by Mr. Secor and Samuel D. Cohen.

Nos. 1, 2 *and* 3 *"Calculation and Measurement of Inductance," appearing in the March, April and September,* 1917, *issues.*

Those interested in these valuable papers can obtain prices of individual back numbers containing them by writing to the "Circulation Department."

In closing, it may be said that the Amateur Radio man will learn much by close observation and the application of common sense and everyday electrical technique to his antenna structures. Don's use faulty lead-in insulators to bring the aërial current into your radio shack—buy a good one, even tho it costs a few dollars. An excellent one is that made of molded Electrose, with threaded tightening flanges. A hole drilled thru the center of a piece of glass, hard rubber or bakelite sheet, at least one foot square, makes a very excellent lead-in insulator. Don't tie your aërial so tight that in a wind-storm it will break at the first swing; suspend one end by a counterbalance weight, or else by springs, so that the flat-top can expand at least 5 to 10 feet in a 100- to 150-foot span. Watch your aërial's behavior in your first wind-storm and you will learn more than by reading several books on the subjects.



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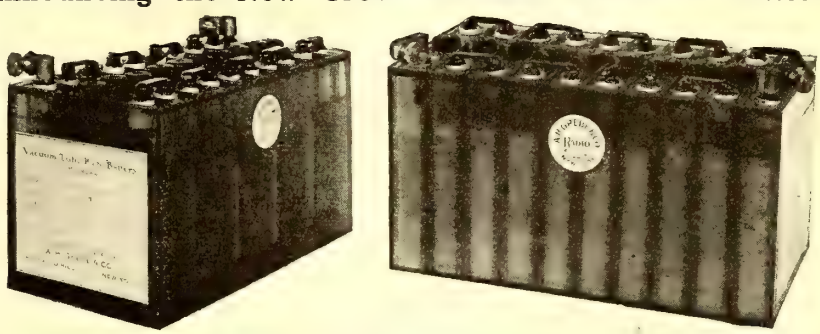
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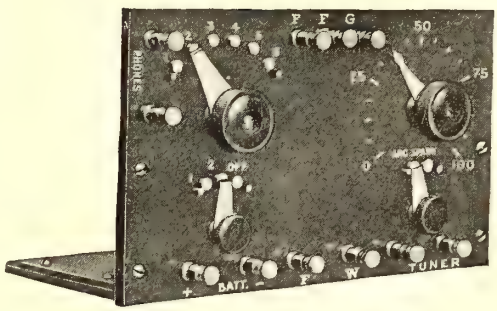
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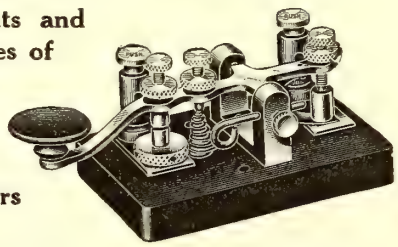
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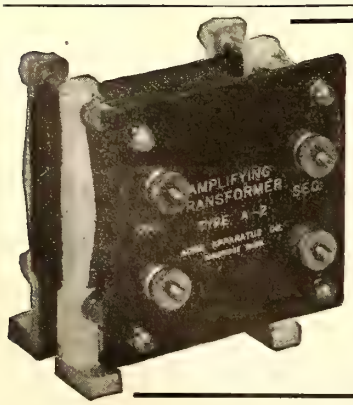
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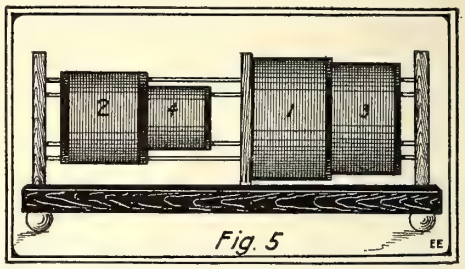
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Eccentric Antennae

(*Continued from page* 432)

the general efficiency of the aërial, but serves to protect it from corrosion. As to the relative merits of the two kinds of wire, there seems to be some doubt. The operaters using each kind declare their own particular kind the best.

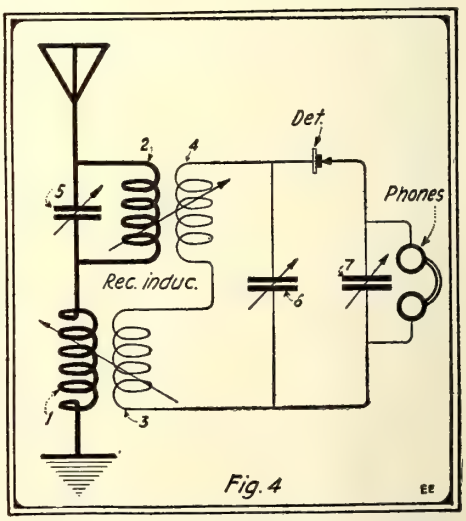


Side View of Special Receiving Transformer Having Four Coils. 1 and 2 Are Primaries, While 3 and 4 Represent Secondaries. This Affords Very Fine Tuning.

There has also been some discussion as to the relative merits of the two forms of aërial—i.e., the *flat-top* and *barrel* types. There is no doubt, however, that the barrel type has far more capacity for the same length than the other. But it also, apparently, would help to increase the static in the phones.

The United States Government has evidently found some very excellent advantages in it tho, for it has adopted the barrel type for use on all its battleships, and has practically abandoned the use of the flat-top aërial on them. It was first tried out by our battleships that were working in conjunction with the Allied fleet in the North Sea.

No doubt the up-to-date Amateur will be glad to give these different antennae a try-out.



Hook-up of Special Variometer Coupler, Provided With Four Coils, Two in the Primary and Two in the Secondary.

NEW HONOR FOR SIR OLIVER J. LODGE.

On June 6th at Clarence House, the Duke of Connaught presented to Sir Oliver Lodge the Albert Medal of the Royal Society of Arts, which was awarded to the famous scientist "in recognition of his work as the pioneer of wireless telegraphy."

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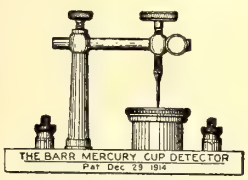
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New 1 K. w. Quenched Gap Transmitter

(*Continued from page 427*)

switch has been named a "Tone Clearer" because poorer tone conditions due to changed operation in the gaps may be compensated for by rotating the handle at the left of the holder as shown in Fig. 3. Precaution is urged never to use the power changer or gap changer with the current on, as the shaft and handle are "alive."

Each gap unit consists of two brass discs which are bolted together thru their centers. A silver ring electrode is riveted to one side of each disc. Two fish paper gaskets, one placed underneath the bolt head and the other between the interior face of the discs. Upon close scrutiny these gaskets will be observed in the gap in the photos herewith presented.

Proper cooling of the gap is afforded by the two sheet metal parallel flanges, which are placed integrally with each gap disc. These flanges join each other at two edges only, the other two edges being left open, forming a flue.

The resonance inductance which is furnished with this set is of the iron-clad type. It has two windings, one being for full power operation, the second, which is larger inductance, is for low-power operation. Actual operating tests show that the natural period of the A. C. armature, resonance, inductance and transformer primary is 425 cycles. The operating frequency ranges from 450 to 550 cycles.

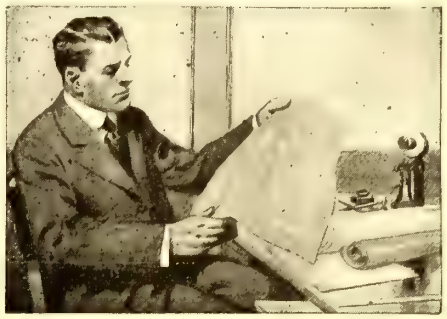
One of the most unique parts of this set is the combination flame-proof Morse key and antenna switch. The key is made with larger contacts for carrying audio-frequency currents at low potential. It is encased in a gas-tight housing of black Japanned sheet brass, this housing making the "live" parts of the key free from all electrical contact with the power circuit. The connection between the key and the panel is made by two lengths of flexible cable, each five feet long. By means of the antenna switch, both the generator armature circuit and also the generator field circuit are broken when the switch is in receiving position.

The thermo ammeter is used in connection with the Weston shunt-block, one end being grounded to the panel frame. It reads from 0 to 15 amperes.

The wave changing device that is used in connection with this set, is built for durability as well as the highest efficiency. It consists of a fixt primary coil and movable secondary coil. They are designed to have corresponding turns as tuning points, and make simultaneous contact with two selector arms. At the left of the upper panel will be seen the handle which varies the wave length. At the left of this handle will be seen three openings, the center one being encircled by a white ring. The correct wave-length of the set is read from this point, the other two openings being for various calculations of wave length. The right-hand handle on the panel is used in connection with the loading inductance. Designated wave lengths of this set when operated on a Navy standard are 600, 752, 952 and 1,905 meters. This set under laboratory tests with a dummy antenna, the same as would be used on a ship, has radiated as high as 18 to 19 amperes antenna current. It has a daylight sending range from actual tests of over 1,000 miles.

This set is at the present time being used by the Navy and is installed on a great many of the merchant vessels, and has proven one of the most efficient sets ever designed.—*Photos courtesy, Emil J. Simon.*

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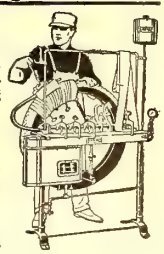
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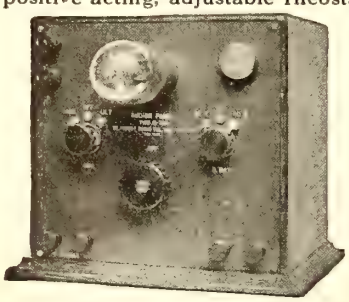
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Developing An Idea

By Nelson Hall

(*Continued from page* 456)

much, gathers up a large amount of information in his travels which he is ready to impart to any one who will give him an attentive ear. By pulling him to your line you can get what he knows and all he has heard. In time he will make a good advertising medium if he is given "the dope."

Then one can inquire in stores handling such a line for the article. They will show the nearest thing in stock and tell if they have seen anything like it. Also it is good to write to mail order houses, for they are posted on a large variety of manufactured commodities.

Trade journals and magazines have special articles describing new inventions as they come out and later advertise them. One can find these articles by consulting such as *Pool's Index, Reader's Guide to Periodical Literature* and *The Industrial Arts Index,* which can be found in public libraries. Often librarians will look up references and sort out the articles if you will write or telephone your request in time. But usually it is best for one to go over the references himself, for while the articles may not directly pertain to the subject they may suggest something worth while considering. Strange as it may seem, the best part of some papers is in the advertising section. By taking papers going to the class of people interested in your article you can see what is being offered. It is well to look over several different papers, because advertisers do not confine themselves very closely and often try the dailies as well as trade journals. A good paper for general interest is the *Saturday Evening Post;* for office supplies, *System;* for household supplies, *The Ladies Home Companion;* for agricultural implements, *The Farm Journal* or *The Country Gentleman;* for tools, *Machinery;* for marine supplies, *The Marine Engineer;* for power plant equipment, *The Electrical World,* and the ELECTRICAL EXPERIMENTER, for what the electrical experimenter and "bug" will want. Nearly every public library has all of these and many more along the same lines on its files. But if one desires most of them can be obtained from newsstands.

From the advertisers many circulars, catalogs and leaflets can be had for the asking. In some libraries there is a file of trade catalogs in the industrial department that may be profitably consulted.

Sometimes going to all of this trouble will not bring to light the fact that some one has taken out a patent on this very article and has not put it on the market—yet. Hence it behooves one to make a patent search or have one made. Patent attorneys will make the search from a drawing, model, or description if it is clear to them, for a nominal fee. But it is usually more satisfactory for one to make the search himself; then he can see what has been done and the looking about may suggest something new. The *Patent Office Gazette* is on file in public libraries and in offices of many patent attorneys. One can go thru the indexes of these, get the numbers and read the short description given in the Gazette, and if it interests him send for a copy of the original patent. These can be obtained from the Commissioner of Patents, Washington, D. C., for five cents each in coin or money order (no stamps accepted). If one decides to have the search made, be very certain that the attorney has the idea right, understands how it works, and sees the novelty of it. He should be furnished with an assembly drawing, lettered so it can be described, clearly showing how it works, and laying special stress on the novelty. A copy of the one taken to the notary public is all right.

Some may think this is carrying the research too far, but after an inventor has developed an idea or two with much laborious study and a fair amount of money on experimental work he will then realize the importance of looking ahead and finding out what has been done by other inventors *and not do the same thing over.* Looking ahead will save the inventor much annoyance and his company from financial distress. Many Teslas and Edisons are turned into insignificant positions because they blundered in their first attempt and lost heart.

The Mystery of Atmospheric Electricity

By Rogers D. Rusk, M. A.

(*Continued from page* 416)

particles the water vapor has condensed as a liquid, forming the large ions, while about others it has only condensed as a dense atmosphere, forming the intermediate ions. When the vapor pressure in the air increases, the dense atmosphere on the intermediate ions may change to a liquid, as in Fig. II, and thus the *intermediate* ions become *large* ions in a fraction of time. This theory is not at all conclusive but it fits in with the observed facts better than any other, and is the only one which explains how the intermediate ions may suddenly become larger and more slowly moving. As water vapor only condenses in this peculiar way on rigid surfaces under certain conditions, we must assume that the centers of the intermediate and larger ions are different from the smaller ones usually found in gases and that they contain some small, rigid dust-like particle. This would also explain why they are not found in dust-free gases even tho the small ions are present, and why they are commonly found in the air.

HOW ATMOSPHERIC PARTICLES ARE ELECTRIFIED.

How these particles become *electrified* is another and vital question. There are many possible ways in which the phenomena may be accounted for. The ultra-violet light from the sun is a very powerful ionizing agent, having the power to detach electrons from the molecules of the air, as it passes thru the air. This ultra-violet light is particularly strong in the upper and thinner layers of the atmosphere, and tho the air absorbs a great many of these waves on account of their shortness, still a large number reach the lower levels of the air. Some more visionary theorists claim that ions and electrified particles are actually carried in huge streams from the sun to the earth, and there is some striking evidence that this may be true during periods of the sun's greatest activity. Friction is a great producer of electric charges, as is evidenced by the action of the well known friction *static machine,* and it is highly probable that friction of the air and dust particles in the air may be one of the potent causes of the electrification of the air. Again it may be due in part to radio-active substances in the earth's surface which constantly give off electrified particles into the air.

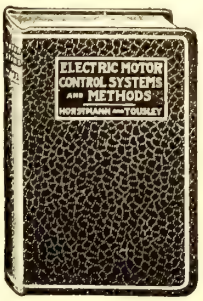
The mystery of the electricity in the air is a double one and if we could discover just how the ions are produced we could more easily ascertain just what they consist of. When these two questions are solved we may be in a position to harness the "electricity of the air" to our own use.

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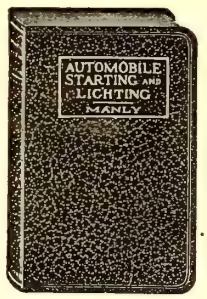


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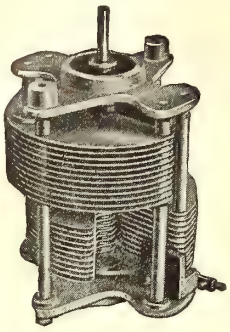
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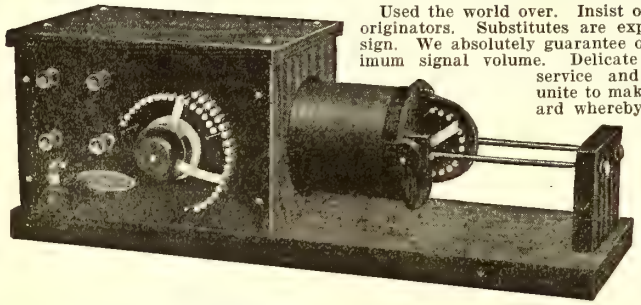
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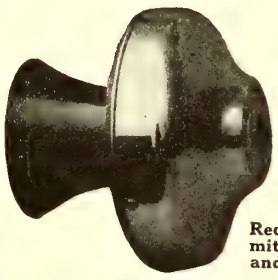
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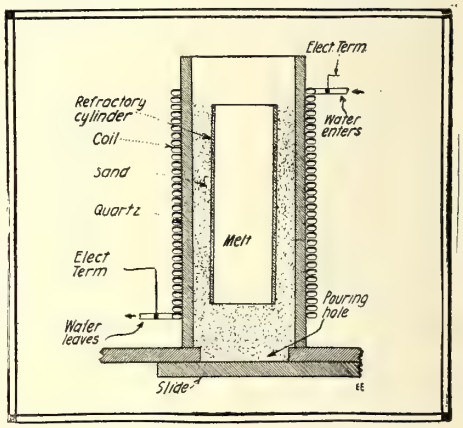
Possibilities of High Frequency Currents

(*Continued from page* 410)

could hardly be called power transmission, for only a very small portion of the original energy eventually reaches its destination in any case.

Very few investigators have given any thought to the utilization of these currents, for great power distribution.

Very new and strange phenomena are apparent when these currents are working. For instance, currents can be induced efficiently in circuits *without iron* as a magnetic medicine. Hysteresis losses are practically eliminated. Without iron in a transformer, it would be lighter for a given power than the present 60 cycle ones. It would be more compact, thereby reducing magnetic leakage. There is no saturation point to consider because of an air core. The reactive effect of a few turns of wire



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is very great; but a small condenser will cause resonance. Therefore the power factor can be easily made unity.

Among the few original engineers in this field of high frequency A. C. power transmission is Prof. Dr. E. F. Northrup, who was assisted by the writer at the Palmer Physical Laboratory, Princeton University, in extensive research along these lines. With these currents, it was possible to get results never before obtained by any other investigator.

Advantages of High Frequency Transformers

With an *air core* transformer, having a resistance load, more efficient results were noticed than could be procured with transformers having iron for a core. The losses were mostly due to the resistance of the conductors; but they were very small, as the circuits were of large cross-section. The hysteresis was negligible, due to the absence of iron. Magnetic leakage was reduced to a minimum because the coupling between primary and secondary was close. The capacity was 10 kilowatts, with three turns primary, insulated for 7,200 volts, and one turn secondary, reducing to 2,400 volts. The circuit was *resonant; therefore the power factor was unity*, or numerically 1.

It remained for Prof. E. F. Northrup to critically study these currents at *low voltage*. He found they could be confined in a mass of metal, thereby producing a terrific heat in a very simple and efficient manner.

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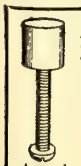
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The present day development in wireless has been to *raise* the voltage and frequency, because under these conditions maximum radiation of energy is brought about.

After several years of careful experimentation, a *high frequency, electric induction furnace* was produced that was applicable for the production of heat in either a *conductor* or *non-conductor*. Its extreme simplicity, owing to the absence of iron and a few turns in the inductor coil, leads one to believe that along these lines lay perfection in electrical mechanics.

At present there is in actual operation under industrial conditions a 20 K.W. furnace of this type. It is used for studying glass at high temperature in *vacuum or under pressure*.

A few years ago applications of this sort were purely imaginary.

There is now under test a 50 K.W. unit. Most all tests were carried on with the damped oscillations of condenser discharges up to 50 K.W., but the undamped oscillations of the high frequently alternator will be used for greater capacity.

With the spark method for producing these currents, a two phase field was used, no doubt for the first time. Altho nothing other than a half revolution of a circular conductor on an axis in this field was noticed, the writer is firmly convinced that, with proper apparatus and research, an induction motor could be made utilizing these currents. *A motor of this sort would be* WITHOUT IRON as a magnetic medium and therefore extremely light. Proper design would undoubtedly make it efficient.

High frequency lighting has already given promise to be eventually the means whereby the much heralded "cold light" may be produced.

The fundamental principles involved in producing these currents has been firmly establisht in "wireless" and with these methods, slightly changed, it is possible to investigate a brand new field of "endless wonders."

In the last decade there has been marvelous advances in electricity; but these have only paved the way for far greater things.—*Photos courtesy Pyrolectric Instrument Co.*

Practical Chemical Experiments

By Albert W. Wilsdon

(*Continued from page* 418)

soluble glass as it is called. Into most laundry soaps both sodium silicat and sodium carbonat are *crutched*, as a filler to soften hard water and to give additional detergent properties.

Toilet soap is made either by melting raw soap, by perfuming an odorless soap, after cutting in fine shavings and drying, or by making the soap directly by the use of pure materials. In either case the mass is colored by metallic oxids or anilin colors, and is perfumed by the use of essential oils, and is then prest into molds while yet fresh. To make a transparent soap it is necessary to dissolve an ordinary soap in alcohol, allow the insoluble residue to settle out, and distill the alcoholic solution to jelly. This may then be prest into molds and dried. Another method quite frequently utilized is to make a cold process soap, with coloring matter and perfume aded, and then to add to the mass more glycerin, or a strong sugar solution, which renders it still more transparent. Soft soap is made directly by the use of potash lye, or by the use of soda lye and considerable water. The glycerin and the excess of lye, if any, remain in the soft soap. This is used in *fulling* or shrinking cloth and in other manufacturing operations, probably on account of the excess of alkali which it contains. The salt lye which is drawn off

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from the kettle in which soap is boiled is used for the manufacture of glycerin. In this process the soluble soap and impurities are taken out by chemical treatment, and mineral salts are separated by evaporation and crystallization. The purified crude residue containing about 80 per cent glycerin is distilled with steam under diminished pressure.

It is false economy to use a cheap soap, on account of the excess of alkali which it usually contains, it injures the fabrics washed, by causing the fibers to disintegrate and readily fall apart. There is a great advantage in using a well dried soap, as it does not so readily become soft in the water and therefore does not wash away so quickly. A laundry soap will lose 25 per cent of water if the bars are piled and allowed to remain for some time where they are freely exposed to the air. Chevreul in his researches on soap said that the cleaning action was because the soap was decomposed, when brought into contact with the water, into fatty acid and alkali. The impurities are set free by the alkali and entangled by the fat acid salts, and thus removed with the lather. Thus it will be seen that vigorous rubbing is not necessary to remove the dirt, tho, quite naturally, it aids the process.

Ordinary soaps are readily soluble in water, but if the water is *hard* from the presence of lime or similar mineral substances, the alkali soap is decomposed and an insoluble lime soap is precipitated, thereby forming a disagreeable scum on the water. Not until all this lime is thrown down by the soap will the lather begin to have a detergent action. On account of the necessity for using hard soap in some localities *washing soda* is used to *break* the water; that is to precipitat the lime so that less soap will be required. In order to make a laundry soap fit for hard water, sodium carbonat is added to it in the crutching.

Experiment No. 1. To make a hard soap, dissolve in a medium-sized beaker 15 grams of caustic soda (in stick form) in 120 cc. of water, and pour one-half of this into a porcelain evaporating dish of at least 500 cc. capacity, add 60 cc. of water and 50 grams of tallow. Boil this solution for three-quarters of an hour, carefully replacing, from time to time, the water that has been lost by evaporation; then add the remainder of the solution of caustic soda and boil for at least an hour more. Water should be added as before, but the volume of the liquid may be allowed to decrease about one-third. Add 20 grams of salt, boil for a few minutes, and allow the liquid to cool. The soap will rise to the top, and the glycerin, excess of lye, and salt will remain in solution.

Experiment No. 2. Slightly acidify the water solution separated from the soap in the above experiment with dilute hydrochloric acid. If any fatty acids or impurities separate out, filter. Pour the solution into a porcelain evaporating dish, and evaporate to dryness on a water bath. Dissolve the residue in strong alcohol, filter or decant from the undissolved crystals of salt, and evaporate the alcohol. The slight residue will be sticky, and give the sweet taste of glycerin.

Experiment No. 3. Cut a good quality of soap into shavings and mix with hot water on a water bath, until well dissolved. Add dilute sulfuric acid until the solution is acid. Note that if the soap is *filled*, the sodium carbonat will cause an effervescence on adding acid. Heat on the water bath for some time or boil slowly, and the fatty acid will separate, forming an oily layer on the top. When clear this may be separated from the water by pouring on a wet filter, and the sulfuric acid removed by washing on the filter with hot water.

Washing soda, is often used, not only to soften hard water, but as a stronger

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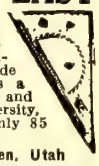
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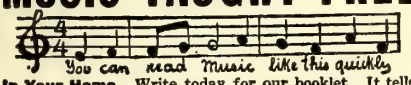
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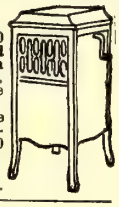
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washing agent than soap. This is a much better material than most of the so-called *washing powders* on the market. It should always be dissolved in a bottle or other vessel, and used as a solution in the quantities necessary. An excess disintegrates the fabrics, or *rots* the goods. Sometimes the washing powders or liquids on the market contain in addition to the washing soda, a little soap or ammonium carbonat or a small per cent of borax, but they are much more expensive than the common washing soda, and no more efficient.

Experiment No. 4. To test a washing powder for sodium carbonat, put a little of it in a test tube and add a few drops of hydrochloric acid. If there is a brisk effervescence it will indicate the presence of a carbonat, and if the gas that is given off colors the Bunsen burner flame yellow, it is an indication of the presence of sodium.

Bluing.

Bluing is the process resorted to in the laundry to overcome the slight yellow color of the clothes, and for the same purpose in the bleacheries where new goods are finished. Indigo was one of the substances most commonly used some years ago. It was known to the ancient Egyptians as a dye and to the Romans as a pigment. The method of using it for bluing, as it is insoluble in water, is to tie up a lump in a cloth, and when soaked in water the finely divided precipitat which is in suspension will give a blue color to the water, and to the clothes, which are to be immersed in it.

Prussian blue (Ferric Ferrocyanid) is also used for bluing. It is insoluble in water and in mineral acids, but is decomposed by alkalies and dissolved by oxalic acid. It is generally used as a solution or *liquid blue,* but this imparts to the goods a greenish-blue color. On account of the ease with which it is decomposed by the alkalies, there is danger that *iron rust* will be deposited on the goods if this form of blue is used.

Experiment No. 5. Make Prussian blue by the action of Ferric Chlorid upon potassium ferrocyanid in the presence of a few drops of hydrochloric acid. Treat this blue precipitat with an excess of sodium hydroxid, and heat to boiling. Notice the reddish brown precipitat of ferric hydrat.

Experiment No. 6. Make some Prussian blue as in the previous experiment, and add to the precipitat, in the test tube, a few crystals of oxalic acid, and warm the mixture. Notice the intense blue solution obtained (liquid Blue).

Ultramarin is an interesting artificial compound which is put upon the market in the shape of small *bluing balls.* It is similar to the native mineral called *Lapis Lazuli,* and is a double silicat of sodium and aluminum containing sulfur. Like indigo, it is insoluble in water and is simply held in suspension in the liquid. There is a difficulty in preventing the formation of blue spots and streaks with the solid blue. This blue is extensively used for coloring wall paper and for *bluing* white sugar.

Experiment No. 7. To show the presence of sulfur in ultramarin place a part of a bluing ball in water in a test tube, and add to it enough hydrochloric acid to make the solution acid. Notice the odor of escaping gas when the solution is warmed, and test it for hydrogen sulfid by holding above the mouth a piece of paper previously dipt in lead acetat solution. The paper will turn black on account of the formation of lead sulfid.

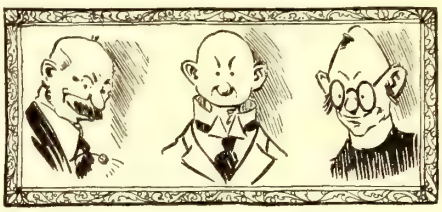
Anilin colors made from coal tar are the basis of most of the liquid blues upon the market at the present time. The soluble blues from this source are very numerous, and they are probably as satisfactory as anything for this purpose.

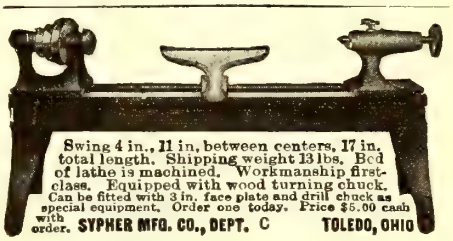

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We want to have one pupil in each locality at once to help advertise our home study method. For a short time, therefore, we offer our marvelous lessons *FREE.* Only charge is for postage and sheet music which is small. Beginners or advanced pupils. *Write* for amazing free book giving all the facts and particulars. Send a postal today!
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Swing 4 in., 11 in. between centers, 17 in. total length. Shipping weight 13 lbs. Bed of lathe is machined. Workmanship first-class. Equipped with wood turning chuck. Can be fitted with 3 in. face plate and drill chuck as special equipment. Order one today. Price $5.00 cash with order. SYPHER MFG. CO., DEPT. C TOLEDO, OHIO

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STARTLING NEW ELECTRICAL TREATMENT

FOR HEALTH, ENERGY, BEAUTY

You can now try the wonderful new Violetta—Violet Ray Machine—10 days free in your own home. Give yourself daily treatments—at less than 1 cent per treatment. Rid yourself of headaches, catarrh, constipation, lumbago, insomnia, nervousness. Relieve your pain from neuritis, rheumatism, indigestion, neuralgia. Give yourself beauty treatments—remove eczema, pimples, blackheads, obesity. Make your body a human dynamo of energy and make your skin fine in texture and free from blemishes or sallowness. Double your strength, sharpen your appetite, soothe your nerves, beautify your complexion. Try Violetta 10 days free.

VIOLETTA—NOT A VIBRATOR

The Violetta does not shock or pain. It does not bind the muscles. It is not a vibrator. The Violetta soothes or stimulates, sending the magic healing power of electricity through every cell, tissue, and organ of the body. Electricity in its highest remedial form. Wonderful and painless even to infants. No other form of electricity for home use is so amazing in its results.

10 DAYS' FREE TRIAL IN YOUR OWN HOME

You can try the Violetta in your own home on our 10 days' trial plan. Not one cent do you have to pay if you are not pleased. Why suffer from physical ailments or from the handicap of a sallow, pimply, imperfect skin when you can try this wonderful treatment in your home without risk. The Violetta is used by thousands of physicians and drugless healers as well as by such prominent beauty specialists as E. Burnham, Chicago, Yvette Parlors in eighteen cities, and hundreds of others. Every penny you pay returned instantly if you are not pleased with the Violetta after 10 days' trial. Write for book describing Violetta Outfits and amazing results of Violet Ray treatments.



WRITE FOR BOOK FREE

Just send your name on a post card or use the coupon below for convenience. We want you to know what physicians, drugless healers, sanitariums, beauty specialists and individual owners say about Violet Ray treatments with the Violetta. We want you to know how it removes pain as if by magic—how it clarifies the skin almost over night—why it is painless, harmless, even to infants.

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326 West Madison Street, Chicago, Ill.

Please send me your free book and 10 days' trial offer on the Violetta Violet Ray Machine. This incurs no obligation on your part.

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Boils	Eye Disease	Paralysis
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Bunions	Hay Fever	Pimples
Callous	Headache	Pyorrhea
Catarrh	Goitre	Rheumatism
Chilblains	Insomnia	Skin Diseases
Colds	Lumbago	Sore Throat
Corns	Nervousness	Sprains
Constipation	Neuralgia	Tonsilitis
Dandruff	Neuritis	Whooping Cough
Deafness		

What Physicians and Users Say

Trixie Friganza, well known actress says "Cheerfully will I add my praise for Violetta. It's the best 'pain chaser' and 'soother' I've had the good fortune to find. It's WONDERFUL. It cured my brother of neuritis. As for myself I use it for facial treatments and general massage. I cannot say too much for it."

Dr. Bert H. Rice, of Vinton, Iowa, says: "I have good results with the Violetta High Frequency Instrument in all cases of neuralgia. Almost instant relief in Facial Neuralgia."

K. L. Allen, D.C., 205 Boone National Building, Boone, Iowa, says: "I have had very good results with the application of High Frequency Current in cases of Paralysis, Rheumatism and Neuritis, and think it a great help in drugless healing."

Dr. Daniels, Lisbon, North Dakota, says: "Have used the VIOLETTA in such cases as Goitre, Bronchitis, Pluerisy, Neuritis, Neuralgia and Lumbago, and find it very beneficial. In fact, I would not be without it in my office."



Experiments in Physics

By John J. Furia, A.M.

(*Continued from page* 417)

the card is turning thru 180 degrees the image remains if the speed of the card is sufficiently high. The image of the reverse side strikes the retina while the image of first side is still on it, and hence BOTH objects appear to be in view. This is the fundamental principle of the *motion picture.*

Figure (4) is another example of an illusion due to persistence of vision. A black star is drawn on a blank card. If the card is placed on the forefinger and spun around, the star will disappear and TWO circles will appear as in B, the inner one *black* and the outer one *gray.* As the card is spun around the image of the points of the star and the image of the white card between the points strike the eye in rapid succession, so that due to persistence of vision, both black and white are seen and the result is the gray circle or mixed shade. Since the center of the star is all black, the center circle is black.

Even tho money is not of much use to many of us now, the following interesting device for "Making Money" provides a fitting conclusion to any performance. A small miniature clothes wringer is brought forth. A piece of paper is cut to the size of a dollar bill. The paper is inserted in the wringer, *the handle is turned and a brand new, crisp dollar bill comes out from the other side!* This may be repeated indefinitely (provided the performer is a multi-millionaire). Figure (5) tells the secret. The two rollers are not two distinct rollers, but are made of a continuous piece of goods wound as in B. Beforehand the performer has wound some dollar bills into one of the rollers and then on performing the "stunt" places the paper in the other roller. *As he winds the paper into one roller, the dollar bill is unwound from the other roller.* If the apparatus is well made and carefully put together, a great deal of fun can be gotten from it without the *modus operandi* of the illusion being discovered.

(*To be continued*)



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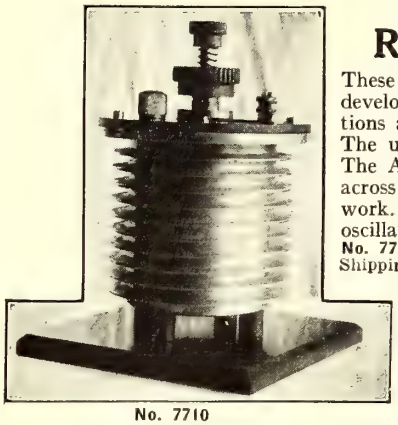
Explain, without obligating me, how I can qualify for the position, or in the subject, *before* which I mark X.

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Machine Shop Practice	Cartooning
Toolmaker	BOOKKEEPER
Gas Engine Operating	Stenographer and Typist
CIVIL ENGINEER	Cert. Pub. Accountant
Surveying and Mapping	TRAFFIC MANAGER
MINE FOREMAN or ENG'R	Railway Accountant
STATIONARY ENGINEER	Commercial Law
Marine Engineer	GOOD ENGLISH
Ship Draftsman	Teacher
ARCHITECT	Common School Subjects
Contractor and Builder	Mathematics
Architectural Draftsman	CIVIL SERVICE
Concrete Builder	Railway Mail Clerk
Structural Engineer	AUTOMOBILE OPERATING
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No. 7710

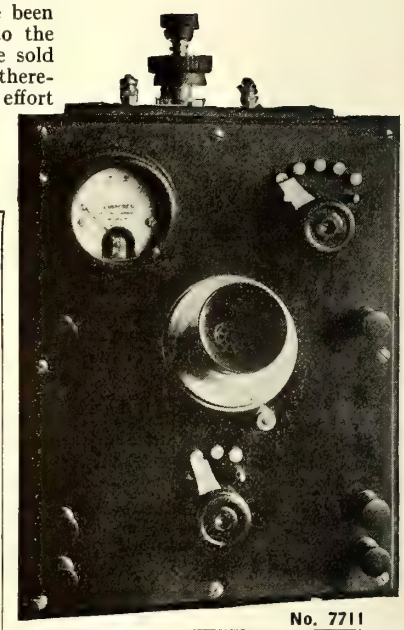
Arc for Generating Undamped Waves for Radio Telephonic & Telegraphic Transmission

These instruments are the acme of perfection in Radio Transmission. The latest and best developments in Radio during the *Great War* are embodied in this apparatus. Educational Institutions and Laboratories can now procure the most modern Radio equipment at a reasonable cost. The undamped *Wave Generator* illustrated is exceptionally well constructed of heavy aluminum. The Arc chamber is flanged in order to offer the greatest cooling surface. The Arc takes place across two solid special Tungsten electrodes which have been found particularly efficient for this work. The electrodes are fully adjustable, permitting very precise adjustment of the emitted oscillatory currents.

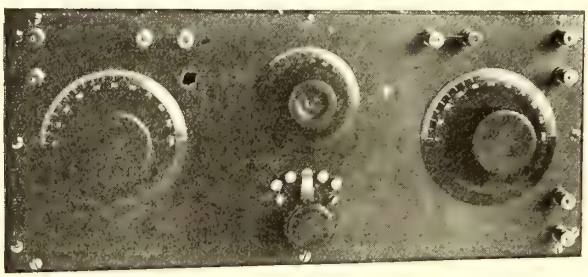
No. 7710—½ K.W. Sustained Wave Generator, as illustrated, operates on 110 V D.C. Size 6½ x 6½ x 8½. Shipping weight, 35 lbs.; price.....**$50.00**

This complete ***Radiophone Transmitter*** is unquestionably one of the finest pieces of Radio apparatus ever placed on the market. A Radiophone might have been sold heretofore; but it was felt that in justice to the purchaser, no instrument of this nature should be sold unless it were possible to obtain efficient results therefrom. This transmitter is the result of great effort expended in the design of a Radiophone set which should meet all requirements as to practicability and compactness combined with highest efficiency. It includes all apparatus necessary for transmission. The Arc is similar to the one illustrated elsewhere on this page.

No. 7711—Complete Sustained Wave Radiophone and Telegraph Transmitter, inclosed in a beautifully finished cabinet; size 14½ x 9 x 12½"; weight 50 pounds; as illustrated; price.....**$150.00**



No. 7711



No. 7712

The Short Wave Regenerative receiving cabinet shown is built in accordance with the most modern methods of reception. In work with oscillating audions it is necessary that all losses be diminuated as it was found that tuning should preferably be done with inductance alone, without using variable condensers.

This Receiving set will be found fully up to the mark in comparison with the highest priced set on the market to-day, yet its cost is well within the reach of all.

No. 7712—Regenerative Receiving Cabinet set, as illustrated; size 16¾ x 7⅝ x 8"; weight 25 pounds; price.....**$50.00**



No. 7715

The Vacuum Tube Socket illustrated was designed to be used by those who are desirous of assembling their own vacuum controls and who need a good socket to hold the bulbs. It is well designed, durable and reasonably priced.

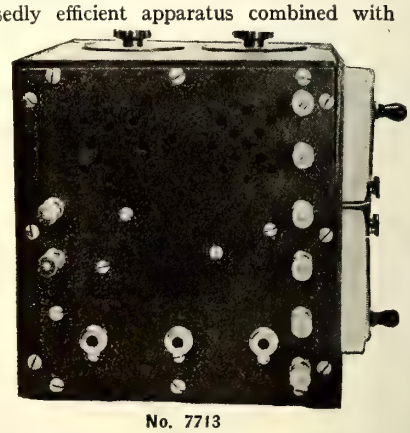
No. 7715—Vacuum Tube Socket; 2¼ x 2¼ x 1½"; weight 1 pound; price.....**$1.50**

This Tube socket is adaptable for both receiving and transmitting tubes.

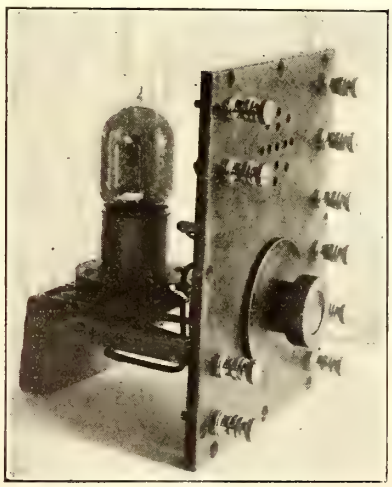
The Two Step Amplifier illustrated is undoubtedly one of the finest instruments offered to the experimenter. It is an example of unsurpassedly efficient apparatus combined with exceptional mechanical skill in its design and construction. Two Vacuum Tube sockets are mounted within the cabinet which also contains the two amplifying audio-frequency transformers which were especially designed for this instrument. It is of great consistance in amplifying live and radio telephone currents.

The telephones are plugged in any of three jacks mounted on the panel, permitting the use of either one or two steps of the amplifier or simply cutting the amplifier out entirely.

No. 7713—Two Step Amplifier, as illustrated; size 7⅝ x 7¼ x 8"; weight 7 pounds; price.....**$55.00**



No. 7713



No. 7714

The Vacuum Tube Control Cabinet is one of the essential instruments of the modern radio station. The Vacuum Tube holder, filament, rheostat, grid condenser and grid leak are mounted within the cabinet, the only part on the exterior being the rheostat control knob and dial. The construction throughout is on the same high level of excellence with the other instruments illustrated on this page.

No. 7714—Vacuum Tube Control Cabinet, as illustrated; size 6 x 7⅝ x 6¾; weight 5 pounds; price.....**$25.00**

P. S. No Tubes furnished by us with these instruments.

THE ELECTRO IMPORTING CO.

MANUFACTURERS

231 FULTON STREET N. Y

SEE OUR FULL PAGE "AD" ON PAGE 392

Telephone Solves "Lower Berth" Squabble.

(*Continued from page* 408)

The disadvantages of this system of distribution of cards are numerous, the greatest one being that while one agent may entirely fill his cards, another may not, and thus there will be vacancies in spite of a heavy demand at some other window. Added to this there is a good deal of time wasted while the ticket agent is trying to get in touch with some other agent who has a berth open, not to mention your good time and patience wasted while waiting for him to get the desired information.

But this new system which has been installed in the Grand Central Terminal obviates all this. All the time and energy that were formerly wasted are now saved by the creation of one central telephonic distributing system, which has been installed on the second floor of this railroad terminal and known as the *Pullman Distributing Office*. It is kept open all night long, and in it are maintained all the records and diagrams of every parlor and sleeping car operating out of the terminal.

Altogether this office takes care of the seventeen groups of ticket offices spread over New York City, Weehawken, and Yonkers.

This whole system was built especially to order for this railroad company, the idea being the outcome of a long and exhaustive study of the problem by Mr. Neil Mooney and Mr. Devlin, of New York City.

The equipment proper consists of a distributing board 18 feet long, 3½ feet wide and 2½ feet high. For its whole length this is surmounted by a rack containing pigeonholes which accommodate 190 sets of diagrams. This distributing board is built in three sections, with four operators to a section, each operator being assigned a certain set of trains. On the table in front of her is a set of signal lights, and she is equipt with head 'phones and a mouthpiece as shown in the illustration.

In all of the seventeen groups of ticket offices taken care of a duplicate set of buttons is given to each ticket agent. (See illustration.) He is also furnished with a key showing which operators are taking care of certain trains. By this method the agent in Yonkers or at any of the other stations presses a button, and instantly a light flashes before an operator in the distributing room, who answers "All right", —then the conversation runs like this:

TICKET SELLER:
"25.
"Chicago.
"Thursday, April 10th.
"Lower."
PULLMAN CLERK, at Distributing Board:
"All right."
TICKET SELLER:
"1776" (meaning railroad ticket number).
PULLMAN CLERK:
"Lower 12.
"Car 42.
"25.
"Chicago.
"Thursday, April 10th.
"1776."
TICKET SELLER (repeats):
"Lower 12.
"Car 42.
"25.
"Chicago.
"Thursday, April 10th.
"1776."

Translated into good English language this means that a lower berth is desired on train No. 25, the 20th Century Limited, on Thursday, April 10th, New York to Chicago. This formula reduces conversation to a minimum, and is very strictly adhered to. No girl is given "another chance".

At one side of the room are several desks which take care of nothing but telegraphic requests for reservations. Nearly a thousand requests per day are received, and it is easily seen that this forms no small part of the day's work.

Because of this concentration of distribution space may be sold until two minutes before the train leaves, when the diagrams are sent by special messenger from the distribution office to the conductor of the train.

There is one more feature that deserves mention, and that is the entire absence of all bells. All the signals and calls are made by different colored lights. The only time a bell rings is when one of the different circuits opens, or a fuse blows, in which case an expert electrician is immediately set on the job, and the trouble is fixed up very quickly.

Possibly a word as to the operators themselves would not be amiss. They are all well educated girls, some of them from college, a number of them having husbands in the American Expeditionary Force. The majority of them have been chief operators at some other exchange, and all of them have exceptional "speaking voices." The head of that department, Mr. Devlin, was very careful to make clear the difference between the "speaking" and the "talking" or "telephone" voice. A beginner there is paid $87.50 per month, and the more experienced operators get $125. In return the company demands a most rigid discipline while on duty, but at the same time everything is made as pleasant as possible for the girls. On the floor above is a big rest room fitted up with easy chairs and sofas, where the girls may go whenever they feel sick or faint.

Taken all together, the New York Central Railroad is doing its best to present to the long suffering public a good and efficient method of coping with the Pullman proposition, and they feel that their present method is nearly 100 per cent efficient.—*Photos courtesy New York Central Lines.*

Twin Cell Design of Dry Battery

(*Continued on page* 413)

each consisting of flat zinc strips 15/16 in. wide by 24 in. long, bent in the form of a letter "M." The maker points out that these zinc anodes present to the material contained in the cell a surface of around 90 sq. in., as against 42 sq. in. in a round design. It is therefore claimed that the density of current per square inch is greatly reduced with an increase of life of the cell that is of great practical importance.

The common positive electrode can be used with either negative electrode separately or together by joining the two negative electrodes by a connection. This is the way the battery is furnished. Either half of the battery will give 1½ volts, so that when only one-half the cell is used, the remaining half is kept fresh. The battery measures 1⅛ in. by 3 in. by 6 in., and weighs 2 lbs. 2 oz. The outside case is waterproof and non-conducting. On test it is claimed the battery has shown a voltage of 1.5 to 1.55 and on short circuit a current of 35 amperes.

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Epilepsy	Fevers
Pleurisy	Jaundice
Constipation	Dyspepsia
Rheumatism	Paralysis
Asthma, etc.	

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A Tell-tale Submarine Net

(*Continued from page* 406)

holding the net sets in motion the signaling alarm devices provided by the inventor.

The anchoring devices at each end of the net each comprise a buoy in the form of a cylindrical body or tube containing an air chamber and ballast at the lower end. The lower end of the buoy is connected with a number of chains having weights or anchors at their lower extremities, and all of which may be adjusted and set to maintain the net or nets at the usual depths traveled by submarines. A series of nets can be arranged at various levels so as to form an effective barrier wherever required. The buoys remain in their original position, even if the net is detached by the submarine, and can be used for replacing another net.

Each buoy carries a float chamber having a dependent stem extending into a chamber at the upper end of the main buoy, and on this stem is placed a spool carrying a cable. When the net is pulled away from the anchoring devices, a set of catches disengage the spools so that the floats rise to the surface of the water and are carried along by the net. The float will thus serve to indicate that the net has been torn away from its anchorage by a submarine enmeshed therein, and moreover indicate the position of the sub-sea raider. At the same time a set of *marker floats* rise from the buoys to indicate their position.

In order to detect a submarine that has enmeshed with the net during the night, the float devices have suitable illuminating means which are easily set into operation by electric current. The float chamber contains a storage battery or other source of current connected in circuit with lamps adapted to be illuminated when the circuit is closed, by a special time-clock device connected with the release mechanism of the buoys. At the same time that the signal lamp circuit is closed in the floats, by means of the time-clock arrangement, an aërial bomb or rocket is projected into the air as shown in the accompanying illustration, this bomb being arranged in a barrel having at its lower end a charge of explosives, which is ignited by a spark plug connected up with an electric battery and spark coil circuit within the float. The bomb is fitted with a fuse, which will cause it to be exploded when it reaches a certain height. A red light or flare may be produced on the floats when the bomb is projected. For this purpose a charge of *red light* or other signal powder is arranged in a compartment within the float chamber.

ELECTRIC SHIP WELDING SUPERIOR.

The displacement of riveting by electric welding in ship construction is being considered in English insurance circles, with regard to possible reduction in rates. It is claimed that welded plates stand the impact test as well as riveted plates, but underwriters require further information on the question of the results of stranding and collision. The cost of electric welding is stated to be much below that of riveting, and if similar insurance rates may be secured will undoubtedly supplant riveting to a great extent.

A New Cam Regulator for Auto Dynamos

(*Continued from page* 415)

A number of voltage regulators have been developed, but of these only two—the bucking-winding system and the third-brush system—have been generally used. To these has been recently added a third, the Cam-Regulator System.

This system is very different from the usual systems both in principle and in operating characteristics. Some of the chief advantages claimed for it are as follows: The voltage is held more nearly constant than is the case with the other systems. Ideal battery-charging conditions are provided, since the amount of current delivered to the battery is large when the battery is discharged, and small when the battery is full. The battery is not necessary to the proper operation of regulator. Hence, in an emergency the generator can be operated with the battery disconnected, and in some cases the battery can be dispensed with altogether.

The generator for this system is of the simple *shuntfield* type, and voltage regulation is effected by *inserting resistance in the field circuit.* This principle is the same as that employed in ordinary power-generator service, but the method of application is quite different.

In power service the voltage of a generator is kept constant by increasing or decreasing the *amount* of resistance in series with the shunt field as the voltage tends to rise or fall. With the cam-regulator, however, a fixt amount of resistance is always used but the voltage is regulated by varying the *length of time* during which this resistance is in the field circuit. How this is accomplisht can be best understood by referring to the diagram of the cam-regulator.

This device consists of four main parts—a magnet coil and core, a set of contacts, a cam mounted on the generator shaft, and a resister. The resister is so connected that it is *short-circuited* when the contacts are *closed,* and *in series* with the shunt field of the generator when the contacts are *open.* The arm carrying the lower contact rests on the cam and is moved up and down with every revolution of the generator shaft. The upper contact is mounted on a pivoted arm, and when the generator is not in operation, it is prest against the lower contact by a spring finger.

With the engine running at low speed, as in starting, the contacts are together and the resistance short-circuited. When, however, an increase in the engine speed brings the voltage of the generator up to the operating point (7 volts), then the magnet comes into play.

The coil of this magnet is connected across the brushes of the generator, and when the voltage rises above 7 volts, it has sufficient strength to draw the upper contact away from the lower, thus inserting the resistance in series with the generator field. Immediately the voltage starts to fall, and the magnet drops the upper contact, closing the points and cutting out the resistance. This increases the voltage again, and the magnet picks up the contact, only to drop it immediately afterwards. Since the strength of the magnet's pull depends upon the voltage of the generator, the higher the voltage the longer the upper contact will be held, and the fewer will be the number of closings per minute. This is equivalent to an increase in the amount of resistance.

The operation of opening and closing the contacts takes place so rapidly that the eye can not follow it, nor can the variations in voltage be noted on a voltmeter. In practice the regulator is adjusted to hold the voltage at approximately 7 volts at all operating speeds and under normal loads.

—Photo courtesy Westinghouse Elec. & Mfg. Co.

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Battery Charging Pays Big Profits. City current or gas engine operates. Easy terms. Hobart Brothers, Troy, Ohio.

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Auto Motors and Supplies. Buick, Hupp, Franklin, Michigan, Everett, Hudson, Chalmers. Both water and air cooled motors, $40 each and up. Bosch Magnetos, $15 each and up. Presto Tanks, $5. Coils, Carburetors, Head Lamps, Horns, Air Compressors, Generators, Starters. Write for bargain bulletin second-hand auto accessories. Johnston, West End, Pittsburgh, Pa.

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Signs for store and office windows. $50 a week easily made. Chicago Sign System, G 326 River St., Chicago.

$10 Daily refinishing chandeliers, brass beds, automobiles by new method, without capital or experience. Free particulars and proofs. Write today. Gunmetal Co., Ave. D, Decatur, Ill.

Wonderful Chance—Men's shirts and furnishings at wholesale rates, or make $10 daily starting real business. Goodell Co., Duratex Bldg., New York.

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Wireless apparatus patent for sale. High merit. Information, pictures, address Mr. Teele, 139 Genessee St., Buffalo, N. Y.

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Collapsible Scenery for all plays. Decorations. Amelia Grain, Philadelphia.

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July 17, 1919

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N. Y. City.

Attention, Mr. DeMott.

Gentlemen:—Herewith two small ads. for next issue of your two magazines. We also expect one along in a day or so from a Cartoon School out in Pennsylvania, but he is making a drawing for same and no doubt this is what is delaying it. As soon as we receive it we will rush it right over to you.

Your magazines are pulling good for us and it all seems to be a good class of trade, which indicates your readers are wide awake and answer ads.

Very truly yours,

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Clean, Neat, Perfect Kodak Finishing at the lowest prices. Work returned the same day received. Send film for sample print and copy of catalogue on developing, printing, enlarging and hand coloring, also copy of Photo Craft Magazine, which will help you make better pictures. Photo Craft Co., Box 69, Ann Arbor, Mich.

For 15c we will develop and furnish prints from one, six or eight exposure film or enlargement 8x10, your favorite negative, 20c to show quality and service. Associated Photo Company, Sta. A 12, Cincinnati, Ohio.

Roll Film Developed, 6c. Prints, 2c up. Send for price list. The Blad Photo System, Wareham, Mass.

Mail us 15c with any size film for development and six velvet prints. Or send six negatives any size and 15c for six prints. Or send 35c for one 8 x 10 mounted enlargement. Prompt, perfect service. Roanoke Photo Finishing Co., 255 Bell Ave., Roanoke, Va.

Exchange Ads.

Exchange, Buy, Sell. Wireless, electrical goods, etc. Large list 6c. State what you have and want. Zehrbach, Box 250, Hiram, O.

Wanted Tribune light car or parts. State lowest cash price and full particulars. Van Deurs, 325 Beta Place, Glendale, L. I.

Photographs wanted of Autolite and Hoyt (Gray-Davis) automobile Ammeters. Also speedometers. Will pay $1.00 each. Write Victor Todd, Rainbow Lake, New York.

Amateurs! Complete Audiotron regenerative cabinet, $18.50. Write for photo and particulars. H. Springfels, 70 E. Utica St., Buffalo, N. Y.

Let's swap! What'ye got? What d'ye want? Free Advertising. Three months, dime. Swap Bulletin, Wayne Congress, Detroit.

Sell—Gilbert's $10 Electrical Set. Tank developing outfit. Fine condition. Write. James Raiford, Route 1, Bessemer, Alabama.

2-$4.00 3-slide tuning Coils, sell for $2.50 each. 1-Murdock Loose Coupler, cost $8.00, sell for $5.00. Instruments used only 2 months. Prepaid. Sidney Kronengold, 5508—5th Ave., Brooklyn, N. Y.

For Sale—DeForest audion on panel, Oscillation Transformer and sending, receiving switch, $8. Also I.C.S. Electric Lighting Course, $20. Stamp for particulars. Eldred Hall, Solvay, N. Y.

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5000 Meter Coupler and other instruments for sale. Write quick. Ritchey Hume, University, Mississippi.

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Amateurs. Write me for list of Radio Apparatus for sale at big bargains. All in good order; closing my station. Wendell Holst, 3619 N. St. Louis Ave., Chicago.

65 Chemical Set, $5.00. Bricktor, $4.00. Lionel Gates, Coalport, Pa.

Sell 1/20 H.P., 110 volt, 60 cycle continuous duty induction motor, $7; 40 watt dynamo, $4.50; 20 watt dynamo, $2.25; volt and ammeter, $1.25. Adolph Gedeon, 3296 W. 50th St., Cleveland, Ohio.

For Sale or Exchange—$40 Hawaiian Guitar outfit, $25. Write. Arthur Ellwein, Wrightsville, Pa.

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For Sale—Audion, complete, except bulb, $6.50; Walnut case, no bulb or battery, $3.50; Blitzen, ¼ K. W. transformer, mounted, $10.00; Audion coil, $1; 55 galvanized pole steps, $1.00; Double variometer, $2.50; Telegraph outfit, $1.00; 30 Algier stories, $2.50. Rule D. Egbert, Tiffin, Ohio.

Will Exchange 5 H.P. gasoline engine for shot gun. Schmelzers, 90 St. Marks Place, New York.

Sell—Electrical apparatus. Thompson, 36 John St., Worcester, Mass.

Sale—22 Remington Rifle $5.00. Two telegraph sets $4.00. No. 6 Erector $5.00. Electric Miroscope $4.00. W. Grus, 505 Clinton Ave., Oak Park, Ill.

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100 induction motor winding diagrams, 1, 2, 3 phase, star delta. 2 to 12 poles inclusive. Postpaid, $5.00. W. Glass, 2108 South Broad St., Philadelphia, Pa.

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Lava Insulation is not molded but individually sawn, lathe turned, milled, drilled, threaded. No limitation on form, only on size. Kilned at two thousand degrees. Hard, strong, accurate, fire, acid proof. Ask for book. American Lava Insulator Company, Chattanooga, Tenn.

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Radio Apparatus of Quality. Manufactured to your own specifications. Radio Engineering Company, Baltimore, Md.

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Enter a New Business. Earn $3,000 to $6,000 yearly in professional fees making and fitting a foot specialty, openings everywhere with all the trade you can attend to; easily learned by anyone at home in a few weeks at small expense; no further capital required; no goods to buy; job hunting, soliciting or agency. Address Stephenson Laboratory, 18 Back Bay, Boston, Mass.

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Make $4.00 a Day Silvering Mirrors. Complete instructions, 10c (coin). Lloyd Stultz, Middletown, Maryland.

Build Up an Income in Oil. Others are doing it—Why not you? Today is the opportunity. Join our easy monthly payment plan now—it may mean hundreds in profits. Write for information. National Oil Drilling Co., Dept. K, Houston, Texas.

Dollars Yearly in Your Back Yard. No ginseng, mushroom dope. New ideas. Investigate. Particulars free. Metz, 313 East 89, New York.

Money-Making Farms. 19 States. $10 to $100 acre. Stock, tools, crops, often included to settle quickly. Write for big illustrated catalog. E. A. Strout Farm Agency, 150 E C Nassau St., New York.

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Radio Amateurs; Here is an opportunity for you to secure a very efficient amateur radio set complete. Photos and description furnished on receipt of postage. Address Clarence Bornofska, 1322 Lincoln St., Racine, Wis.

Complete Course on compiling and selling names by mail to advertisers. Description free. Globe Publishing Co., 120 Syracuse, N. Y.

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"Quick-Action Advertising—How It Is Building Business for the Progressive Advertisers of America"; A little story of results told by the advertisers themselves—not the publishers. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 W. 39th St., New York.

Start a Profitable Business manufacturing "Puffed Crisp." Delicious confection. Whirlwind money-maker. Machine, Instructions complete $6.50. Samples 10c. Bestever Products Co., 2426-PE-9, Polk St., Chicago.

Blue Prints, 236 A.C. diagrams,contains 54 single phase, 42 two phase, 50 three phase Star, 40 Delta, 12 Star-Delta. Appendix 68 changes of voltage, phases, speed, cycles, etc. 10 samples 25c. Particulars free. Charles L. Chittenden, 811 West 18th Street, Kansas City, Missouri.

Salesmen—New proposition that nets $100 to $200 weekly. Give moving picture shows at schools, colleges, universities, chuches, Y. M. C. A's, clubs, lodges, societies and homes. We furnish complete outfit. Write for particulars. W. H. Wade, Dept. 5, 14 N. Michigan Ave., Chicago.

Make Big Money opening safes and setting combinations. Wayne Strong, P. O. Box 1430, Los Angeles, Cal.

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Electric Arc Generator halves expense. Your engine operates. Easy terms. Hobart Brothers, Troy, Ohio.

Earn $1200 A Year in Spare Time writing photoplays. Experience unnecessary. Send for free book, valuable information, special prize offer. Photo Playwright College, Box 278 E-5, Chicago.

Photoplays Wanted. Big prices paid. You can write them. We show you how. Free particulars. Rex Publishers, Box 175, E5, Chicago.

Continued on Page 486

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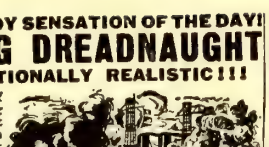
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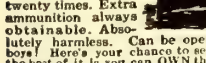
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Here is a model of Uncle Sam's fighting monsters. Eight big guns, each of which flashes, at correct intervals, from twelve to twenty times. Extra ammunition always obtainable. Absolutely harmless. Can be operated indoors or out. Now boys! Here's your chance to see a battleship in action, and the best of it is you can RUN the ship and command the firing yourself! By having two or more Battleships, you can arrange EXCITING NAVAL BATTLES in your own home. **Price of Warship and Ammunition, 25c, three for 40c, or a fleet of 3 ships for $1.50 postpaid. Extra Ammunition, 5 cents per doz.**

TOOTH-ACHE STOP

EASY TO USE



Stops the Pain; Stops the Tooth

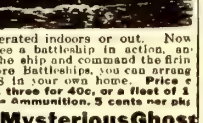
Squeeze a little in hollow of tooth; the **Ache Stops Instantly;** the paste hardens, forming an antiseptic Filling. Absolutely harmless. Have it ready for the next bad attack. **25c per tube, postpaid.**

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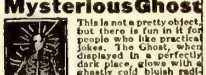
A clever novelty. National Safety First Movement has made them very popular. Wear one and show your sympathy with the movement. Also handy for wearing of amateur theatricals and the like. Two sizes, ⅝ in. (gold plated) and 1¼ in. (nickel-plated) **6c** each, two for **10c** p. pd.

Mysterious Ghost



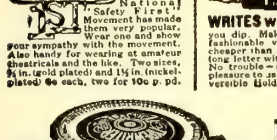
This is not a pretty object, but there are many people who like practical jokes. The Ghost, when displayed in a perfectly dark place, glows with a ghastly bluish radiance, very apt to give one a "creepy" sensation, even when you know all about it, but a regular terror for those who come upon it unexpectedly. A great joke to play on your mother-in-law. **Price only 15 cents each, or two for 40 cents.**

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WRITES with WATER 600 words to every time you dip. Makes its own ink. Writes fashionable violet color. Better and cheaper than fountain pens. Writes a long letter with one dip in plain water. No trouble—no bother—no mess. A pleasure to use. With Nickel Plated Reversible Holder **10 CENTS.** 8 for 25c

SIMPLEX TYPEWRITER ONLY $2.50



Cheap But Good. So Simple a Child Can Use It. We Guarantee the Writing.

Though so marvelously cheap, this machine is a **thoroughly practical Typewriter.** We positively guarantee it to produce writing **equal in every respect to that of any $1.00 machine.** It does not seem possible at the price, but examine a specimen of its work and you will be convinced. With reasonable care it will last a lifetime. It is so simple that a child can write on it. You can learn all there is to know about it in **five minutes,** and an hour's practice will make you an **expert operator.** Every business man must have a typewriter. If illegible pen writing is abandoned and creates the impression that the firm is a no-account and slow going concern. We assure you that the **Practical Typewriter** fully deserves its name—as it is the correspondence typewriter of the professional, and to **do it well.** You should not miss this chance of securing a bargain. The letters of the alphabet, the numerals 1 to 10, and punctuation marks are so grouped that the letters most used are before the operator most of the time, enabling him to write rapidly. The rollers hold the paper in position while writing and at the end of each line a slight turn of the roller moves the ratchet which makes a click and forces the paper forward, giving the proper line spacing, so that the lines are all an equal distance from each other, ready for the next letter writing. Each typewriter packed in a strong box, with full printed instructions for use. Price complete, $2.50 sent by mail postpaid.

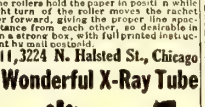
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You may have a lot of fun with this Sparkling Gem Squirt Ring. It consists of a handsomely plated ring, attached to a rubber ball, so arranged that the latter is quite out of view when the ring is in the proper position. Such an attractive looking ring as this cannot fail to be the center of attraction. While the victim is absorbed in getting a closer view, you just squeeze the rubber ball and the observer experiences a very great surprise. **PRICE 20 CENTS,** three for **50 cents postpaid. J. S. & Co.**

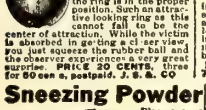
Wonderful X-Ray Tube



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Price **10 cents;** 3 for **25 cents;** 1 dozen, **75 cents.** Sent by mail, postpaid.

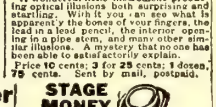
Sneezing Powder



Place a very small amount of this powder on the back of your hand and then blow it into the air, and everyone in the room or car will begin to sneeze without knowing the reason why. It is most amusing to hear their remarks, as they never suspect the real source, but think they have caught it from the other. Between the laughing and sneezing you have a jolly time during the time of your life. For **parties, political meetings, car rides,** or anywhere at all where there is a gathering of people, it is the **greatest joke out. Price 12c or 3 for 30c.**

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With a bunch of these bills, it is easy for each person of limited means to appear prosperous. By flashing a roll of these bills at the proper time and peeling off a genuine bill or two from the outside of the roll, the effect created will be found to be all that can be desired. **Prices, postpaid: 15 Bills 10c, 150 Bills 25c, 125 for 50c, or $1 Bundle.**

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A marvelous musical instrument. No other instrument produces such wonderful music, whether it be the joyous notes of a violin or the solemn strains of a church hymn—in fact, any class of music can be played upon the Humanatone without practice, as it is almost a self-playing instrument. When played with a piano accompaniment, or any other musical instrument, the effect is charming. Full printed instructions for playing sent with each instrument.

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Uses Standard Films same as the larger machines. Very easily managed. Simply turn the handle. Good Variety of Films always obtainable

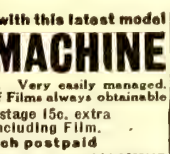
PRICE Complete ONLY $2.65 Postage 15c. extra including Film.

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THIS IS A GENUINE MOVING PICTURE MACHINE and the motion pictures are clear, sharp and distinct. The Moving Picture Machine is finely constructed, and carefully put together by skilled workmen. It is made of Russian Metal, has a beautiful finish, and is operated by a finely constructed mechanism. The projecting lenses are carefully ground and adjusted, triple polished, standard double extra reflector, throwing a ray of light many feet, and enlarging the picture on the screen up to three or four feet in area. The light is produced by a safety carbide generator, such as is used on the largest automobiles. This throws a dazzling white light on the screen.

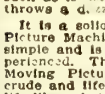
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JOHNSON SMITH & CO.

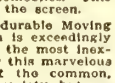
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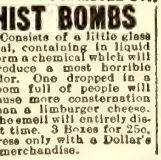
Consists of a little glass vial, containing in liquid form a chemical which will produce a most horrible odor. One dropped in a room full of people will cause more consternation than a lingering sneeze. The smell will entirely disappear in a short time. 3 Boxes for 25c, shipped by express only with a Dollar's worth of other merchandise.

ITCHING POWDER



This is another good practical joke; the intense discomfiture of your victims to everyone but themselves is thoroughly enjoyable. All that is necessary to start the ball rolling is to deposit a little of the powder on a person's hand and the powder can be relied upon to do the rest. The result is a vigorous scratch, then some more scratch, and still more. 3 Boxes for 25c. Sent only by express. (Must order at least One Dollar's worth of other merchandise.)

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The most confidential messages can be written in this Ink, but the writing **MAKES NO MARK.** Cannot be seen unless you know the secret. Invaluable for many reasons. Keep your pupils and other private memorandums away from prying eyes. Great fun for playing practical jokes. **Only 15c Bottle**

LOVE LETTER INK

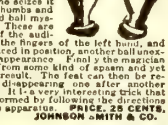
Writing written with this remarkable ink vanishes entirely in a few weeks (sooner if desired), leaving the paper QUITE BLANK. **15c p. pd.**

LUMINOUS INK Writing can be READ ONLY IN A DARK ROOM; writing shines like fire. Quite invisible at daytime. Full directions. **15c bottle; 3 for 40c postpaid.**

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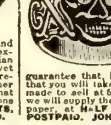
The Best Feat of Its Kind



This trick is an effective and surprising The performer has around the ball for examination, and immediately it returned to him he seizes it by the tips of his thumbs and fingers and a second ball mysteriously appears. These are held in full view of the audience by the tips of the fingers of the left hand, and even while being placed in position, another ball unexpectedly makes its appearance. Finally the magician apparently suffers from some kind of spasm, and yet another ball is the result. The feat can then be reversed, the balls disappearing one after another until none remains. It is a perfect trick that is quite easily performed by following the directions that accompany the apparatus. **PRICE 25 CENTS, POSTPAID. JOHNSON SMITH & CO.**

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A VERY striking and uncommon ring, made of gun metal. Skull and cross-bone design, with two initials. Rub it and a genie sparkling out of the eyes. A never failing object of interest. Said by many to bring Good Luck to the wearer, hence its name **Good Luck Ring.** It will be made to suit any finger. If you will send us a piece of paper, we will be pleased to do so. **25 CENTS, POSTPAID. JOHNSON SMITH & CO.**

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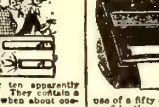
A box containing ten apparently genuine Cigarettes. They contain a cap which explodes when about one third is smoked.

They appear so real, and afford so good a smoke (while they last) that the victim is entirely taken by surprise. A great laugh producer and entirely harmless. **Price, box of ten, 25 cents, postpaid.**

Johnson Smith & Co., Dept. E11

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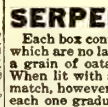
A First Class Writing Machine For $1.25



A per cent little typewriter for $1.25. There are thousands of persons who would like to own a typewriter but whose needs and business do not warrant the expense attached to the purchase and operation of the machines. We will supply them to customers mentioning this paper, at the **PRICE, 25 CENTS, POSTPAID. JOHNSON SMITH & CO.**

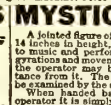
A box containing one of the machines, which we confidently recommend our Little Giant. It is strongly made, but simple in construction, so that any one can quickly learn to operate it, and write as rapidly as they would with pen and ink. The letters of the alphabet most frequently used being grouped so as to enable one to write rapidly, the numerals, 1 to 10, and the punctuation marks being together. With this machine you can send your best girl ten love letters, address envelopes, make out bills, and do almost any kind of work not requiring a large expensive machine. With each typewriter we send a book containing full printed instructions for using the machine. Price complete **$1.25** by mail postpaid.

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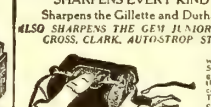
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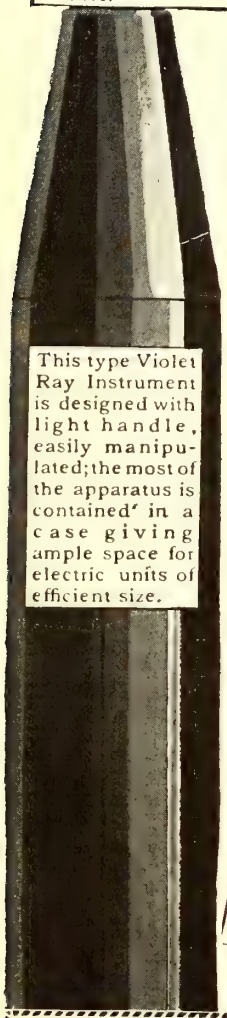
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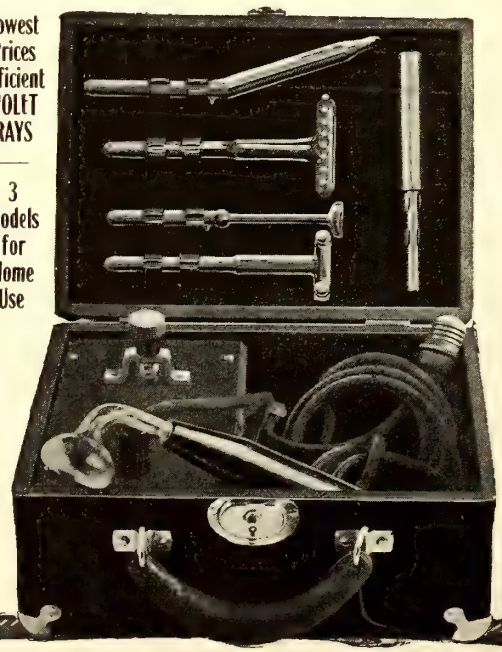
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EDITORIAL

The Elusive Martian Canals

IN 1877 Schiaparelli, in his *Memoria,* published the first maps of the planet Mars, on which were shown for the first time *canali*—the now famous—or infamous—Martian canals. In Italian this word does not mean canal, but channel, and it is due mainly to this erroneous conception that the word canal was introduced into the English, French and German languages. Just the same it stuck from the beginning, altho Schiaparelli did not at first take his "channels" to be "canals," as we understand the term. For canal with us always means an artificial waterway, and this Schiaparelli did not claim.

From 1877 down to Lowell and Pickering, astronomers and scientists have waged one of the most remarkable scientific battles in history. Books by the dozens, pamphlets by the hundreds were printed and are printed this very minute, discussing the *pros* and the *cons* of the mysterious canals. The one camp—the largest by far—believes absolutely in the existence of the Martian canals, be they artificial or natural. Hundreds of astronomers have seen the net-like lines, criss-crossing the face of our sister planet by the hundreds in all directions.

The other camp—the minority—flatly denies all existence of these lines. Their contention is that what the other fellow sees is nothing more than an optical illusion. The followers of this theory have never been able to see the fine lines on Mars, or if they really did glimpse them they have been unconvinced, stoutly maintaining their belief that what they saw was, of course, an optical illusion. They follow up the argument with the triumphant "proof" that the photographic plate, which always tells the truth, has never been able to record any one of the Martian canals.

This sounds like a good argument, *for there is no clear record* of an actual photograph showing the canals on Mars.

It is true that the Lowell observatory actually *did* photograph some of the more prominent canals, but these show up exceedingly faint, and would not be considered evidence by non-believers.

Plausible as this argument is, it can only deceive laymen; the astronomer, however, will smile at it, for it is preposterous.

And here are the reasons: When we look at the Martian canals, the light rays pass thru two atmospheres, that of Mars and our own. The terrestrial atmosphere is about thirty-five miles thick and very dense. The air of Mars is thin and passes the light rays easily. Unless Mars is exactly overhead—and it is far from that when nearest to the earth—we would view it thru thirty-five miles of air. But we never do. More often, because Mars is many degrees from zenith, we view it thru hundreds of miles of air. And this is what makes all the trouble. The air is nearly always in motion—very seldom the "seeing," as astronomers call it, is perfect. So when we attach a camera to our telescope the fine lines become blurred, due to the distortion, and consequently do not register on the plate. But there are several other reasons why we cannot photograph the canals. One is because the grain in the photographic plate is too coarse to show such exceedingly fine lines. Take a silk sewing thread and stretch it across your yard. You can see it readily in bright sunlight thirty or forty yards away, but the best photographic snapshot will not be able to register a trace on the sensitized plate.

Another important reason why we cannot photograph the canals is, because we cannot take instantaneous pictures for the reason that the light received from Mars is rather weak, and if we take a short-time exposure the moving atmosphere tends to blur the picture.

H. GERNSBACK.

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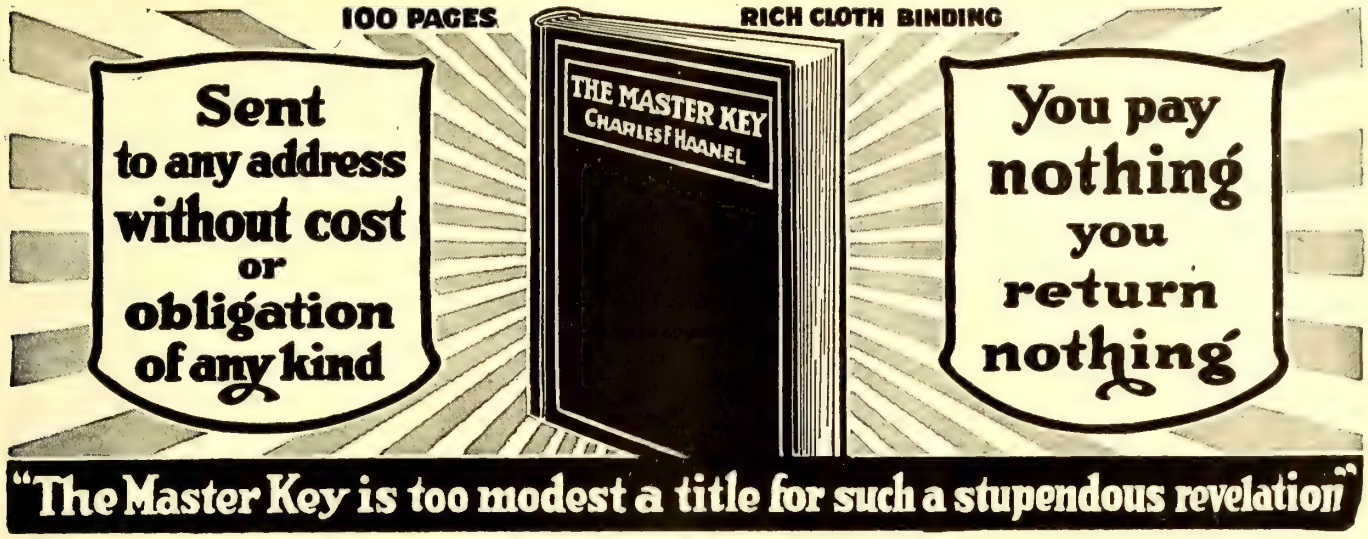
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You need not feel under the slightest obligation to buy. Let merit decide.

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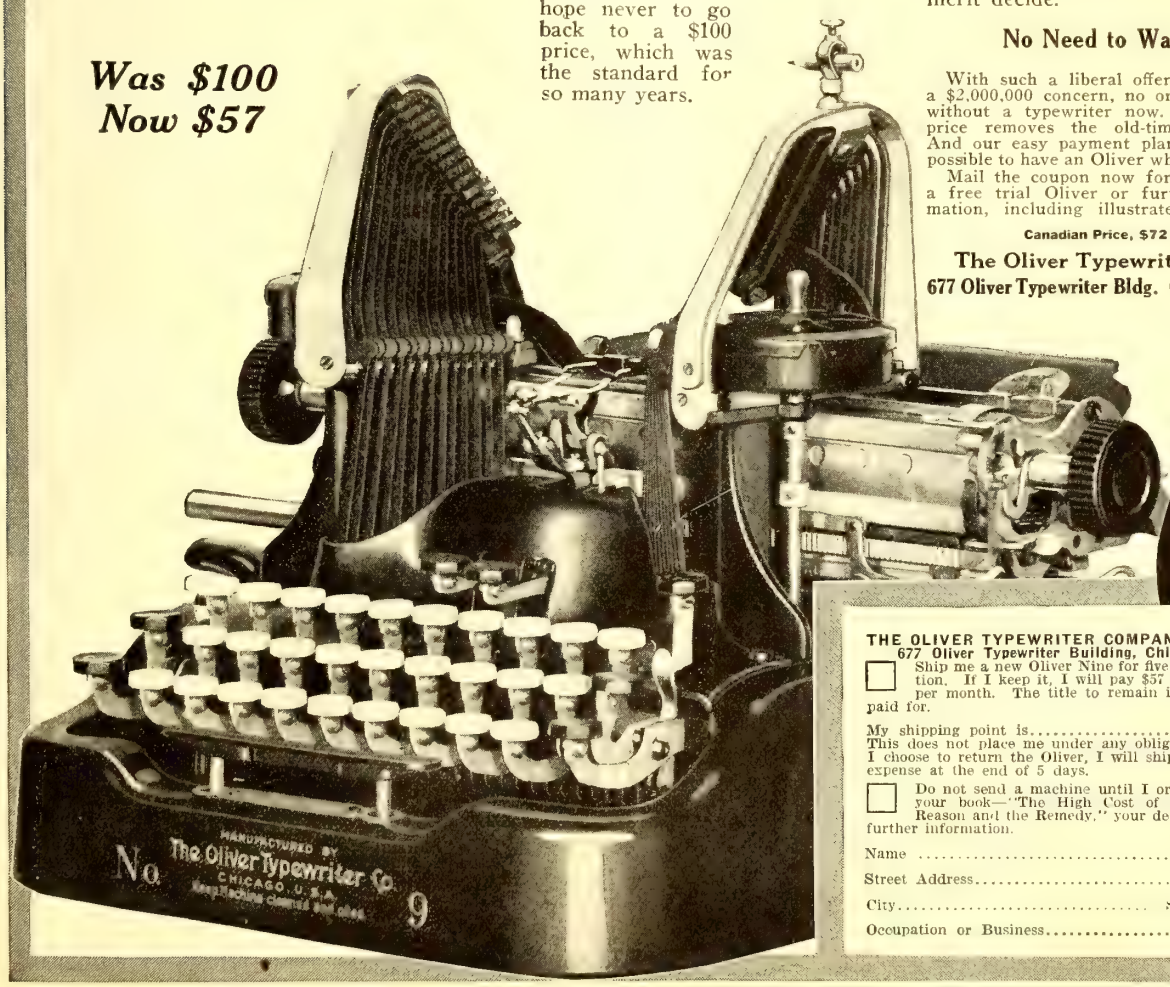
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The Secret of Making People Like You

"Getting people to like you is the quick road to success—it's more important than ability," says this man. It surely did wonders for him. How he does it—a simple method which anyone can use instantly.

ALL the office was talking about it, and we were wondering which one of us would be the lucky man.

There was an important job to be filled — as Assistant-to-the President. According to the general run of salaries in the office, this one would easily pay from $7,000 to $10,000 a year.

The main requisite, as we understood it, was striking personality and the ability to meet even the biggest men in their offices, their clubs, and their homes on a basis of absolute equality. This the firm considered of even more importance than knowledge of the business.

You know just what happens when news of this sort gets around an office. The boys got to picking the man among themselves. They had the choice all narrowed down to two men—Harrison and myself. That was the way I felt about it, too. Harrison was big enough for the job, and could undoubtedly make a success of it. But, personally, I felt that I had the edge on him in lots of ways. And I was sure that the firm knew it, too.

Never shall I forget my thrill of pleasure when the president's secretary came into my office with a cheery smile, looked at me meaningly, handed me a bulletin and said, "Mr. Frazer, here is the news about the new Assistant-to-the-President." There seemed to be a new note of added respect in her attitude toward me. I smiled my appreciation as she left my desk.

At last I had come into my own! Never did the sun shine so brightly as on that morning, and never did it seem so good to be alive! These were my thoughts as I gazed out of the window, seeing not the hurrying throngs, but vivid pictures of my new position flashing before me. And then for a further joyous thrill I read the bulletin. It said, "Effective January 1, Mr. Henry J. Peters, of our Cleveland office, will assume the duties of Assistant-to-the-President at the home office."

Peters! Peters!—surely it *couldn't* be Peters! Why, this fellow Peters was only a branch-office salesman. . . . *Personality!* Why, he was only five feet four inches high, and had no more personality than a mouse. Stack him up against a big man and he'd look and act like an office boy. I knew Peters well and there was nothing to him, nothing at all.

January the first came and Peters assumed his new duties. All the boys were openly hostile to him. Naturally, I felt very keenly about it, and didn't exactly go out of my way to make things pleasant for him—not exactly!

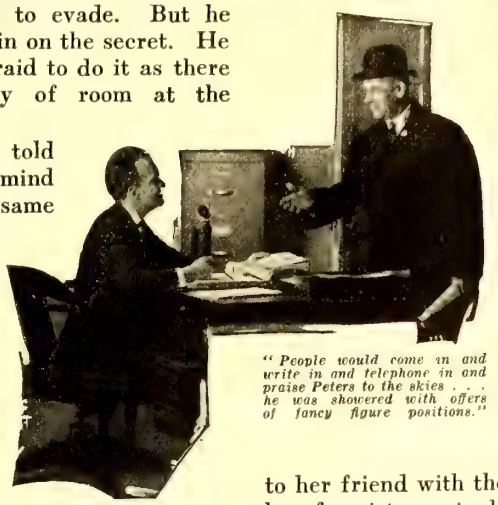
But our open opposition didn't seem to bother Peters. He went right on with his work and began to make good. Soon I noticed that, despite my feelings against him, I was secretly beginning to admire him. He was winning over the other boys, too. It wasn't long before we all buried our little hatchets and palled up with Peters.

The funny thing about it was the big hit he made with the people we did business with. I never saw anything like it. They would come in and write in and telephone in to the firm and praise Peters to the skies. They insisted on doing business with him, and gave him orders of a size that made us dizzy to look at. And offers of positions! why, Peters had almost as many fancy-

figure positions offered to him as a dictionary has words.

What I could not get into my mind was how a little, unassuming, ordinary-to-look-at-chap like Peters could make such an impression with everyone—especially with influential men. He seemed to have an uncanny influence over people. The masterly Peters of today was an altogether different man from the commonplace Peters I had first met years ago. I could not figure it out, nor could the other boys.

One day at luncheon I came right out and asked Peters how he did it. I half expected him to evade. But he didn't. He let me in on the secret. He said he was not afraid to do it as there was always plenty of room at the top.



"People would come in and write in and telephone in and praise Peters to the skies . . . he was showered with offers of fancy figure positions."

What Peters told me acted on my mind in exactly the same way as when you stand on a hill and look through binocular glasses at objects in the far distance. Many things I could not see before suddenly leaped into my mind with startling clearness. A new sense of power surged through me. And I felt the urge to put it into action.

Within a month I was getting remarkable results. *I had suddenly become popular.* Business men of importance who had formerly given me only a passing nod of acquaintance, suddenly showed a desire for my friendship. I was invited into the most select social circles. People—even strangers—actually went out of their way to do things for me. At first I was astounded at my new power over men and women. Not only could I get them to do what I wanted them to do but they actually anticipated my wishes and seemed eager to *please me.* But let me tell you some of my experiences.

One of our biggest customers had a grievance against the firm. He held off payment of a big bill and switched to one of our competitors. I was sent to see him. He met me liked a cornered tiger. A few words and I calmed him. Inside of fifteen minutes he was showering me with apologies. He gave me a check in full payment, another big order, and promised to continue giving us all his business.

For certain reasons it became necessary for the firm to obtain a signed letter from a prominent public man. Three of our men had tried, and failed. Then I was given the job. I felt I had been made the "goat." But I got the signed letter, and with it an inside tip which enabled us to land a prize order about which our competitors are still guessing and wondering.

Then trouble sprang up at one of our factories. Then men talked strike. Things looked ugly. I was sent to straighten it out. On the eve of a general walkout, I pacified the men and headed off the strike. And not only this, but ever since then this factory has led all our other plants in production.

I could tell you dozens of similar instances, but they all tell the same story—the ability to make people like you, believe what you want them to believe, and to do what you want them to do. I take no personal credit for what I have done. All the credit I give to the method Peters told me about. We have told it to lots of our friends, and it has enabled them to do just as remarkable things as Peters and I have done.

Which reminds me: One of my wife's close friends moved to another town where she was a stranger. My wife of course knew of my method. She told it to her friend with the idea that it might be of assistance to her in meeting new people. It helped her so wonderfully that in a very short time she won the close friendship of many of the "best families" in the town. Every one wonders how she did it. But WE know.

But you want to know what method I used to do all these remarkable things. It is this: You know that every one doesn't think alike. What one likes another dislikes. What pleases one offends another. And what offends one pleases another. Well, there is your cue. You can make an instant hit with any one if you say the things they want you to say, and act the way they want you to act. Do this and they will surely like you, and believe in you, and will go miles out of their way to PLEASE YOU.

You can do this easily by knowing certain simple signs. Written on every man, woman and child are signs, as clearly and as distinctly as though they were in letters a foot high, which show you from one quick glance exactly what to say and to do to please them—to get them to believe what you want them to believe—to think as you think—to do exactly what you want them to do.

In knowing these simple signs is the whole secret of getting what you want out of life—of making friends, of business and social advancement. Every great leader uses this method. That is why he IS a leader Use it yourself and you will quickly become a leader—nothing can stop you. And you will want to use it for no other reason than to protect yourself against others.

What Peters told me at luncheon that day was this: "Get Dr. Blackford's 'Reading Character at Sight.'" I did so. This is how I learned to do all the remarkable things I have told you about.

You have heard of Dr. Blackford, the Master Character Analyst. Many concerns will not employ a man without first getting Dr. Blackford to pass on him. Concerns such as Westinghouse Electric and Manufacturing Company, Baker-Vawter Company, Scott Paper Company and many others pay Dr. Blackford large annual fees for advice on dealing with human nature.

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Why Some Foods Explode in the Stomach

And How 48 Hours Makes New Stomachs from Old

By R. S. THOMPSON

A MAN'S success in life depends more on the co-operation of his stomach than on any other factor. Just as an "army moves on its stomach" so does the individual. Scientists tell us that 90% of all sickness is traceable to the digestive tract. Yet in a surprisingly large number of cases even chronic stomach trouble can be remedied in from 48 to 72 hours.

Physical efficiency is the back-bone of mental efficiency. Unless our stomachs are effectively performing their functions in the way Nature intended, we can't be physically fit. And unless we're physically fit, we can't be thoroughly successful.

As Dr. Orison Swett Marden, the noted writer, says, "the brain gets an immense amount of credit which really should go to the stomach." And it's true — keep the digestive system in shape and brain vitality is assured.

Of course, there are successful men who have weak digestions, but they are exceptions to the rule. They succeeded *in spite* of their physical condition. Ten times the success would undoubtedly be theirs if they had the backing of a strong physique and a perfect stomach. There are a thousand men who owe their success in life to a good digestion to every one who succeeded in spite of a poor digestion and the many ills it leads to.

The cause of practically all stomach disorders — and remember, stomach disorders lead to 90% of all sickness —is wrong eating.

Food is the fuel of the human system, yet some of the combinations of food we put into our systems are as dangerous as dynamite, soggy wood and a little coal would be in a furnace—and just about as effective. Is it any wonder that the average life of man today is but 39 years — and that diseases of the stomach, liver, and kidneys have increased 103% during the past few years!

The trouble is that no one has, until recently, given any study to the question of food and its relation to the human body. Very often one good harmless food when eaten in combination with other harmless foods creates a chemical reaction in the stomach and literally explodes, giving off dangerous toxics which enter the blood and slowly poison our entire system, sapping our vitality and depleting our efficiency in the meantime.

And yet, just as wrong food selections and combinations will destroy our health and efficiency, so will the right foods create and maintain bodily vigor and mental energy. And by right foods we do not mean freak foods — just good, every-day foods properly combined. In fact, to follow Corrective Eating it isn't even necessary to upset your table.

Not long ago I had a talk with Eugene Christian, the noted food scientist, and he told me some of his experiences in the treatment of disease through food. Incidentally Eugene Christian has personally treated over 23,000 people for almost every non-organic ailment known, with almost unvaried success. An enviable record when one considers that people nearly always go to him after every other known method has failed. And the remarkable part of it all is that Eugene Christian's methods often remedy chronic cases of stomach trouble in 48 hours.

One case which interested me greatly was that of a young business man whose efficiency had been practically wrecked through stomach acidity, fermentation and constipation, resulting in physical sluggishness which was naturally reflected in his ability to use his mind. He was twenty pounds under weight when he first went to see Christian and was so nervous he couldn't sleep. Stomach and intestinal gases were so severe that they caused irregular heart action and often fits of great mental depression. As Christian describes it, he was not 50 per cent efficient either mentally or physically. Yet in a few days, by following Christian's suggestions as to food, his constipation had completely gone, although he had formerly been in the habit of taking large daily doses of a strong cathartic. In five weeks every abnormal symptom had disappeared—his weight having increased six pounds. In addition to this he acquired a store of physical and mental energy so great in comparison with his former self as to almost belie the fact that it was the same man.

Another instance of what proper food combinations can do was that of a man one hundred pounds overweight whose only other discomfort was rheumatism. This man's greatest pleasure in life was eating. Though convinced of the necessity, he hesitated for months to go under treatment, believing he would be deprived of the pleasure of the table. He finally, however, decided to try it out. Not only did he begin losing weight at once, quickly regaining his normal figure, all signs of rheumatism disappearing, but he found the new diet far more delicious to the taste and afforded a much keener quality of enjoyment than his old method of eating, and he wrote Christian a letter to that effect.

But perhaps the most interesting case that Christian told me of was that of a multi-millionaire—a man 70 years old, who had been traveling with his doctor for several years in a search for health. He was extremely emaciated, had chronic constipation, lumbago, and rheumatism. For over twenty years he had suffered from stomach and intestinal trouble which in reality was super-aciduous secretions in the stomach. The first menus given him was designed to remove the causes of acidity, which was accomplished in about thirty days. And after this was done he seemed to undergo a complete rejuvenation. His eyesight, hearing, taste, and all of his mental faculties became keener and more alert. He had had no organic trouble—but he was starving to death from malnutrition and decomposition—all caused by the wrong selection and combination of foods. After six months' treatment this man was as well and strong as he had ever been in his life.

These instances of the efficacy of right eating I have simply chosen at random from perhaps a dozen Eugene Christian told me of, every one of which was fully as interesting, and they applied to as many different ailments. Surely this man Christian is doing a great work.

I know of several instances where rich men and women have been so pleased with what he has done for them that they have sent him checks for $500 or $1,000 in addition to the amount of the bill when paying him.

There have been so many inquiries from all parts of the United States from people seeking the benefit of Eugene Christian's advice and whose cases he is unable to handle personally that he has written a course of little lessons which tell you exactly what to eat for health, strength and efficiency. This course is published by The Corrective Eating Society of New York.

These lessons, there are 24 of them, contain actual menus for breakfast, luncheon, and dinner, curative as well as corrective, covering every condition of health and sickness from infancy to old age and for all occupations, climates, and seasons, including special summer menus which enable you to withstand the heat and retain winter's vigor.

Reasons are given for every recommendation based upon actual results secured in the author's many years of practice. Technical terms have been avoided —every point is explained so clearly that there can be no possible misunderstanding.

With these lessons at hand it is just as though you were in personal contact with the great food specialist, because every possible point is so thoroughly covered that you can scarcely think of a question which isn't answered. You can start eating the very things that will produce the increased physical and mental energy you are seeking the day you receive the lessons and will find that you secure results with the first meal. And if you suffer from acid stomach it is quite likely that your trouble will successfully be overcome in from 48 to 72 hours.

If you would like to examine these 24 Little Lessons in Corrective Eating, simply write The Corrective Eating Society, Inc., Dept. 16410, 443 Fourth Avenue, New York City. It is not necessary to enclose any money with your request. Merely ask them to send the lessons on five days' trial, with the understanding that you will either return them within the time or remit $3.00, the small fee asked.

The reason that the Society is willing to send the lessons on free examination without money in advance is because they want to remove every obstacle to putting this knowledge in the hands of the many interested people as soon as possible, knowing full well that a test of some of the menus in the lessons themselves is more convincing than anything that can possibly be said about them.

Please clip out and mail the following form instead of writing a letter, as this is a copy of the official blank adopted by the Society, and will be honored at once.

CORRECTIVE EATING SOCIETY, INC.
Dept. 16410, 443 Fourth Ave., New York City

You may send me prepaid a copy of Corrective Eating in 24 Lessons. I will either remail them to you within five days after receipt or send you $3.

Name .....

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"THE 100% WIRELESS MAGAZINE"

Partial CONTENTS OF OCTOBER ISSUE:

Arc Undampt Transmission.
By Ensign P. H. Boucheron, U.S.N.R.F.

Developing Audions for the Amateurs.
By E. T. Jones, Associate Editor.

Cascade Amplification at Radio Frequencies.
By Thomas Benson.

Save Your Old Coupler.
By M. B. Lowe.

Audion Protective Device.
By Edgar Terrain Johnstone.

Selector Switch for "Rogers" Underground Antenna.
By Stanley J. Brown.

How to Make A Good Variable Condenser.
By A. Warr.

A New Radio Dynamic Controlling System.
By Lieut. W. R. Coventry.

Long Wave Receiving.
By H. L. Beedenbender.

Magnet Control for Vacuum Tubes.
By Herbert Webb.

An Amateur's Retrospect.
By Scott E. Vance.

A Short Wave Receiving Transformer.
By Raymond Evans.

Improved "B" Battery Construction.
By J. G. Reed.

An Undampt Transmitter of the De Forest Type.
By E. Dynner.

What "Radio Amateur News" Is:

With its fourth issue RADIO AMATEUR NEWS holds the field undisputedly as the greatest radio magazine in print today. In point of circulation, number of articles, illustrations, RADIO AMATEUR NEWS now leads all other wireless magazines. Take for instance the September issue with its fifty-six pages; there were fifty-one separate purely radio articles and 112 illustrations. *Over twenty-five thousand copies were printed and circulated.*

Each issue of the RADIO AMATEUR NEWS now contains 56 pages (or more) and an artistic cover in two colors. The illustrations average 125 every month and there are from 40 to 50 up-to-date articles, some by our biggest radio scientists, in every issue.

RADIO AMATEUR NEWS is the greatest and biggest radio magazine in print today.

RADIO AMATEUR NEWS is the only INDEPENDENT monthly wireless magazine in existence. It caters to no commercial interests—it has no boss save its readers. It is "different"—it has the latest radio news. It is a scientific magazine but it caters largely to the RADIO AMATEUR—it is by and for the Amateur. It is publisht by the publishers of the ELECTRICAL EXPERIMENTER, but there will be no duplication of articles in the two magazines. Both are entirely different—but both together will give you ALL the radio news of all the world. Whether you are a professor or an Amateur, get a sample copy or order it from your Newsdealer today.

Junior Radio Course By E. T. JONES Associate Editor

A distinctly new feature began with the September issue in our new **Junior Radio Course.** In the October issue Lesson No. 2 will appear complete. This course is intended for the beginner and everything presented will be in plain English—even the merest tyro in radio will find no trouble in understanding and assimilating the knowledge. The series is a very important one and nothing like it has ever appeared in print before. Everyone owes it to himself in this new age to know something about wireless and this course will enlighten all laymen. Profusely illustrated with pictures that anyone can understand.

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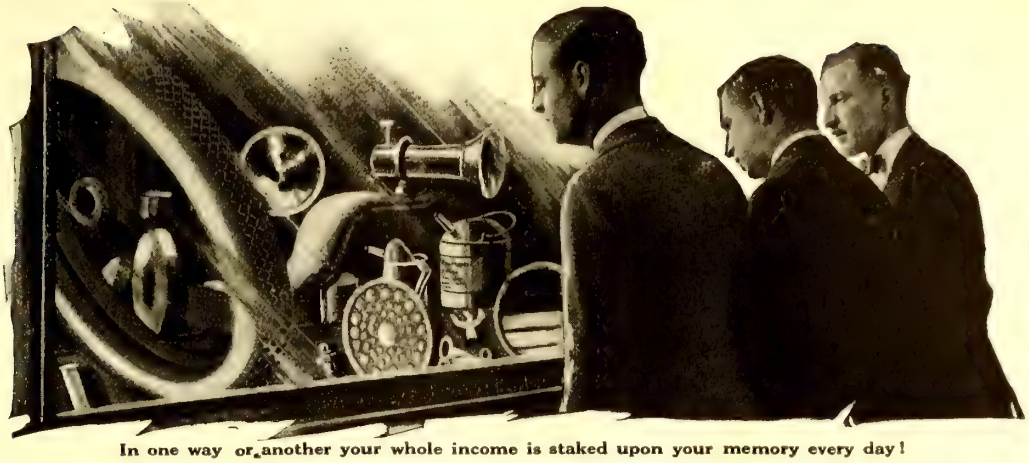
56 PAGES
125 ILLUSTRATIONS

SPECIAL OFFER

Gentlemen:

Please enter my subscription for RADIO AMATEUR NEWS for the term of one year for which I enclose herewith $1.50. For this you will send to me immediately your great Wireless Course, containing 160 pages, 350 illustrations, size 6¾ x 10" with fine flexible cloth cover. I have added 5c extra for postage. (I have written my name and address in margin below.)

EXPERIMENTER PUB. CO., 231 Fulton St., N. Y. C.



In one way or another your whole income is staked upon your memory every day!

A Simple Test To Measure Your Memory

Could You Get By With This Big Employer Who Judges His Men On What Their Minds Retain? Try It.

NOT long ago a large eastern concern was looking for a man to fill an important position as district manager.

Several hundred applications for the job were received. The choice finally narrowed down to four names, and from these the successful candidate was to be selected.

Before the decision was made these four men were asked to do what seemed to them a most unusual thing. They were put through a test such as they had never before heard of, and each man understood that he would be judged, to a large extent, on the showing he made.

The job was filled at last and the man who won out was probably more surprised at his success than any of the others would have been had they gotten it. He knew that his experience was far less than that of two of the applicants, he was younger than any of them and it had seemed to him all along that his case was anything but hopeful. He determined to find out just why the firm put so much reliance on the simple test that each man had been asked to take.

"That little device is one of our most valuable aids in finding the men we want as employees", an officer of the company told him. "We apply it to every person who seeks a position with us from office boys up to high priced executives. The result is that our whole organization is a great deal more efficient than in the old days.



David M. Roth

"We borrowed the test from the works of David M. Roth, the memory expert, and it is our experience that one of the surest ways to know a man's mental power is to measure his memory. The fellow with a good memory has the qualities that go with a good memory and those are the things we pay big salaries for."

THIS firm had installed in a special room a replica of a store show-window facing into the room as a real store window faces the street. Behind its glass were arranged perhaps fifty different articles which were manufactured by the company itself and formed a part of their regular line. The window was well lighted and every article in it was something familiar to all.

Each man who takes the test is permitted 30 seconds to observe and memorize the objects in the window. Then he is required to leave the room and write down as many as he can remember. The proportion of them that he is able to recall determines his memory rating and, largely, his chances for getting the job.

You can measure your memory at home by means of this same test. Have someone select and arrange twenty-five articles of ordinary household use on a table. Let those who are taking the test observe them in silence for 15 seconds. Then let each person go into another room and write down the names of as many of the articles as he can remember. The result will reveal a surprising state of affairs. It will dismay you to find how quickly and absolutely the names of familiar articles, some of which perhaps you see and use every day, will slip out of your mind and refuse to return.

But the most interesting part of this test is the way it exposes the tremendous handicap you are struggling under in your daily work.

When you find what a small number of the articles on the table you are able to name after the most intense effort to impress them on your mind you begin to realize how many facts of value, how much useful knowledge, how many names, faces and figures that would make you a better man in your job drop out of your mind and are gone, leaving you in point of knowledge and experience barely ahead of where you were the month before or the year before.

Do you wonder at the importance of the memory test in hiring men for high-salaried permanent positions? Can you doubt the tremendous money value of a trained, dependable memory in business and the professions?

A STRIKING instance of this very thing came to light recently.

Forty years ago in the state of Virginia a boy of thirteen was forced to quit school and go to work when his father died. He became an apprentice in a blacksmith shop.

Today he is Vice President in charge of Production of the American Locomotive Company and one of the biggest executives in the country. He is C. K. Lassiter and his job is one of the hardest in all the range of American business. He keeps six plants with thousands of employees running smoothly. He knows every detail of the machinery in every one of these plants. He has to see that the company's locomotives are turned out on schedule time, and that each one reaches its buyer in good condition and working order.

In an interview with Mr. Lassiter appearing in the **American Magazine** for May, 1919, he says:

"My memory is today my greatest asset in business. . . . I learned to work for knowledge and to hold on to what I gained."

Such testimony is the usual thing from big leaders in all lines of work. It is because a good memory is so much more than the mere ability to recall the name of the man you met last week or the telephone number which you neglected to write down. These are merely the smaller conveniences of a good memory—the daily advantages that make you more efficient.

But in its larger phases, power of memory is power of judgment, power of foresight, power of knowledge. It matters very little what you learn today if the benefit of your experience is not with you tomorrow, or a year from tomorrow. Your judgment is only as good as your memory, because all sound decisions must be based on something learned in the past. Otherwise they are mere guesses, —gambles.

Foresight,—that quality which marks the most successful men everywhere—is nothing more nor less than applied memory. We can only foresee what **may** occur from our experience of what **has** occurred in the past. A simple matter of memory.

And all knowledge itself exists only through the ability to remember things that have been learned, information gained through experience, facts that have come to our attention at one time or another, ideas that have reached us from all sources and the knowledge of others expressed to us in speech or in printed words.

SO it is that the words "I forgot", and all these words stand for, have come to be regarded by men generally as a confession of needless weakness and an admission of failure.

And it has been David M. Roth who has showed the world just how needless a poor memory is. He has given to the public the secret of how to improve even a poor memory in a single evening. By the Roth Method hundreds of thousands of people all over the country have discovered for themselves that it is easy to have a sure-fire memory. And they have gained clearer thinking powers, stronger leadership and better self-possession along with their better memories.

One man not long ago wrote to Mr. Roth:

"You should have said that any person can improve their memory in two hours."—Charles A. Horan, 1541 W. Lehigh Ave., Philadelphia, Pa.

and another:

"The Roth Memory Course has been worth hundreds of dollars to me already."—L. D. Smith, Buffalo, Okla.

Such letters come in by the hundreds from men and women who asked to see the seven lessons of the Roth Memory Course while half in doubt about its simplicity, usefulness and power to build a leakproof memory. They have become as enthusiastic as you will be when you find that a better memory is so easy to have and so close at hand.

PROVE it? Mr. Roth, through his publishers, The Independent Corporation, gladly assumes that burden.

Send no money whatever. Simply put it up to him to show you that the Roth Course will improve your memory in a single evening's reading and give you a 100% better memory inside of a week. He is so sure of it that he will leave all argument to the seven easy lessons which comprise the course. They will be sent you all charges prepaid as soon as you give us your name and address. Use the coupon below. If the course does not satisfy you simply return it any time within five days and you owe nothing. Fair enough, isn't it?

But unless you are different from hundreds of thousands who have accepted this offer before, you'll know that you want to own the course inside of thirty minutes after you open the first lesson. When you decide to keep it, send only $5 in full payment.

Yes, it is worth finding out about. Very much so.

Free Examination Coupon

Independent Corporation
Publishers of The Independent Weekly
Dept. R11010, 119 West 40th Street, New York

Please send me the Roth Memory Course of seven lessons. I will either remail the course to you five days after its receipt or send you $5 in full payment of the course.

Name .....

Street No. .....

City ..... State .....

Elect. Exp. 10-19

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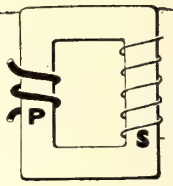
PERSONALLY CONDUCTED

by a man who has long experience as a consulting electrical engineer and who has developed the ability to impart his knowledge to others.

RIGHT in your own home, if you are ambitious, you can fit yourself for an electrical position and graduate forever from the ranks of those who are held back because of lack of technical knowledge. I don't make any false statements about the wonderful salaries you will command. But I do promise, if you are in earnest, to give you unusually valuable service that has enabled many others to increase their earnings greatly.

Each Lesson Meant for You

My method is different from others. It is based upon my years of practical experience. It leads the student quickly over fundamentals right up to practical information, such as is experienced in everyday work. You get my personal attention. It's really a class where you who want to learn and I who know the angles of the electrical industry from experience, get together. This method has been so successful that my students are sending others to me and a number of concerns require their employees to take my course.



Advancement

is made possible to any ambitious man—whether a beginner or experienced in electrical work—who will conscientiously devote his spare time to my course of study.

Tough Problems Made Simple

There isn't a problem that can't be solved if you have the proper foundation of knowledge. There is no limit to what you can achieve with the aid of the practical electrical information supplied in my course. It's up to you. I can't tell you much in this little space. Let me send you my catalog.

RESULTS OF MY SERVICE

Practical Electricians Recommend My Course to Others.
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Over 65 Per Cent. of My Students Are Engaged in the Electrical Business.
Over 11 Per Cent. of My Present Enrollment Came Through Satisfied Students.
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You pay me a small amount each month. You may stop any time and your payments will then stop. I don't want your money if I'm not teaching you satisfactorily.

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Electrical material, charts, electrical apparatus, drafting material, etc., are furnished with the course without charge.

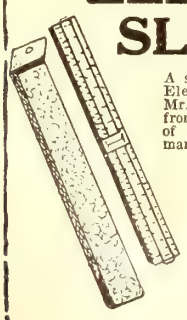
Write me frankly about yourself—what you are doing now and what you hope to do. Let's get together on your problems.

SEND FOR MY BOOK which clearly tells you how the work is handled, what I have done for others and the benefits you can expect to receive.

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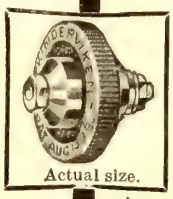
Yorke Burgess, President
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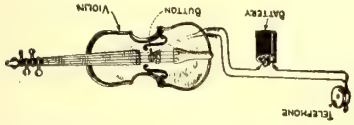
SKINDERVIKEN TRANSMITTER BUTTON

MOST SENSITIVE MICROPHONE FOR $1.00

YOU can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

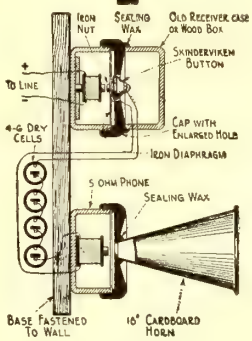
You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *This outfit was used by secret service operatives during the War. It is being used on the stage.*


Actual size.



So much for its commercial adaptations! *You* can procure apparatus of the same type.

One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons cannot be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.



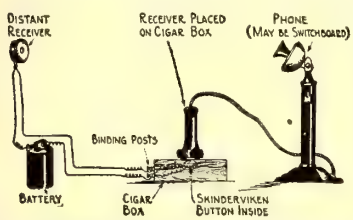
Full directions for connecting up the button for use as a detectophone are given in booklet which is sent with each button.

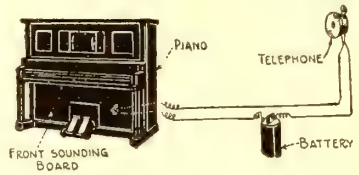






The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.





AMONG electrical experimenters the button has created a sensation. It is not uncommon to receive unsolicited letters like these: "I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

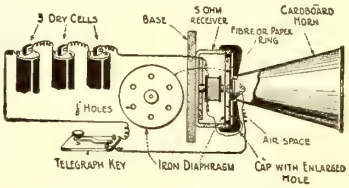
"I have been using one of these transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimenting." "I have been using one of these transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"

Mr. H. Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In the writer's opinion, obtained by actual elaborate tests, the Skinderviken Transmitter Button is probably the most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

We have the utmost faith in this transmitter button. We guarantee satisfactory service or we will refund the purchase price. Boys—Young and old—send in a dollar bill RIGHT NOW! You can't lose. If you're not satisfied, you receive your dollar back. Isn't that fair?



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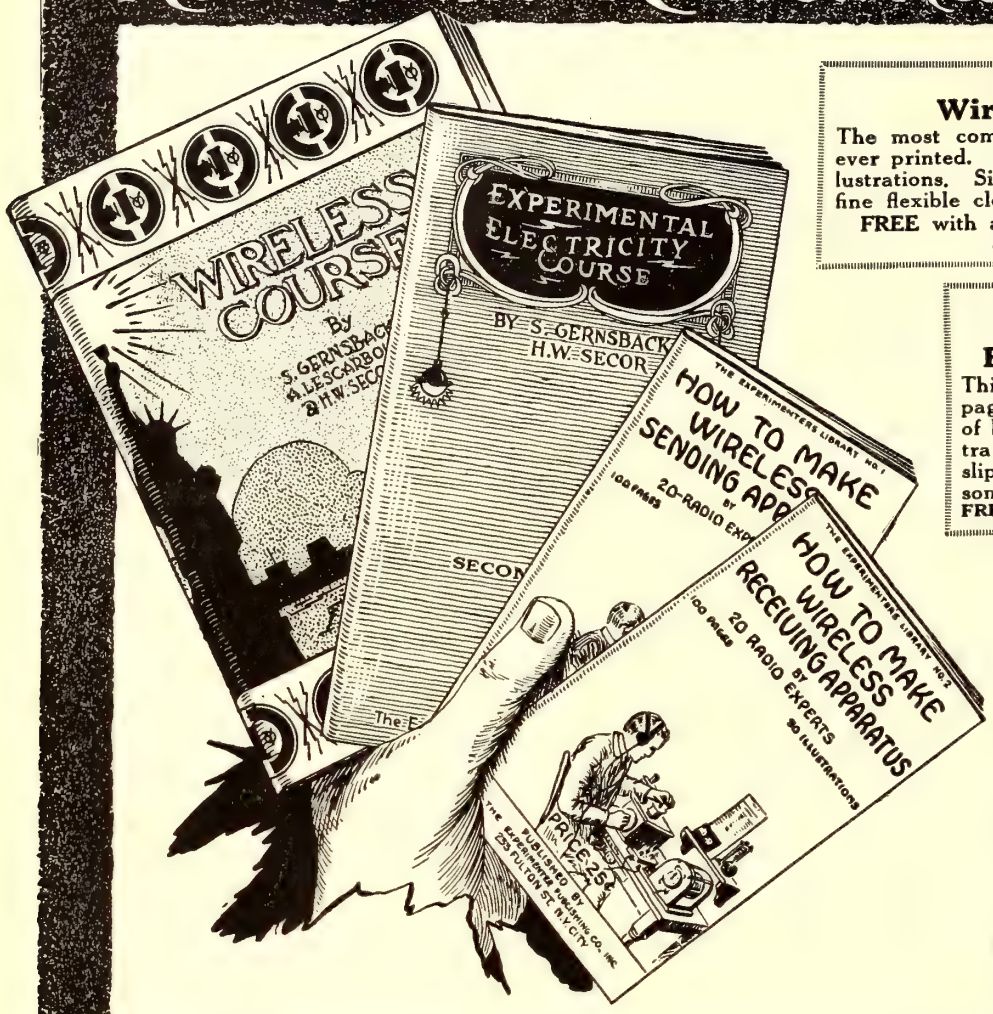
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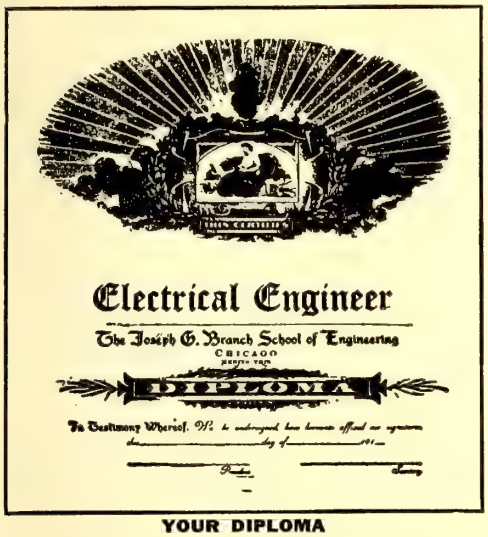
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The course in Electrical Engineering covers the installation and operation of all kinds of modern electrical machinery and appliances, including power plant work, viz.: Practical Electricity, Alternating Currents, the Electric Motor, Practical Mathematics and Electrical Wiring. Under Practical Electricity both direct and alternating currents, high potential and high frequency currents are covered.

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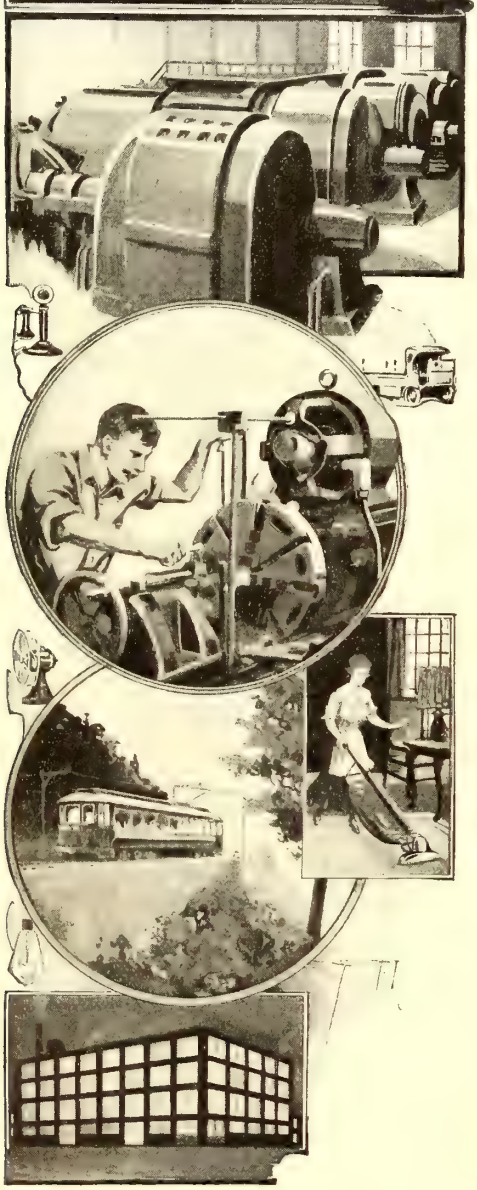
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ELECTRICAL EXPERIMENTER

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Vol. VII. Whole No. 78 OCTOBER, 1919 No. 6

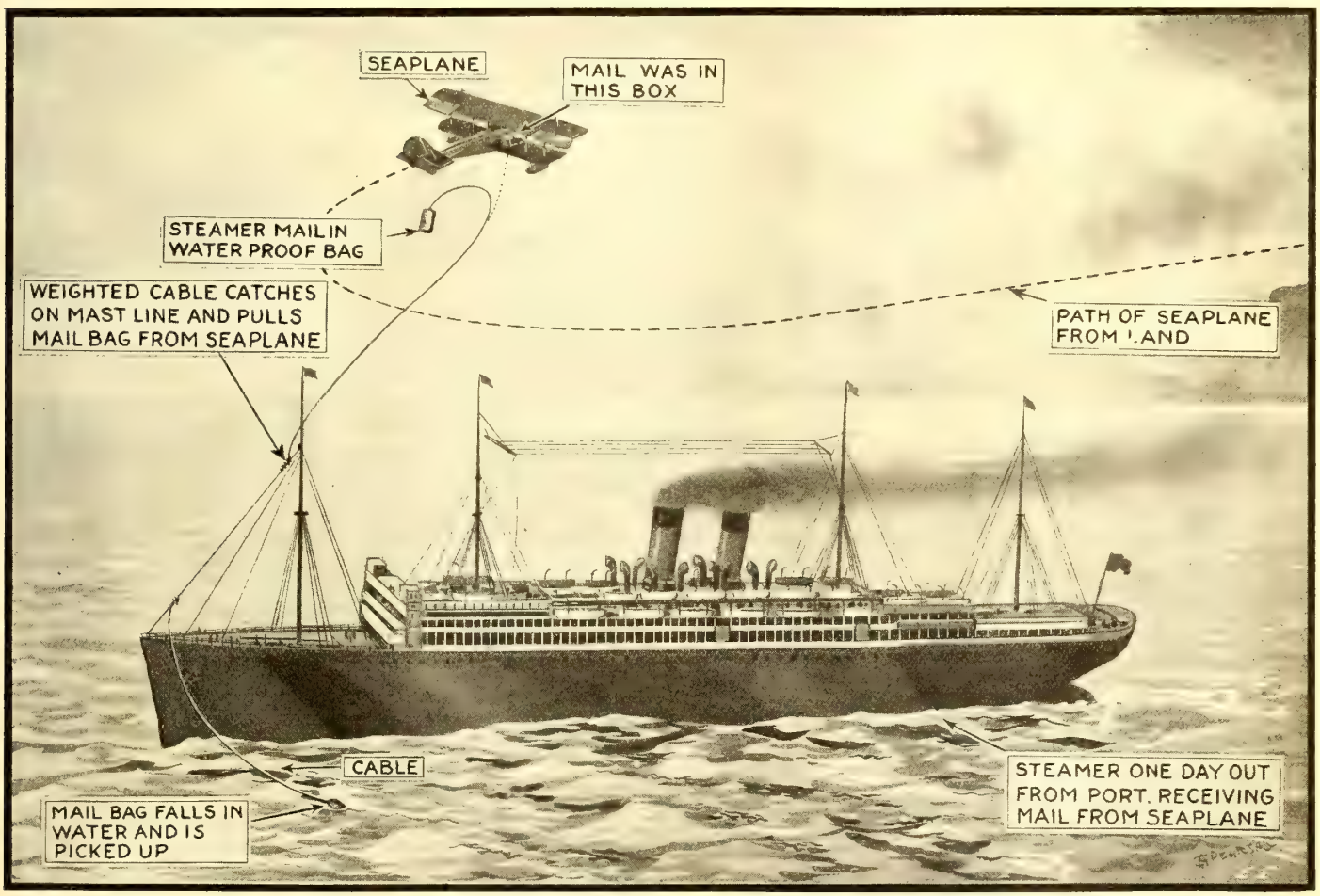
Seaplane Delivers Ship Mail at Sea

OCEAN travelers on the S.S. *Adriatic*, the sailing of which on August 15th marked the reopening of the White Star Line's service to Cherbourg and Southampton, witnest the successful attempt of the Post Office Department to use aircraft for the first time in delivering European mail to a steamer. Congratulatory messages were sent by passengers to Postmaster Thomas G. Patten and officials of the Aeromarine Plane and Motor Corporation, who were responsible for the demonstration.

The hydroaeroplane, piloted by C. J. Zimmerman with Richard Geisinger as mechanic, left the surface of the Hudson River off Eighty-sixth Street, New York, at 1:30 P. M., an hour and a half after the Adriatic had sailed. Before the mail pouch was placed on board the plane Zimmerman, the pilot, was sworn in by Daniel E. Jordan, Assistant Superintendent of Mail, as an employe of the Post Office Department.

Overtaking the Adriatic at Ambrose Channel the plane flew for a distance ahead of the steamer and then, turning around, flew directly toward her. As the plane past over the Adriatic at a height of about 50 feet above masthead, a specially devised weighted cable with shock absorbers was released, catching and wrapping itself around a cable which ran from the masthead to the deck, as shown in the accompanying illustration. The mail pouch, which was contained in a pocket constructed of laminated wood on the forward right fuselage, was pulled out when the cable contracted, dropping into the water. The pouch, also specially constructed to insure its being waterproof, was then hauled on board.

The achievement was witnest by Postmaster Patten, Inglis M. Uppercu, President of the Aeromarine Plane and Motor Corporation, and a party of guests who went down the bay on the yacht *Lounger*. The passengers on the steamer cheered as the seaplane glided away.



Copyright, 1919, by E. P. Co.

The Latest Mail Carrier—the "Seaplane." A Seaplane Successfully Delivered Mail to the S.S. Adriatic When She was a Considerable Distance at Sea, thus Demonstrating How the "Mail Time" Between America and Europe can Be Greatly Shortened.

My Inventions

By Nikola Tesla

VI. THE ART OF TELAUTOMATICS

How Tesla's Mind Recuperates.

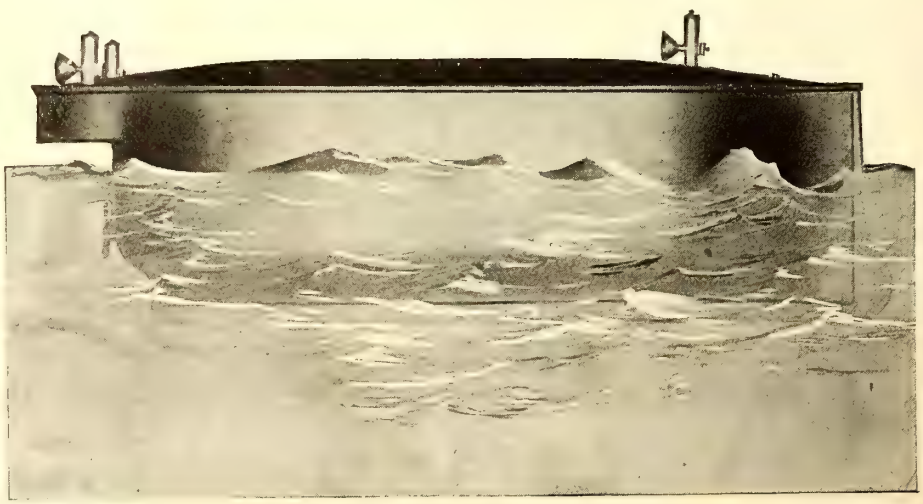
NO subject to which I have ever devoted myself has called for such concentration of mind and strained to so dangerous a degree the finest fibers of my brain as the system of which the Magnifying Transmitter is the foundation. I put all the intensity and vigor of youth in the development of the rotating field discoveries, but those early labors were of a different character. Although strenuous in the extreme, they did not involve that keen and exhausting discernment which had to be exercised in attacking the many puzzling problems of the wireless. Despite my rare physical endurance at that period the abused nerves finally rebelled and I suffered a complete collapse, just as the consummation of the long and difficult task was almost in sight. Without doubt I would have paid a greater penalty later, and very likely my career would have been prematurely terminated, had not providence equipt me with a safety device, which has seemed to improve with advancing years and unfailingly comes into play when my forces are at an end. So long as it operates I am safe from danger, due to overwork, which threatens other inventors and, incidentally, I need no vacations which are indispensable to most people. When I am all but used up I simply do as the darkies, who "naturally fall asleep while white folks worry." To venture a theory out of my sphere—the body probably accumulates little by little a definite quantity of some toxic agent and I sink into a nearly lethargic state which lasts half an hour to the minute. Upon awakening I have the sensation as though the events immediately preceding had occurred very long ago, and if I attempt to continue the interrupted train of thought I feel a veritable mental nausea. Involuntarily I then turn to other work and am surprised at the freshness of the mind and ease with which I overcome obstacles that had baffled me before. After weeks or months my passion for the temporarily abandoned invention returns and I invariably find answers to all the vexing questions with scarcely any effort. In this connection I will tell of an extraordinary experience which may be of interest to students of psychology. I had produced a striking phenomenon with my grounded transmitter and was endeavoring to ascertain its true significance in relation to the currents propagated through the earth. It seemed a hopeless undertaking, and for more than a year I worked unremittingly, but in vain. This profound study so entirely absorbed me that I became forgetful of everything else, even of my undermined health. At last, as I was at the point of breaking down, nature applied the preservative inducing lethal sleep. Regaining my senses, I realized with consternation that I was unable to visualize scenes from my life except those of infancy, the very first ones that had entered my consciousness. Curiously enough, these appeared before my vision with startling distinctness and afforded me welcome relief. Night after night, when retiring, I would think of them and more and more of my previous existence was revealed. The image of my mother was always the principal figure in the spectacle that slowly unfolded, and a consuming desire to see her again gradually took possession of me. This feeling grew so strong that I resolved to drop all work and satisfy my longing. But I found it too hard to break away from the laboratory, and several months elapsed during which I had succeeded in reviving all the impressions of my past life up to the spring of 1892. In the next picture that came out of the mist of oblivion, I saw myself at the *Hotel de la Paix* in Paris just coming to from one of my peculiar sleeping spells, which had been caused by prolonged exertion of the brain. Imagine the pain and distress I felt when it flashed upon my mind that a dispatch was handed to me at that very moment bearing the sad news that my mother was dying; I remembered how I made the long journey home without an hour of rest and how she passed away after weeks of agony! It was especially remarkable that during all this period of partially obliterated memory I was fully

IN this article, Dr. Tesla dwells on the future possibilities of his magnifying transmitter, especially in connection with the art of Telautomatics, which was first conceived by him and doubtless constitutes one of his most brilliant gifts to the world.

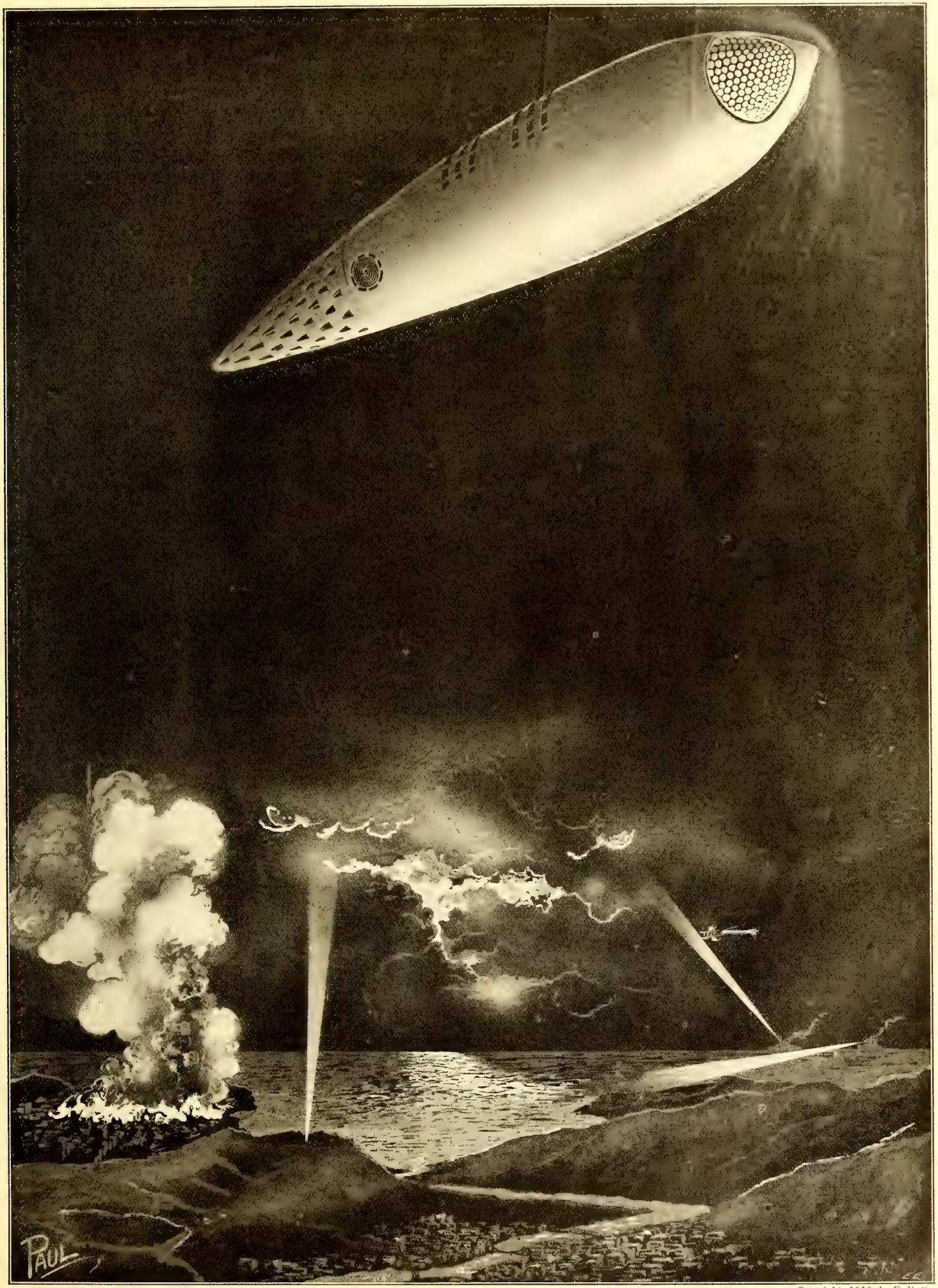
Tesla was the first to build and successfully operate Automata in the form of boats steered and otherwise controlled by tuned wireless circuits and agents ensuring reliable action despite of all attempts to interfere.

But this was only the first step in the evolution of his invention. What he wanted, was to produce machines capable of acting as though possessed of intelligence. It will be readily perceived that if Dr. Tesla has practically realized his conception, the world will witness a revolution in every field of endeavor. In particular will his inventions affect the art of warfare and the peace of the world.

Dr. Tesla dwells eloquently on a number of topics agitating the public mind, and this article of his is perhaps the most brilliant and absorbing he has written.



One of the Telautomatic Boats (Submersible) Constructed By Tesla and Exhibited By Him in 1898. Controlled By Wireless Without Aerials.



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Tesla's New Self-Propelled Aerial Tel-Automaton. Devoid of Propeller, Sustaining Wings and All Other Means of External Control. Can Attain a Speed of 350 Miles Per Hour, and Will Reach a Predetermined Point a Thousand Miles Away Accurately Within a Few Feet.

alive to everything touching on the subject of my research. I could recall the smallest details and the least insignificant observations in my experiments and even recite pages of text and complex mathematical formulae.

My belief is firm in a law of compensation. The true rewards are ever in proportion to the labor and sacrifices made. This is one of the reasons why I feel certain that of all my inventions, the Magnifying Transmitter will prove most important and valuable to future generations. I am prompted to this prediction not so much by thoughts of the commercial and industrial revolution which it will surely bring about, but of the humanitarian consequences of the many achievements it makes possible. Considerations of mere utility weigh little in the balance against the higher benefits of civilization. We are confronted with portentous problems which can not be solved just by providing for our material existence, however abundantly. On the contrary, progress in this direction is fraught with hazards and perils not less menacing than those born from want and suffering. If we were to release the energy of atoms or discover some other way of developing cheap and unlimited power at any point of the globe this accomplishment, instead of being a blessing, might bring disaster to mankind in giving rise to dissension and anarchy which would ultimately result in the enthronement of the hated regime of force. The greatest good will come from technical improvements tending to unification and harmony, and my wireless transmitter is preeminently such. By its means the human voice and likeness will be reproduced everywhere and factories driven thousands of miles from waterfalls furnishing the power; aerial machines will be propelled around the earth without a stop and the sun's energy controlled to create lakes and rivers for motive purposes and transformation of arid deserts into fertile land. Its introduction for telegraphic, telephonic and similar uses will automatically cut out the statics and all other interferences which at present impose narrow limits to the application of the wireless. This is a timely topic on which a few words might not be amiss.



Dr. Tesla is Rapidly Becoming Younger. Judge for Yourself from His Latest Photograph.

Tesla Raps "Static" Men Vigorously.

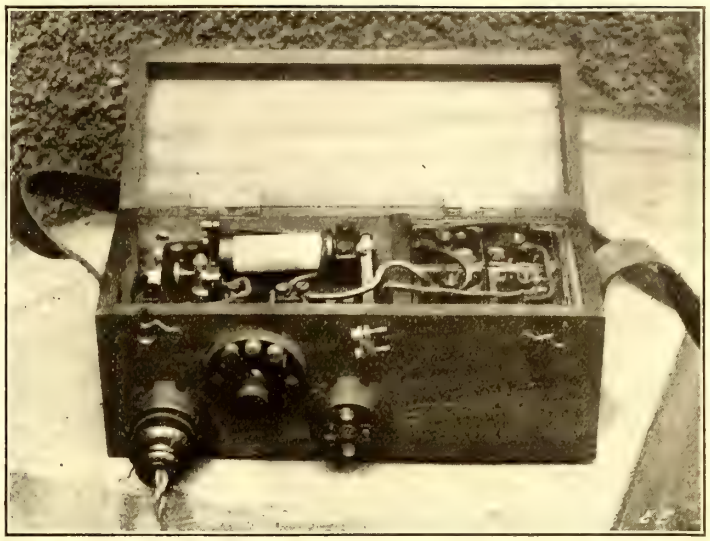
During the past decade a number of people have arrogantly claimed that they had succeeded in doing away with this impediment. I have carefully examined all of the arrangements described and tested most of them long before they were publicly disclosed, but the finding was uniformly negative. A recent official statement from the U. S. Navy may, perhaps, have taught some beguilable news editors how to appraise these announcements at their real worth. As a rule the attempts are based on theories so fallacious that whenever they come to my notice I can not help thinking in a lighter vein. Quite recently a new discovery was heralded, with a deafening flourish of trumpets, but it proved another case of a mountain bringing forth a mouse. This reminds me of an exciting incident which took place years ago when I was conducting my experiments with currents of high frequency. Steve Brodie had just jumped off the Brooklyn Bridge. The feat has been vulgarized since by imitators, but the first report electrified New York. I was very impressionable then and frequently spoke of the daring printer. On a hot afternoon I felt the necessity of refreshing myself and stepped into one of the popular thirty thousand institutions of this great city where a delicious twelve per cent beverage was served which can now be had only by making a trip to the poor and devastated countries of Europe. The attendance was large and not over-distinguished and a matter was discussed which gave me an admirable opening for the careless remark: "This is what I said when I jumped off the bridge." No sooner had I uttered these words than I felt like the companion of Timotheus in the poem of Schiller. In an instant there was a pandemonium and a dozen voices cried: "It is Brodie!" I threw a quarter on the counter and bolted for the door but the crowd was at my heels with yells: "Stop, Steve!" which must have been misunderstood for many persons tried to hold me up as I ran frantically for my haven of refuge. By darting around corners I fortunately managed—through the medium of a fire-escape—to reach the laboratory, where I threw off my coat, camouflaged myself as a hard-working blacksmith, and started the forge. But these precautions proved unnecessary; I had eluded my pursuers. For many years afterward, at night, when imagination turns into spectres the trifling troubles of the day, I often thought, as I tossed on the bed, what my fate would have been had that mob caught me and found out that I was not Steve Brodie!

Now the engineer, who lately gave an account before a technical body of a novel remedy against statics based on a "heretofore unknown law of nature," seems to have been as reckless as myself when he contended that these disturbances propagate up and down, while those of a transmitter proceed along the earth. It would mean that a condenser, as this globe, with its gaseous envelope, could be charged and discharged in a manner quite contrary to the fundamental teachings propounded in every elemental text-book of physics. Such a supposition would have been condemned as erroneous, even in Franklin's time, for the facts bearing on this were then well known and the identity between atmospheric electricity and that developed by machines was fully established. Obviously, natural and artificial disturbances propagate through the earth and the air in exactly the same way, and both set up electro-motive forces in the horizontal, as well as vertical, sense. Interference can not be overcome by any such methods as were proposed. The truth is this: In the air the potential increases at the rate of about fifty volts per foot of elevation, owing to which there may be a difference of pressure amounting to twenty, or even forty thousand volts between the upper and lower ends of the antenna. The masses of the charged atmosphere are constantly in motion and give up electricity to the conductor, not continuously but rather disruptively, this producing a grinding noise in a sensitive telephonic

(*Continued on page* 550)



This New French Inductive Water Pipe Locater Can Be Used by Either One or Two Men.



A Close-up of the "Chanoit" Electric Water Pipe Locating Apparatus. A Battery and Induction Coil Are Used.

Paris Letter

By JACQUES BOYER
Paris Correspondent "Electrical Experimenter."

ENGINEER CHANOIT has conceived the idea of using a new electrical induction balance invented during the war by Prof. Gutton for the location of non-exploded shells, to locate underground water terminals of the waterpipe distribution system.

The new apparatus is a little different in form, but the principle is the same. This induction balance "Alpha" (Model 1919) consists of two flat coils mounted in series in the same circuit, and in which alternating current induces currents in two neighboring coils. In these coils the wire is wound in such a way that the electromotive forces are reversed every instant. The coils measure 70 centimeters in diameter; the wire is wound at the rate of 20 turns on the primary and only 10 turns on the secondary. As to the armature, sieve chassis are used. A wooden traverse mounted across the diameter insures the rigidity of these drums, covered by a rubber tissue to protect the wire wound on the same. Attached to the traverses are two wooden uprights mounted at an angle toward each other, and supporting at their junction a special regulating system.

Induction Balance Locates Water Pipes

If both pair of coils are exactly identical, the electro-motive forces would be compensated and a telephone connected in circuit would remain silent. But in view of the impossibility of obtaining a perfect similarity between these two pair of coils, a variable inductive regulator is added, enabling the neutralization of the mutual induction of the two primary and secondary circuits. All that is necessary is to mount in each of the circuits a small coil with four turns of wire, which is illustrated in the photograph herewith, in the center of the instrument underneath the handle; one of these coils moving inside, the other around the common center. This rotation in modifying the mutual induction of the two circuits, permits the regulation of the "Alpha" balance instrument at the moment of use.

When a mass of iron is in the neighborhood of one of the pair of coils, it creates an asymmetry which wards off the compensation. The 'phone will then give forth a sound. Moreover, in a portable box there is mounted with a condenser a battery of four cells, or a storage battery, which excites a vibrator. The electro-motive forces of self-induction in the coil of the vibrator, charge and discharge the condenser periodically, realizing in this manner the primary excitation.

When the employees of the Water Department want to proceed, they attach the apparatus to their backs, mount their bicycles, and ride toward the pipe line which they want to explore. Once upon the grounds, they mount the apparatus and connect the wires. Usually two work together, but one man alone can do the work satisfactorily. If working in pairs, the observer goes along the road with the balance, holding the same at a little distance over the ground, his assistant following with the box containing the battery, condenser and vibrator. If working alone, the man puts his box on the ground and moves it as he goes along. When passing over a buried waterpipe up to a depth of one yard, the 'phone will indicate by its characteristic buzz the exact location of the same.

New Hospital Call Switch

Most modern hospitals are equipt with *hospital call systems*, which, in many instances give fairly satisfactory service, but one trouble often arises from their use because a great majority of them employ some form of standard electrical device which the patient uses to signal the nurse. The device usually consists of a pendant type of push button fastened to a flexible conductor which is hung over the head of the bed. These standard wiring devices are not intended for such service, and there is considerable wear and tear on the cord, and as a result the cord frequently becomes worn, thus making the signal inoperative.

A new device called a Hospital Call Switch has just been developed. It is made for a standard switch outlet box, and the wiring for it does not extend beyond the box. No flexible conductors or pendant switches are required for its use, and consequently, the annoyance of having these parts worn or broken is eliminated. It is so constructed that the patient can only complete the circuit to signal the nurse, and she can push it "off" only at the bed-side.



A New Hospital Call Switch. Individual Indication At Each Bed Is Effected. The Nurse Cannot Ignore It.

The accompanying illustration shows one of these new switches installed in the wall near the patient's bed. A pull chain, to which a linen cord is attached, is used to pull the switch "on." The push-button, located above the horn, thru which the pull chain extends, is used by the nurse to push the switch "off." In a ward, where two or more switches are used on the same signal, the protruding button indicates to the nurse which patient called. The signal remains "on," therefore, until the nurse comes to the bed to push the switch "off." Hence there is no excuse for the patient's call not being observed and answered.

What the X-Rays Show

Scientific and Industrial Applications of X-Rays in War and Peace

THE X-ray to most of us conjures up visions of white robed nurses, surgeons, and hospital operating rooms. But today the X-ray, discovered by Wilhelm Conrad Röntgen in 1895, gives promise of becoming one of the world's greatest and most useful accomplishments. No longer is the X-ray confined alone to hospital and physicians' diagnostic requirements, but it has been used in the past few years, especially during the World War, for many hitherto undreamt of purposes. In fact, one could write a book on the industrial applications of X-rays which would read like a romance. How they helped to foil the German conspirators in America who tried to plant infernal machines and contraband rubber and nickel into bales of cotton; how steel needles and other metal objects were actually placed into bags of powder in U. S. Government arsenals by pro-German workers; how defects were allowed to pass in shells, other ammunition and guns, and dozens of other dangerous practices, as well as interesting scientific developments —all of these are a matter of history now.

Figure 1 of the accompanying illustrations shows a large X-ray machine being used to detect the presence of contraband rubber or metal placed in bales of cotton. A number of these X-ray machines were used at the leading cotton shipping ports of the South during the war. Infernal machines timed to go off at sea were often detected in this way, altho little or nothing was ever said about these discoveries for very good reasons. If these discoveries on the part of Uncle Sam's secret service and shipping experts had been made public at the time, naturally the perpetrators of such crimes would have directed their energies to other ways and means of attaining their objects.

More romantic perhaps is the application of the X-ray for discovering the presence of pearls or the nuclei of pearls starting to grow in oysters. Figure 2 shows the X-ray apparatus in use for this purpose. Previously, many thousands of oysters were annually obliterated by being opened in an effort to determine the presence of pearls or pearl nuclei. All of this is now obviated, thanks to the X-ray, and if Mr. Oyster does not show up with a pearl nuclei, he is replanted in his natural habitat, the water, once more. Here it develops to maturity. If an undeveloped pearl is detected by the X-ray pearl expert, then the oyster is at once laid aside for further treatment.

Bullets and shell have been examined by thousands, as shown in Figure 3, by powerful X-rays. The X-ray in this case shows the amount of powder in the shell, how it is loaded, et cetera, and the same is true also for bullets. A different shadow is cast on the X-ray plate or fluoroscope for each different material, so that differentiation between each substance is readily possible. Defects in the loading and assembling of shell were frequently detected in this way at the great shell factories and arsenals during the war, thus preventing misfires and premature explosions, with a possible large loss of life.

Concrete ships have been rapidly coming to the fore in the past few years, and were developed to quite a large extent during the war, many being built in this country and abroad. No matter how expert the inspectors on such hulls may be, they cannot tell in any case how the interior of the concrete structure looks, especially the steel reinforcement bars, which may have become bent or misplaced during the pouring process.

Figure 4 gives an idea of how valuable the special portable X-ray outfits prove in finally checking up the hulls of such vessels before they are launched. A bent or misplaced steel reinforcement or an air-pocket, either of which would constitute a serious altho unnoticeable weakness in the hull, can be quickly detected by the X-ray. For such large area X-ray examinations a fluoroscope is invariably used, and not the photographic plate.

How many railroad accidents have been caused by defective car wheels? Many of them, if the truth were known. And why is this? Simply because the iron wheels appeared to be all right, and withstood possibly a fair mechanical test, but inherently they possest a weakness, perhaps in the form of air pockets or invisible cracks caused by strains in cooling when they were cast, etc., etc.—defects which only the X-ray can and does detect at once in a minimum of time.

For such purposes an X-ray is used in the manner here illustrated at Figure 5. The X-ray tube together with exciting spark coil, batteries, et cetera, are placed in a portable carrying case, which can be placed behind the car wheel or other object. The fluoroscope, or, in special places, the X-ray plate in its light-proof holder, is placed before the car wheel or other object. A few seconds' exposure to the X-ray gives a *skiagraph* or X-ray photograph on the plate, which is afterward developed and printed, or the image may be, and usually is, examined on the negative itself, no print being made. Of course, if the fluoroscope is used for directly viewing the object under examination, then the object is seen clearly at once, and various parts of it examined by moving the fluoroscope over the surface.

Many lives have been lost due to the explosion of anarchists' bombs and infernal machines, not only when they happened to explode in locations where they were *planted,* but also when they have been under the process of examination by bomb experts of various city police departments. The examination of bombs and infernal machines now bids fair to presently become as concrete and specific a procedure as weighing a pound of coal. The X-ray has already been used with marked success in determining the structure of such dangerous devices beforehand, which is of course a great stride in advance of the erstwhile method of "yanking" the bomb apart and "waiting to see what would happen." See Figure 6.

Even the field of Art, including cubist paintings, has been invaded by the mechanistic X-ray tube with its prying eyes, the discerning powers of which will not be denied. To the Scientist and his X-ray tube must come the Artist or the Art Connoisseur with his ancient and almost priceless Rembrandt, Van Dyke, Corot or Blakelock, the *authenticity* of which may be in question. A number of notable forgeries in supposedly valuable paintings have been detected by the scrutinizing X-ray. Figure 7 shows the X-ray being used to determine the authenticity of old paintings.

Another fruitful field in which the X-ray has proven its value many times is in the examination of large diamonds and other precious stones. Instead of X-raying the diamond to determine its value as a diamond, another application in this same field lies in its use at one of the large South African diamond mines for the purpose of detecting the presence of a diamond within the body. This may sound somewhat startling at first, but there have been cases where diamond miners have even "swallowed" diamonds in order to smuggle them out of the mines. Therefore, at this particular mine all of the miners undergo an X-ray examination, as shown in the accompanying illustration, Figure 8, before they leave the mine at the end of the day's work.

The modern Dentist has found that the X-ray is the only means whereby he can be sure that he is properly diagnosing the ailment of his patient. As pointed out in an exhaustive article by Dr. Henry A. Cotton, Medical Director of the New Jersey State Hospital, Trenton, N. J., in the August issue of this journal, defective teeth are sometimes due to *abscesses* and other growths forming at the roots, whch are not visible in any other way by physical examination, except by the X-ray. Such abscesses are the cause of serious organic and systemic disorders and ailments, such as rheumatism, neuralgia, stomach and intestinal troubles, and many other ills which would

(*Continued on page* 603)

The "November" Electrical Experimenter

Church Sermon Heard for a Mile —Audions and the Magnavox Did It. Think of hearing a human voice a mile away. Sounds uncanny—doesn't it?

Slow Movies—How they are taken with a new arc-light more powerful than sunlight. By Joseph H. Kraus.

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Magnetic Storms—How sunset, wind and other weather phenomena actually cause "magnetic storms." By Prof. Lindley M. Pyle, Department of Physics, Washington University.

Rochelle Salt—It talks, acts as a microphone, and also as an amplifier.

"My Inventions"—Part VII—by Dr. Nikola Tesla, himself. A particularly interesting and educative paper which you should not miss.

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Talking to Mars, by Prof. Brainin.

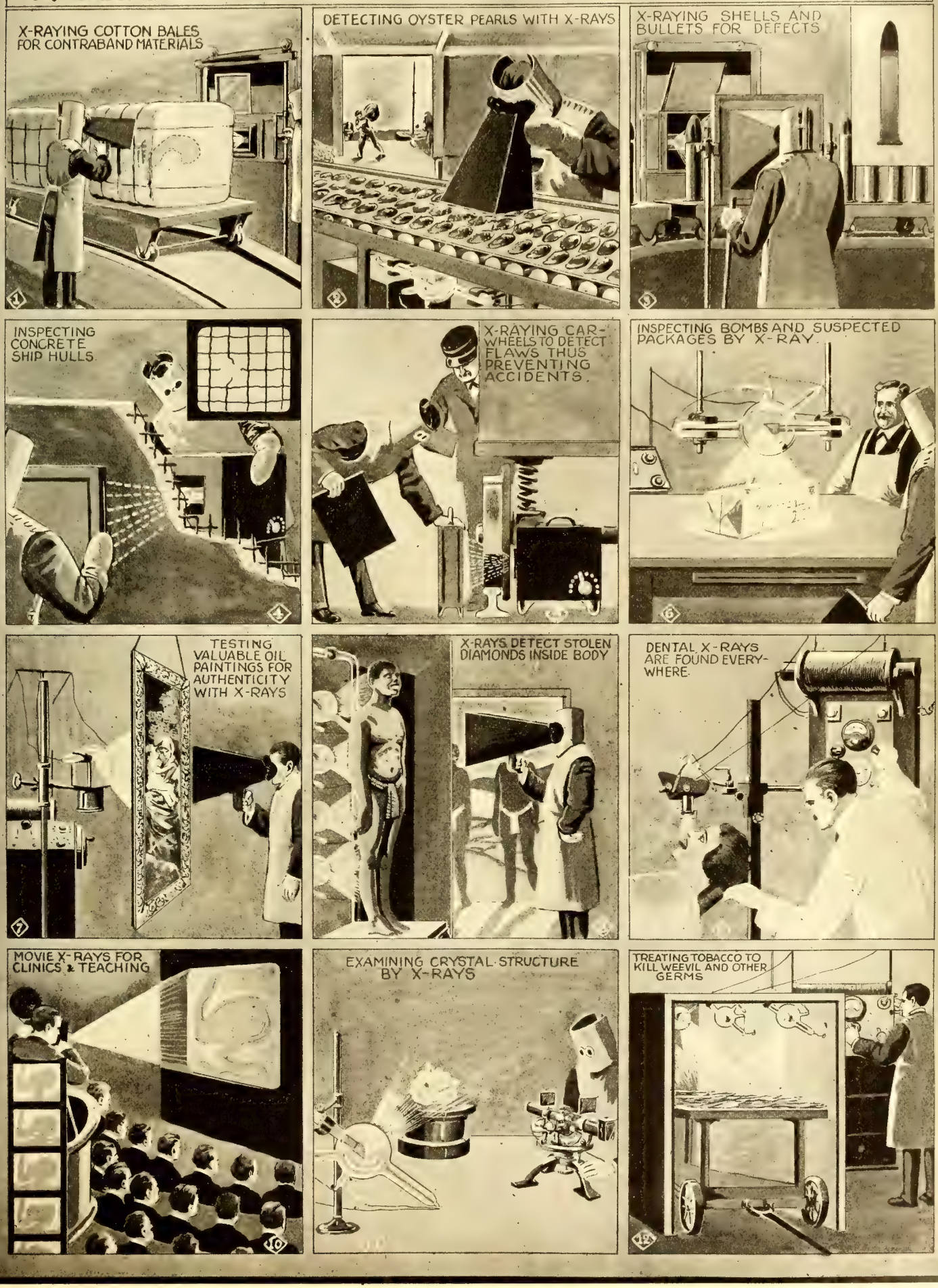
How the Electrical Engineer Works—His daily work in a large engineering works explained in an interesting way by H. Winfield Secor.

Magic for Everybody—by Joseph H. Kraus.

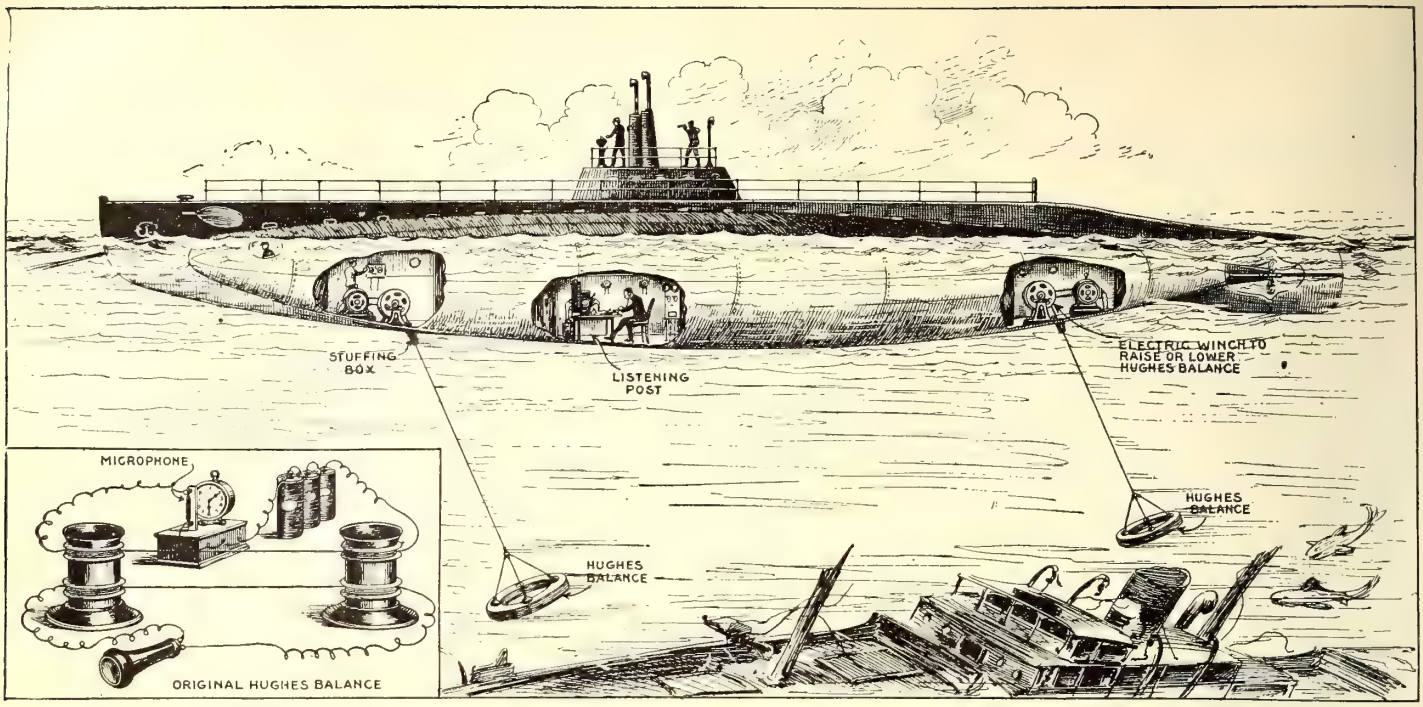
A new article on "Psychical Phenomena," by Dr. Hereward Carrington.

Besides all the usual Departments —Machine Shop Practise; Practical Chemical Experiments; Experimental Physics; The Constructor; How-to-Make-It; Popular Astronomy.

WHAT THE X-RAYS SHOW



(FULL DESCRIPTION ON OPPOSITE PAGE)



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As Our Front Cover Illustration Shows, this New Invention for Locating Sunken Ships Can Be Operated Without the Aid of Divers or Diving Machines. It is Based on the Hughes Induction Balance, Where a Slight Change in the Induction Between Four Balanced Coils Causes a Sound to Be Heard in One of the Circuits.

Treasure Ships Located Electrically

By H. GERNSBACK

THE salvage of 440 vessels and the recovery of property valued at $250,000,000 is the record in four years of the British Admiralty Department, which under Rear-Admiral Philpotts has been conducting salvage operations in home and foreign waters.

Thus reads a recent newspaper clipping. But the $250,000,000 worth of property recovered represents only a very small percentage of the ships that had been sunk during the present war as well as during the past century.

The ocean is dotted with sunken ships containing such fabulous treasures that it is difficult for the mind to grasp the enormous figures. It runs way up into the billions, and while we do not pretend to claim that all of this property, even if recovered, would be of value, there still remain many billions' worth of sunken treasures which can be salvaged today.

When a ship with a cargo sinks, that cargo is not always valuable if recovered. For instance, it might have had on board grain or other perishable goods, which, even if salvaged, would be found useless. But many other ships containing mixed cargoes, such as metal, coal, bullion, certain chemicals, etc., do not deteriorate even if they have been on the bottom of the ocean for years, and the great majority of sunken ships contain at least a large part of their cargo, which is quite imperishable.

Then, too, if a vessel is raised within one or two years after it has been sunk, it can in many cases be refitted and will do service just as good as new, after it has been overhauled. Here the ship whose intrinsic value is quite high is well worth salvaging, if there is a possibility of us doing so.

The main trouble in the past has not been so much in actually salvaging the ship, but in *accurately locating it* so that divers or the diving apparatus can be brought into action. It is one thing to know the *approximate* position where a ship has been sunk, but it is quite another matter to know the *exact spot*. In other words, tho we have a chart which gives the spot on which a ship has been sunk, *this spot may measure five square miles or more,* and if the ship is located in any channel or such parts of the ocean where there are heavy undercurrents, such a ship will soon be covered over with sand, moss, barnacles, etc., which effectively hide the ship and make it very difficult for the divers to locate it.

Many a salvaging company has found to its regret that it is one thing to obtain a commission to raise a sunken ship and quite another to actually locate it in order to start the salvaging operation. How then are ships located?

We have several means at hand. One of the simplest is to send down divers, using powerful under-water searchlights, and then make a systematic search in order to find the wreck. This is not only a lengthy and difficult procedure, but when the ship lies at a great depth the high water pressure makes it impossible for the divers to reach the bottom.

The next method is to use grappling irons or anchors, which may be termed the "fishing" method. This, perhaps, is the least satisfactory as it takes a long time and does not always bring results. It is at most a long and weary procedure, and very expensive on account of the enormous time losses involved.

We still have another method which, while not new, is not known as well as it deserves. It is a purely electrical method in locating sunken ships. It is very efficient, and the cost is negligible as long as we own a ship or a submarine on which to install the apparatus. The writer advances the idea of using the submarine in a peaceful mission to raise the ships wantonly sunk by its war sisters during the world war.

In order to detect the sunken hulls, use is made of the induction balance invented by Hughes in 1881. The insert in our illustration on this page shows the basic principle of the apparatus. Two wooden or hard rubber cups about four inches high and one and a quarter inches in diameter are turned out. Upon each of these cups we now wind 150 yards of single silk copper wire No. 32, which gives us a spool about a quarter of an inch high. Each wooden cup has two such windings, as will be noted from the illustration. These two wooden cups now form the pans of the thus constructed induction balance. The connections are made as in the illustration; the two lower windings connecting with an ordinary telephone receiver, while the other two spools are in series with a microphone and three dry cells. We now have an instrument of extraordinary sensitivity. In the position shown in the illustration, if you pick up the telephone receiver no sound is heard because the two parts of the balance are in equilibrium. If, however, we drop into one of the cups a piece of metal, no matter how small, the electrical compensation will be disrupted, due to the difference of resistance thus created, and we now hear the clock ticking in the telephone.

This instrument is so extraordinarily sensitive that even if two equal coins are dropt, one in each cup, the telephone will sound just the same because these two coins are not *exactly* of the same weight nor of the same alloy. The slightest chemical difference will thus be shown in the induction balance. For that reason this instrument has been used a good deal for exploration work, and the idea to use the induction balance for finding sunken vessels is by no means a new one. It has been used successfully for a number of years.

Our illustration shows how it is accomplished. If we fit out a submarine as shown, which has two induction balances lowered into the water and which are trailed from underneath, the telephone receiver on board located in the control station will give forth no sound as long as the two balances move thru the water. But the minute one of them comes within the vicinity of a wreck, say within five hundred feet or more, the electrical balance will be disturbed immediately, and the telephone will sound its warning to the operator. The nearer the balance comes to the wreck the louder the sound will be. It is thus a

(*Continued on page* 559)



Electricity Foils Bank Robbers

BANK robberies being so prevalent at the present day induced a very ingenious inventor, Mr. Scholder, of New York, to try out a new invention after he had had it patented. In the Bronx, New York, there is a small bank, entirely too small for the business it is doing, which decided that the only way to safeguard itself, its employees and its patrons was to install an electric Burglar Alarm, which would not have the disadvantages of other alarms, and at the same time work more efficiently than any such device yet perfected. Accordingly a contract was given to the inventor, and the device was promptly installed. A demonstration showed its utmost reliability in every respect. The device is now installed in the Cosmopolitan Bank, Prospect Avenue, Bronx.

It consists of various applications of alarm and signaling systems, original and patented by the inventor. Should a burglar attempt to enter the bank, an alarm is immediately sounded in the form of a large gong and a red lamp flashes; this lamp is so protected outside of the bank that neither the gong nor the flashers can be tampered with, as shown in the photographs. The gong is enclosed in a perforated steel box, of which there are four, one at either entrance of the bank, one in the basement and one in the bank proper. Should one of the gongs thru any chance be destroyed, the other three gongs will immediately set up an alarm, reinforced by the red light flashes, which attract passers-by or any policeman on beat. A special novelty of this protective system is that installed at the tellers' windows. These are equipt with steel drops $\frac{1}{8}$" thick, which are held in place by electric latches, one at each end, the drops running the entire length of the window and high enough to protect those behind from any trouble or misfortune. Should any system of robbery such as has been tried in other banks be attempted here, and the robber enter, levelling his gun with a cry of "Hands Up!" a *slight* foot movement on the part of the teller will immediately release the drop with a terrific bang, as this steel curtain (which effectively protects him from being shot) drops down. Immediately, both inside and out, alarms and electrical flashes announce the hold-up, preventing the killing, accidentally or purposely, of any of the employees and the loss of property as well. The bank is so protected that no burglar can enter the premises thru doors, windows or any other opening; even should he attempt to tunnel into the bank and tear a portion of the wall down, he would be instantly detected. As far as safes and safety vaults are concerned, it is impossible for even an experienced safecracker to touch anything from the inside, whether the outside door is opened by knowing its combination, or by dynamiting the safe, inasmuch as an insert of the safe consisting of a fiber frame, lined with web-like wires, will cause an instant alarm.

Now a word about the device. This consists of a double contact or 2-way relay, which will prevent either cutting, short-circuiting or interference in any way with the wires, this relay actuating an automatic drop. This drop is connected with flashers and well-concealed wires running to the bell and lights, so that any attempt to cut or destroy the signaling devices will set off the alarms in other parts of the building and at other exits. The bank is thoroly wired, and an attempt of breaking thru the walls would be immediately frustrated. Thermostatic fire alarms thruout the building are arranged in a like manner, and wired to a distinct annunciator, which warns of any conflagration by means of the intermittent or continuous bell alarm, and flashes of both red and green lights, the two together indicating *fire,* and the red alone indicating burglary. The approach to the safe itself is thoroly wired. The alarm can be arranged in such a way as to notify the Police Headquarters, at the same time attracting the attention of all those about. The writer has seen an actual demonstration of the device, and in which attempts were made to force open the door. Another scene demonstrating the "hands-up" attempt to make the teller "fork over" met the response on the part of the teller by a prompt lifting up of his hands. Immediately a steel curtain dropt down with a terrific crash (in about 1/100 second), hiding the teller from view and protecting him from all harm. The release of the curtain, together with the crash and alarm is enough to scare any yeggman, no matter how bold he may be.

To Europe in Three Hours

By H. WINFIELD SECOR

ASSOCIATE MEMBER AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The Physics of the Upper Atmosphere. How High Can We Fly and Why?

SEVERAL attempts have recently been made to improve on the high altitude flight records, the highest point so far reached being that attained by the French flier, Adjutant Casale, who unofficially reached a height of 33,136 feet. A few weeks ago Mr. Roland Rohlfs, chief test pilot for the Curtiss Engineering Corporation, established a new official altitude record at Mineola, L. I., N. Y., when he soared to a height of nearly 31,000 feet (30,700 feet Unhomologated). Some of the experiences of Mr. Rohlfs, as well as those of Major R. W. Schroeder, A. S. A., who held the best previous American altitude record of 28,900 feet, made on September 18th, 1918, are given elsewhere in this article.

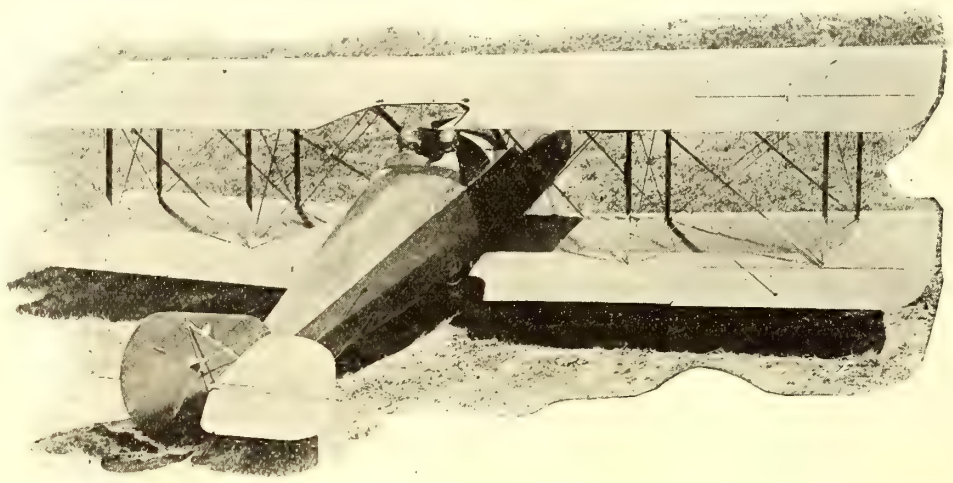
AIR PRESSURE RAPIDLY DECREASES AT HIGH ALTITUDES

It is undoubtedly a common belief that the only requisites necessary in ascending to a great height in an airplane are great stamina and a one hundred per cent physique on the part of the flier, a good plane and engine and devices arranged so as to overcome the effects of the severe cold felt at the higher altitudes, such as 25,000 to 30,000 feet. There are many other factors, however, which come to bear on this important matter of flight in the upper rarefied air strata, one of the most important of which is the rapid reduction in the atmospheric pressure on the body at such altitudes as 30,000 feet and above. Before going further, it should be said that there naturally must be a limit to the permissible reduction of this air pressure in order to live. If we reduce this pressure to a very small fraction of the normal pressure at sea level, which is 14.72 pounds for every square inch of the body surface, then it becomes evident that the pressure of the blood as it is pumped thru the veins by the heart will burst them. If a frog is placed under a glass bell and the air exhausted, the frog will blow to pieces, due possibly for one reason to the air trapt in the lungs, which bursts these tissues when the external pressure is removed from the body, and due to a second and very important reason—that so long as the heart keeps pumping the blood thru the veins of the body this pressure, which is considerable indeed, will cause these vessels to burst. Persons often ask, "How high will our birdmen, with every possible airplane refinement, be able to fly, and if, generally speaking, there is no limit, provided planes and engines can be built which will operate properly in the upper rarefied air strata?" The answer is—that there is certainly and most decidedly a "limit," and we would state here that it is our belief that unless specially arranged engines and carburetor systems, fitted with the new atmospheric compressor and enclosed cabs, possibly *vacuum bottle* cabs, to protect the crew are used, then when flying in an ordinary machine where he will have to breathe the air direct from the atmosphere (even with the aid of oxygen), he cannot hope to ascend to a greater height than 38,000 to 40,000 feet.

The author became particularly interested in this matter and went to the trouble of taking up this subject with the New York branch of the U. S. Weather Bureau, and desires here to give thanks to the courtesy of Mr. J. H. Kimball of that Bureau, who kindly looked up records on some wonderful pilot balloon tests and observations made by the U. S. Weather Bureau Service. Figures for the air pressure and temperature at various altitudes are presented in the illustration herewith, where some interesting speed figures are given for various types of aircraft as well as steamships. It is interesting to note at this juncture that the amount of increased speed for the future is all with the airplane or dirigible—and *not* with the ocean-going steamship. Ocean-going steamships have about reached their highest speed, due to several engineering reasons. Such a vessel displaces constantly a very large amount of water, and the laws governing this are very well known, and have been worked out by technicians to a very high degree in the past ten to fifteen years. It is doubtful if we shall ever see a steamship which can cross the ocean in a shorter time than *three days*, unless an unreasonably large amount of horse-power is consumed for the purpose, which, of course, is diametrically opposed to the high efficiency standards demanded of all such transportation carriers today.

The airship, on the other hand, has the advantage that as it ascends to higher altitudes it meets with less resistance, and not only this, but another wonderful phenomenon of nature occurs—the higher air strata are known, as tests have shown, to be moving at a very high velocity, and so it is readily seen that if an airplane ascends to an altitude of 20,000 to 30,000 feet, or even less, that it may strike a strata of air traveling eastward, or perhaps westward, having a velocity of 200 miles an hour or more. Hence, if the airplane can travel at 100 miles an hour, then its net velocity in a given direction will be 300 miles an hour!

It is believed that the successful pioneer transatlantic flight of Messrs. Alcock and Brown, totaling 1,880 miles, which was made in sixteen hours, at an average speed of 116 miles an hour, was due to the fact that they ascended to a height of 10,000 feet, where they found an air current traveling Europeward with a high velocity. Such is the belief of Mr. Roland Rohlfs, the Curtiss pilot who has just made a new altitude record of 31,000 feet, and who expects to ascend to 33,000 feet or higher in a new flight.

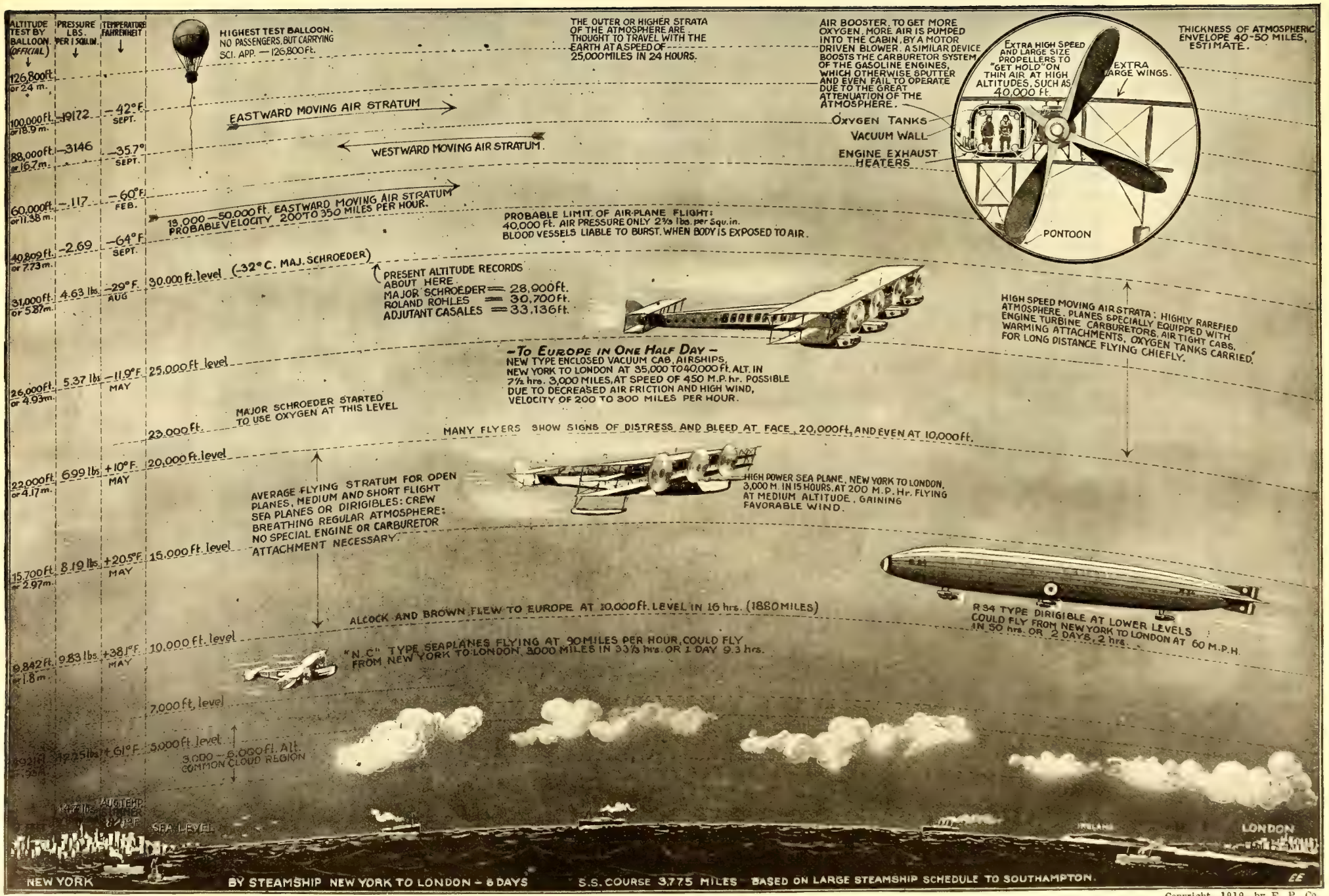


The Thomas-Morse Airplane that Established a new Gliding Record of 35 Miles. A Glide of 35 Miles with a Dead Motor was Recently Made by R. C. Marshall, Test Pilot for the Thomas-Morse Aircraft Corporation. It Is Said that this is a World's Record for Gliding. "Tex" Marshall, as He is Called, Flew from Ithaca to the Head of Cayuga Lake, a Distance of 35 Miles, and Then Flew Upward Until He Reached a Height of 17,500 Feet. He Then Cut Off His Motor and Glided Toward Ithaca. When He Reached the City, It Is Stated, He was Still at a Height of More than a Mile, and Might Have Glided Fifteen Miles Further.

The rarefaction of the atmosphere increases rapidly once an altitude of 30,000 feet is reached, and several writers on the subject have in recent years mentioned that for this reason particularly they do not believe that aviators will ever ascend higher than 40,000 feet in an open-type machine, where they have to breathe the ordinary atmosphere, even with the aid of oxygen supplied from a tank. This belief has been voiced by Mr. Harry E. Dey, a well-known American engineer, in an article which appeared some time ago in *Aeronautics*. He gives several other reasons therein for his faith in this belief. As the figures show in the accompanying illustration, the air pressure has been reduced about 60 *per cent at a height of* 26,000 *feet*, or 4.9 miles above sea level. Here we find the air pressure has dropt to 10.9 inches on the barometer, equivalent to 5.37 pounds per square inch. Such a marked reduction as this, as proven in all altitude flights so far attempted, have a very strong and undesirable effect on the flier. It affects the pulse or heart beat, the respiration, and in fact every part of the body, causing in some cases severe nausea, and at times fainting spells, when the pilot cannot tell whether he is flying upside down, sidewise, or in normal position. Major Schroeder, the American army flier, had all these sensations and more in his 105-minute ascending and 20-minute descending trip at Dayton, Ohio.

Let us look at the air pressure and temperature at 31,000 feet, or 5.8 miles. An official test made by the U. S. Weather Bureau at Huron, S. D., in the month of August shows an air pressure of 4.6 pounds per square inch, or a reduction of 68 per cent in the pressure found at sea level, where the aviator started to rise, probably no longer than an hour previously. Imagine

(*Continued on page* 573)



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To Europe in one-half day and possibly in three hours—that sounds almost preposterous and impossible to say the least, does it not? But a scientific study of the peculiar atmospheric conditions existing in the higher altitudes, such as thirty thousand to forty thousand feet, gives great promise, as several authorities have pointed out, of giving us airplanes of to-morrow which will so far surpass the present aircraft that there will be no comparison. In the first place, the upper air strata is known to travel at a very high velocity, which will carry a plane at from three to four times its sea-level speed. Besides all this, the rapid decrease in air friction would enable the plane to go much faster than at lower levels where the air is denser. "Vacuum cab" airships will undoubtedly have to be used to fly at the higher altitudes with extra large wings and propellers to support the craft in the thin air.

Can Radio Ignite Balloons?

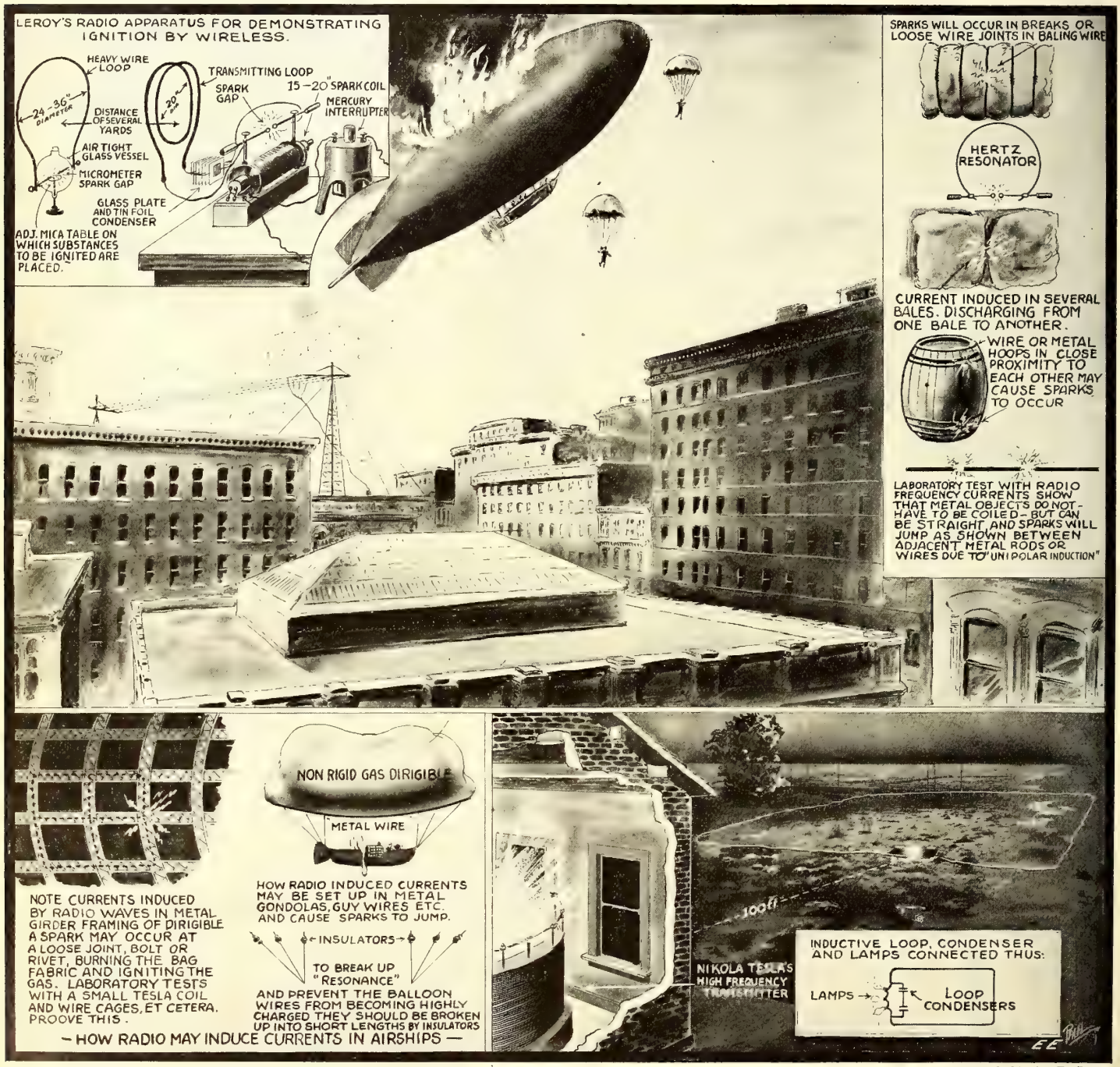
The Opinions of Nikola Tesla and Other Radio Experts

AS a result of the newest theory, that powerful induced currents emanating from the Naval Radio Station in Chicago produced the spark that ignited the Goodyear dirigible airship which plunged in flames thru the roof of a bank building in that city, resulting in death for thirteen persons and injury to twenty-seven others, naval communication officers will aid the authorities in fixing responsibility for the disaster. It was ascertained that technical experts had suggested *this* theory, because the big ship sailed over or near the Transportation building, from the roof of which are projected the antennae of the Naval Radio Station. The building thru the skylight of which the blazing dirigible fell was the Illinois Trust and Savings Bank.

Lieut. F. S. Mason, of the Great Lakes Naval Training Station, district communication service officer, while refraining from agreeing with the theory, said he would cooperate with the investigating officials. Pilot John Boettner, of the ill-fated dirigible, said he had not been aware of the location of the naval radio station. H. M. Byllesby, head of a large engineering corporation and foreman of the coroner's jury of technical men, said experts had suggested the *radio theory* to him.

Col. J. C. Morrow, chief air officer of the central department of the army, the principal witness at the inquest, was a passenger in the dirigible on a trip preceding the fatal one. At that time he said the ship was in safe condition. The pilot he considered competent. He thought the possibility of sparks from the exhaust igniting the gas bag very remote, but said he had not formed an opinion as to the cause of the accident.

(*Continued on page* 591)



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Herewith Are Shown Some of the Plausible Reasons Why the Recent Chicago "Blimp" Disaster Might Have Been Caused By a Spark Induced By An Adjacent Radio Station. The Photo In the Lower Right-hand Corner Shows Three Incandescent Lamps Lighted to Full Candlepower, At a Distance of 100 Feet from Dr. Nikola Tesla's Colorado High Frequency Power Plant. The Oscillator Was Worked At Less Than Five Per Cent of Its Total Capacity.

"Piped Cold"—Prof. Bell Has It

IN the July issue of the ELECTRICAL EXPERIMENTER, the Editor advocated the *piping of cold air* to various parts of dwellings and office buildings, using, if possible, the wintering steam piping systems and radiators. Well, great minds, etc. Here comes prolific Dr. Alexander Graham Bell, inventor of the telephone, airships, and ship salvage schemes, with an actual working installation of "piped cold." This idea occurred to Dr. Alexander Graham Bell when the Washington weather became extremely sizzling. Former President Taft, when he was in the White House, had a refrigerating device put in the offices, which since has fallen into disuse, but Dr. Bell believes he procured better results by his "home made" cooling arrangements in his Connecticut Avenue residence. In a communication to the *National Geographic Society*, Dr. Bell describes how he tricked the thermometer out of some 35 degrees—and you can try this out in your own home if you are "handy" about the house. Says Dr. Bell:

I have found one radical defect in the construction of our houses that absolutely precludes the possibility of cooling them to any great degree. You will readily understand the difficulty, when you remember *that cold air is heavier than warm air.* You can take a bucket of cold air, for example, and carry it about in the summer time and not spill a drop, but if you make a hole in the bottom of your bucket, then, of course, the cold air would run out.

I began to think that it might be possible to apply the bucket principle to at least one room in my Washington home, and thus secure a place of retreat in the summer time. It seemed to be advisable to close up all openings near the bottom of the room to prevent the escape of cold air and open the windows at the top to let out the heated air of the room.

Now, it so happens that I have in the basement of my house a swimming tank, and it occurred to me that since this tank holds water, it should certainly hold cold air; so I emptied the water out to study the situation. The tank seemed to be damp and the sides felt wet and slimy.

I reflected, however, that the condensation of moisture resulted from the fact that the sides of the tank were cooler than the air admitted. Water vapor will not condense on anything that is warmer than itself, and it occurred to me that if I introduced air that was very much colder than I wanted to use, then it would be warming up in the tank and becoming dryer all the time. It would not deposit moisture on the sides and would actually absorb the moisture there.

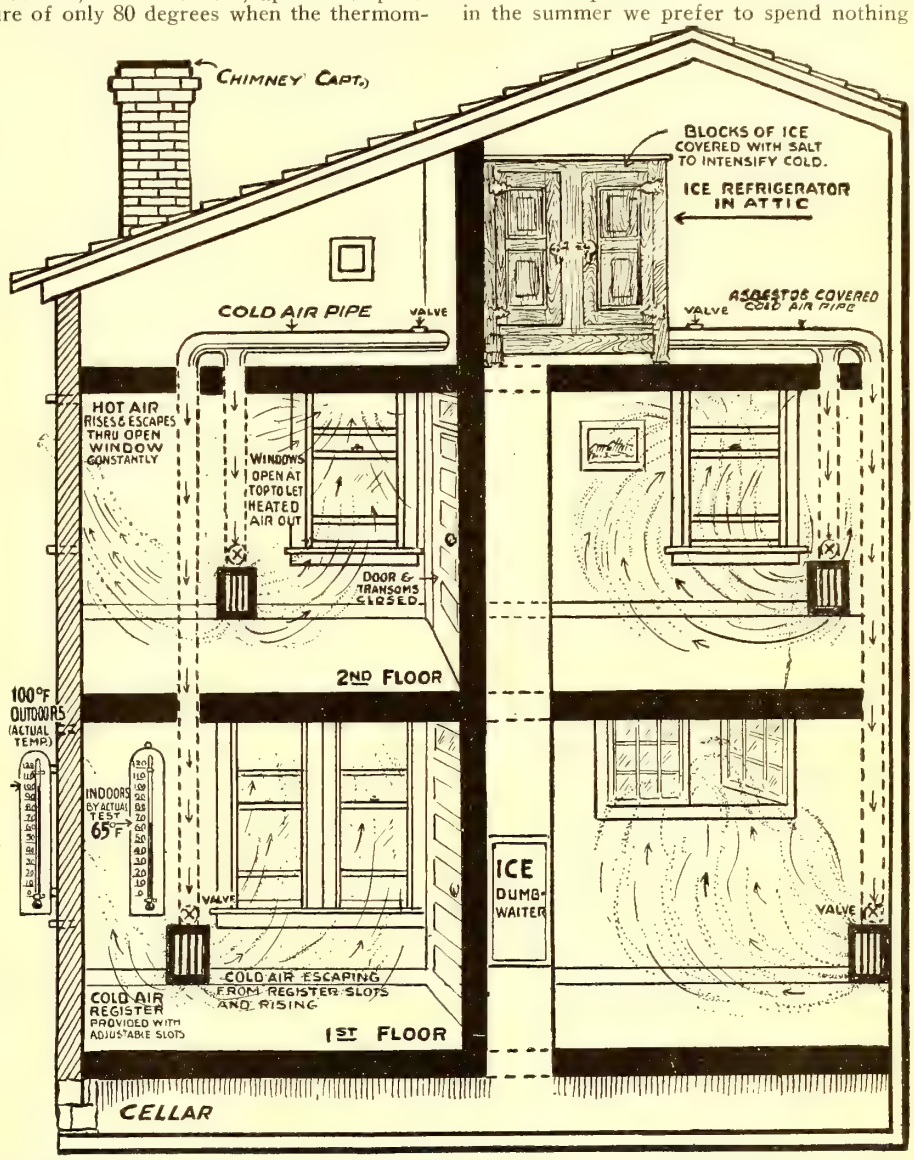
I therefore provided a refrigerator, in which were placed large blocks of ice, covered with salt, to intensify the melting and freezing action of the ice. This was placed in another room at a higher elevation than the tank, and a pipe, *covered with asbestos paper,* was employed to lead the cold air into the tank.

The first effect was the drying of the walls, and then I felt the level of the cold air gradually rising. At last it came over my head. The tank was full, and I found myself immersed in cool air. I felt so cool and comfortable that it seemed difficult to believe that Washington stood sizzling outside. I climbed up the ladder in the swimming tank until my head was above the surface, and then found myself breathing a hot, damp, muggy atmosphere. I therefore speedily retreated into the tank, where I was perfectly cool and comfortable.

Guided by this experience, I tried another experiment in my house. I put the refrigerator in the attic (see drawing herewith) and led the cold air downward thru a pipe covered with asbestos into one of the rooms of the house. The doors were kept shut and the windows were opened at the top. The temperature in that room was perfectly comfortable, *about* 65 *degrees!*

Some time ago the papers were speaking of an ice plant that had been installed in the White House, and congratulated the President, then Mr. Taft, upon a temperature of only 80 degrees when the thermometer showed 100 degrees outside. Under similar conditions (100° F. outside), I enjoyed in my home a temperature of 65 degrees (the ideal temperature), with a delicious feeling of freshment in the air.

The system proposed by Prof. Bell occupies very little space. In fact, it could be placed very easily in tenement houses utilizing the area between the ceiling and the roof, as all houses have at least a three-foot clearance between these two points. No doubt in the future, owners of houses will be compelled to install cooling systems.



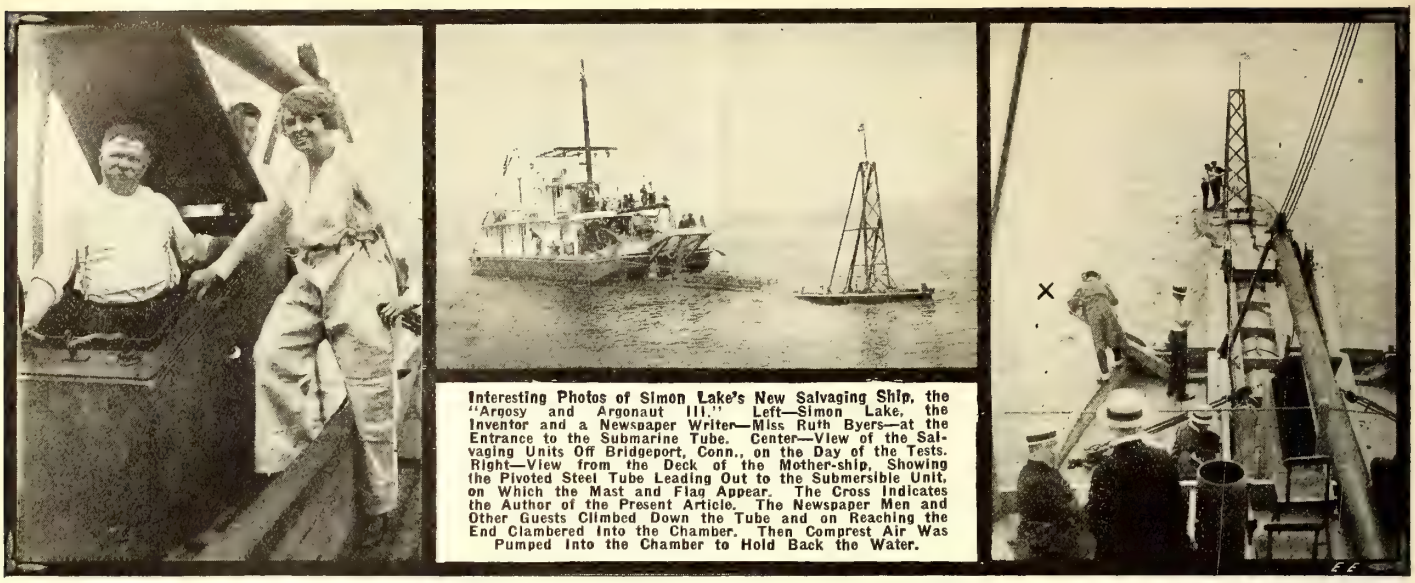
"Piped Cold"? Sure! Why Not? Said Prof. Alexander Graham Bell, Inventor of the Telephone. In His Washington, D. C., Residence He Installed a Refrigerator in the Upper Story as Here Shown. The Cold Aid Descends Thru the "Pipes," and Chases the Heated Air Out Thru the Open Window Tops. 100° F. "Outside" and 65° F. "Inside"—Tells the Story. It Works!

ORIGINAL EDITORIAL BY H. GERNSBACK IN THE JULY ISSUE

One of the most profound annual summer mysteries of the twentieth century—at least to the writer—is our hot office or and suffer untold misery in consequence. Babies and grown up sick folk die like flies by the thousands on account of the heat, while we stand by helpless, or rather as if we were devoid of all intelligence, while the totally unnecessary slaughter goes on incessantly. How our grandchildren will read with astonishment that for decades human beings had their houses piped for heat, but had not enough sense to run a freezing solution or other freezing agent thru the self-same pipes in the torrid summer days!

There might be an excuse for our criminal negligence if we had not the means at hand to keep us cool and comfortable in summer. But we really have all the means, all the apparatus; in fact, everything—including:

(*Continued on page* 550)



Interesting Photos of Simon Lake's New Salvaging Ship, the "Argosy and Argonaut III." Left—Simon Lake, the Inventor and a Newspaper Writer—Miss Ruth Byers—at the Entrance to the Submarine Tube. Center—View of the Salvaging Units Off Bridgeport, Conn., on the Day of the Tests. Right—View from the Deck of the Mother-ship, Showing the Pivoted Steel Tube Leading Out to the Submersible Unit, on Which the Mast and Flag Appear. The Cross Indicates the Author of the Present Article. The Newspaper Men and Other Guests Climbed Down the Tube and on Reaching the End Clambered Into the Chamber. Then Compresst Air Was Pumped Into the Chamber to Hold Back the Water.

Photo © by International Film Service

Reclaiming Sub-Sea Treasures

By JOSEPH H. KRAUS

Walking on the Ocean's Bed Without a Diving Suit—Simon Lake's Newest Invention

A LETTER.

"We expect to have our first press trial of the 'Argosy and Argonaut' on Friday morning, August 1st.

"Very truly yours,

"SIMON LAKE.

"Dictated but not signed."

THIS was a portion of the letter from the inventor of the modern submarine which greeted me not so long ago. With August 1st coming on the next day, it meant hustle and get out. So the two of us, my camera and I, departed for Bridgeport. The next morning found me at the Stratford Hotel with a party of about forty editors and cameramen, representing newspapers, photograph agencies and motion picture concerns, all there bright and early awaiting our trip to the salvage ships. Not very long afterward a short walk brought us to the pier to which one of Mr. Lake's vessels was moored. A little joking while the refreshments were being placed on board, the blow of a whistle and we departed for the open sea. About one-half hour's ride brought us to the good ship *Argosy and Argonaut.* This is a combination of two ingenious devices used for ship salvaging and wreck recovering. The "mother ship," about 100 feet long, has a 65-foot tube connected to it in a little *well* in the forward part of the ship. At the end of the tube is the submarine, which is hinged directly with it so that entrance may be effected thru the tube while the submarine is at the bottom of the water. A few trips around the vessel while the cameramen ground out hundreds of feet of "movie" news film and the submarine going thru maneuvers, demonstrated to us the ease and safety with which the device would work.

The launch which was taking us around soon pulled up alongside of the salvage vessel. We clambered on board once more, all ready for the descent, a demonstration of which was to be given in a very short time. Mr. Lake then singled out the parties, four or five of which went down into the tube at a time, and each group had some of the most interesting stories to tell. Altho before starting down I thought songs like "Nearer, My God, to Thee" or "Asleep in the Deep" would have been very appropriate for the occasion, no one even as much as hummed them. We were all too engrost in the surroundings and awed by the masterful engineering spectacle around us.

THE DESCENT.

A hatchway measuring about 3 by 4 feet opens into the 65-foot tube, which latter tube is well lighted by electric lamps, the current for which is supplied from the mother ship. Current is likewise provided to actuate all the mechanisms in the submarine. The tube, 4½ feet in diameter, has struts across the bottom. These struts are 6 inches apart and assist in getting a foothold in the tube. A rail on each side helps to hold you in a "hunchback" position. It is necessary, in order to descend in this tube, to stoop over, and for safety's sake to go down backward, as a "bump on the bean," as someone called it, is not such a pleasant thing to get, and there is less chance of "bumping" in walking down backward than in attempting to go down the other way. Furthermore, the body would not have to be bent at such a great angle descending backward. Soon the tube narrowed, and instead of the rail on each side, a large number of steel ribs greeted our clutching fingers. Mr. Lake being first, directed us to wait a while, and started to release the air pressure in the diving chamber. A hiss of escaping air and dense clouds of mist filled the lower end of the tube completely. Shortly a massive iron door opened, just large enough to admit a person's body. "All in!" and we filed thru the opening, or rather crawled thru it. We now entered the equalizing chamber, about 5 feet long and 3½ to 4 feet wide. Swinging the door closed again, Mr. Lake opened the valve which admitted air, so that the pressure in this chamber would be the same as that in the operating chamber.

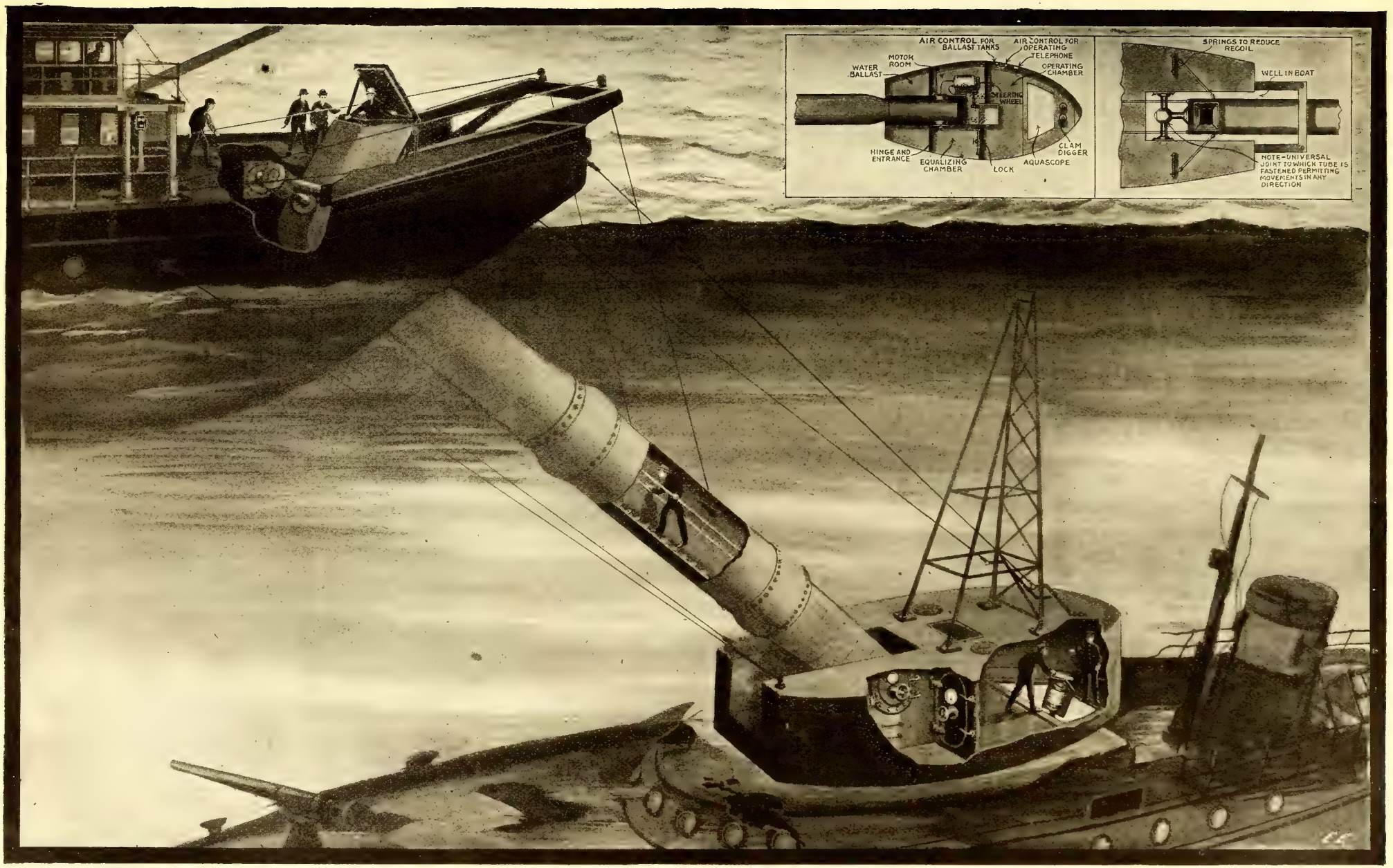
"Should you feel deafening in your ears, swallow," were Mr. Lake's words. Well—we swallowed! It reminded me more of "evolution" than anything else in my life. Have you ever been to the aquarium, and noticed the way some of the big fishes gulp water so as to oxygenate their blood? Well, that was *us.* The door into the operating chamber now permitted its being opened as the air chamber was equal in pressure.

This room is about 9 feet long and 8 feet wide at its broadest point, and sort of triangular in shape. What immediately attracted our attention was a hole in the floor of this chamber. There in front of us was a sheet of water about 6 inches deep, perfectly smooth on top with glistening white sand beneath. It seemed as tho it had been smoothed out and the sand cleaned for our reception. A signal, and the submarine moved forward, the water under us passing in slight ripples, and the sand moving away quite rapidly. Some of the most wonderful seaweed and shells were past, which could be seen easily with the use of no lights whatsoever, the water being of a beautiful translucent green (it's mighty hard to keep a swimmer out of water of that nature). A short time down in the operating chamber completed our visit to Father Neptune, and we again past thru the air-lock in order to give some of the others a chance to see this most wonderful spectacle.

HOW THE SALVAGE SHIP WORKS.

Now a word about the apparatus. The *Argonaut,* which is the mother ship, is 100 feet long with a beam of about 45 feet. It is driven by two 75 horse-power gasoline engines. These drive two propellers each, one forward and one aft. The propellers are so arranged that the forward pair may be disconnected, whence each engine drives the ship by means of the rear propeller. A very complex system of signalling is used on this vessel. The devices work by electricity or manually, by means of which the officer on deck can signal the engineer below in the engine room. In this engine room also is a 125-volt generator driven by an independent engine coupled to it. The energy derived from it is used to charge storage batteries, which supply the 110-volt D.C. for the lights and motor appliances used in the "sub." An air pump operating constantly supplies the air pressure for the "sub" and maintains a pressure of 75 to 80 lbs. per square inch at all times.

There is another extremely ingenious idea which Mr. Lake has incorporated in his salvage work. The device referred to is a semaphore arrangement on the masts of the salvaging ship. This semaphore consists of two arms, which are operated



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Simon Lake's New Salvage Machine for Reclaiming Sunken Vessels

Hundreds of millions of dollars' worth of cargo and ships lie sunken in the ocean and in coastal regions, which can be salvaged either partly or in whole, when the proper engineering means have been provided. It appears that the new salvaging vessel recently perfected by Captain Simon Lake, of submarine fame, will perform such operations in a very expeditious and efficient manner; and this belief is all the more strengthened by the successful tests made during the past August in Long Island Sound in the vicinity of Bridgeport, Conn. Captain Lake made successful explorations of the bottom of Long Island Sound at depths up to 50 feet and over. The principle of the device is as follows: A mother ship of fairly large proportion carries a pivoted steel tube at one end as the illustration above herewith shows. The lower end of this steel tube which forms a passage-way for the salvaging crew, is fitted by means of a large pivot joint to a "submarine" as it is called, and which in fact it really is. When one climbs down thru the tube, he finds himself in a rear chamber of the "submarine" and directly he passes thru an air-lock door, shown in the plan view above, into the forward air-lock. In this forward compartment air at high pressure is constantly forced in thru a pipe passing down thru the pivoted tube. This air pressure keeps the water down to the level of the floor. There is an opening in the floor as shown and the crew may walk on the sand of the bottom as the submarine is pushed along by the mother vessel. The present illustration shows two men sawing off the starboard light on the sunken "Mary Alice", an armored yacht.

from the deck, by means of which signals are transmitted to the two smaller vessels which accompany the *Argonaut*. These smaller vessels are known as *wreck-finding vessels*, much speedier than the salvage ship (*Argonaut*), and at the same time smaller in size. They are likewise equipt with semaphores for replying to signals. In this way Mr. Lake can guide the course of the wreck-finding vessels without the use of wireless. The submarine proper is 22 feet long and divided into a motor room, opening into the left hinge, and an equalizing chamber, opening at the right hinge, thru which we had to pass in order to reach the operating chamber up forward. On each side and to the rear are two ballast tanks; also one midway between and below these. A large 110-volt motor actuates the wheels under the submarine proper. This motor is controlled from the operating chamber, i. e., the forward-most chamber of the submarine, and is likewise steered from this latter chamber. By its means the *Argosy*, or submarine proper can rest on the bottom of the ocean. These traction wheels under the submarine may be steered in any direction, and the mother vessel may, by this means, be drawn along by the action of the submarine itself, the submarine having the mother ship in tow, so to speak. Entering the right equalizing chamber from the tube, there is a massive iron door (which seems strong enough for a safe) with heavy latches. The door in the equalizing chamber is closed and comprest air is admitted slowly so as to allow the body to become accustomed to the increase in atmospheric pressure. When this is done gradually there is no grave risk.



A Remarkable "Pre-War" Caviar Map of the World's Greatest Ship Graveyard. The Wrecks Pictured Have All Occurred During a Period of Fifteen Years. This Great Loss of Shipping Was One of the Principal Causes Leading Up to the Construction of the Kiel Canal. This Chart Was Prepared, Before the War, by the German Hydrographic Office. Captain Lake's Submarine Salvaging Scheme, Which He Has Successfully Demonstrated, Represents an Invention that Is Expected to Reclaim 75 Per Cent of the $6,000,000,000 Worth of Ships and Cargo Lost During the War. Altho Simon Lake, the Inventor of What for a Better Name Might Be Called a "Salvaging Submarine," Gave His Demonstration Off Penfield Reef, Near Bridgeport Harbor, Conn., He Declared that It Would Be Just as Successful Where the Waters Were 300 Feet Deep. Tests Have Been Successfully Made at a Depth of Fifty Feet. The Salvaging Submarine Really Consists of Two Boats, the Argosy and the Argonaut. The Argonaut Is the Mother Ship and the Argosy the Submarine Attachment or Submarine Tube that Can Be Lowered or Raised by Means of Powerful Engines on the Mother Ship. A Larger Vessel with a Tube 300 Feet Long Is Being Planned for Use in Deeper Waters. One of the First Vessels to Be Salvaged Will Be the Bark "Hussar," Which Was Sunk in Hell Gate, N. Y., During the Revolutionary War with a Treasure of $5,000,000 in Gold on Board.

Some notion of what a difference in air pressure may make can easily be understood when one realizes that every foot below the water level there is an increase of .43 pound on every square inch of the body surface, which means an increase of 1,376 pounds for the entire body. Under normal conditions, the body is subject to a pressure of 14.7 pounds per square inch, which is atmospheric pressure. At a depth of 150 feet the pressure is more than four times that to which we are accustomed, and is an additional 64½ pounds per square inch, or 32,250 pounds increase on body over atmospheric pressure. Under these circumstances the blood is driven back from the surface of the body, the veins become deplete of blood, and a greater amount of blood is forced into the arteries, hence causing the heart action to be of necessity a good deal stronger in order to force the blood thru the contracted arteries. For much the same reason, a deafening sound is produced. This is due to the fact that air pressure on the diafram of the ear (tympanic membrane) causes an inward depression of the diafram

The Eustachian tube which connects the middle ear with the buccal cavity, normally closed, opens a slight fraction of a minute during each swallow, and by this means allows for an equalization of the air pressure on both sides of the tympanic membrane. That is the reason Mr. Lake gave us orders to swallow on opening the valves, which would increase the pressure to that of the water at that depth. Even at depths of 40 to 45 feet the sudden *descent* may prove dangerous, and a too hasty *ascent* may be followed by intense bleeding of the nose and ears, and perhaps a more dangerous hemorrage in the body. All troubles of this nature are due, as we have said, to hasty ascent or descent. There are several pathological reasons for death, which may result from causes such as these, but as that is more a matter for the medico, it will not be discust in detail here.

THE OPERATING CHAMBER.

This chamber is divided up into a forward portion and the controlling portion. Up forward is the *Aquascope*, or underwater telescope, by means of which one can see out into the water. That is to say, the Aquascope is a large glass door, which will allow a person to look thru it or open it and get out and walk, so to speak. There is a depth of 6 inches of water from the interior of the chamber to the bottom of the ocean or deck of the vessel when the submarine is in position, so it's just as easy to walk here without getting any wetter than if wading in a brook. In this chamber likewise is a telephone, which communicates with the deck of the "mother vessel," as are likewise controls for all operations, such as derricks, degrees of air pressure and signals. In the aft portion of the submarine are three air tanks, which are placed one at each side, and one in the center and below the other two. It is only necessary to allow the water to pass into these containers, and the increase in weight will carry the submarine to the bottom, or anywhere midway between. It may likewise be forced out and the submarine made to rise to the surface.

The tube itself is hinged in such a manner that an up and down motion does not materially affect the submarine, neither does the side to side motion of the mother ship have any effect. A sort of universal joint, very powerfully constructed, holding the tube in position, while ropes connected to the pulley blocks on the deck prevent the tube from rocking either way to a great extent, due to the fact that these blocks in turn connect to springs.

Is salvage practical commercially? Well, let us quote a few cases. *La Lutine*, an old hulk of a British frigate, sailed from Yarmouth Roads for Hamburg on October 9, 1799, carrying a large amount of treasure in the form of gold and silver bars and coin. She struck a sand bank at the entrance of the Zuyder Zee and was lost. The minimum estimate of the coin on board is valued at $2,085,335. All attempts to recover the treasure have been futile, or nearly so (only $500,000 having been reclaimed), altho its location is exactly known. Inasmuch as the position in which she lies is an exposed place, divers have been unable to recover the cargo. Vessels around Hell Gate and other treacherous Atlantic ports can be easily salvaged—or at least their cargoes salvaged.

As for salt water spoiling cargoes, Mr. Lake has recovered cotton which has been submerged from two to five years, nothing but a very slight portion having been spoiled. Silk has likewise been recovered. Hardly any article decreases in value, even tho lying at the bottom of the ocean for a long period of time. Not only may cargoes of this nature be recovered, but also coal, a special device being utilized in this case. It will be noted in one of the photographs that a well runs down thru the center of the submarine. In this well is placed a hose running to a centrifugal pump, located on the deck of the mother ship. Nor does this pipe call for the services of a diver, as it can be brought into position by means of either an electric winch, or by lowering the submarine over the space where the coal is to be pumped. Mr. Lake's present vessel is, of course, by no means a large salvaging ship, nor will its operation be as cheap as a much larger vessel capable of doing much more work. Coal has been recovered from the bottom at an actual cost of less *than* 5 *cents a ton*, 15 *tons having been recovered in a minute*. It has been said that coal submerged in salt water is a good deal better than coal which has been left in the open, inasmuch as it burns away almost entirely, leaving a pure soft white ash. Hence many housewives sprinkle salt over their fires to make them brighter.

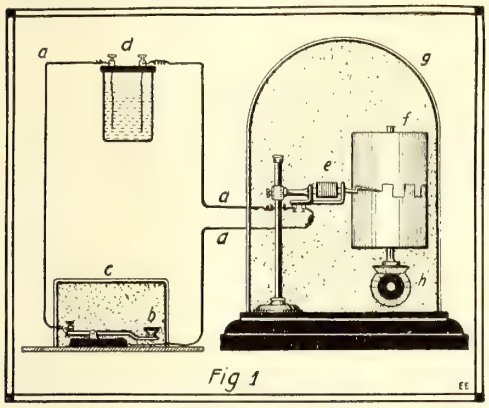
A very wonderful method of salvaging sunken ships has also been conceived and worked out by Mr. Lake.

Investigating "Psychical Phenomena" With Scientific Instruments

An Account of Some Recent Researches In This Field of Inquiry

By HEREWARD CARRINGTON, Ph. D.

IT is generally conceded that Aristotle possest the greatest single intellect the world has ever known; yet any schoolboy today knows more of the structure of our universe than did Aristotle! The reason for this is that Science has more fully penetrated the secrets of Nature, and we now know approximately the constitution of matter and a good deal concerning life and mind. How has this progress been possible? Only in one way. Improvement in the *mechanical instruments* by means of which we study Nature. We might "speculate" as to the constitution of matter for a thousand years, but we should never have arrived at our present positive *knowledge* had it not been for the delicate and sensitive instruments which are today in the hands of the physicist and the chemist, and employed by him in his laboratory.



In a Series of Séances Conducted in Naples, the Apparatus Here Shown Was Used to Investigate the Psychic Phenomena. The Psychic "Power" Successfully Prest the Key, Thru a Cover, and Caused the Magnet Needle to Record on the Revolving Drum.

Doubtless much the same law will be found to apply in the realm of "psychics." Until we can apply definite "laboratory methods," and study psychical phenomena by means of physical instruments far more delicate than our senses, it is probable that the present state of things will continue to exist; but it is my firm belief that, were a laboratory fitted up with physical and electrical apparatus, suitable for this work, and if we could by their aid study a promising case of "psychic" or "mediumistic" phenomena, we should (within ten years or so) arrive at some definite conclusions! We should then know something about the *laws* and conditions under which telepathy, clairvoyance, telekinesis (the movement of objects without contact), et cetera, operate, and not until this is done, I believe, will such positive conclusion be reached.

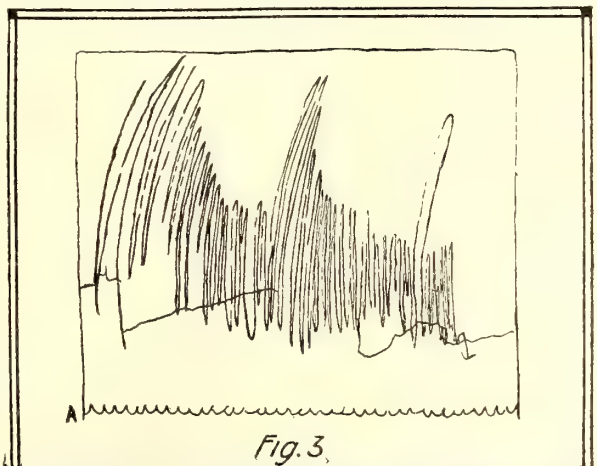
Of course the reader may object, just here, that I am assuming such phenomena to be *true*—while the tendency of many present-day scientists is to regard them as unreal, hallucinatory, and the result of fraud. I cannot spare the time in the present article to argue the point. While I admit freely that a very large percentage of such phenomena *are* so produced, and while I freely admit that probably 98 per cent of so-called "mediums" are fraudulent; I am equally emphatic in declaring that a residuum of genuine phenomena exists—that supernormal manifestations *do* occur, and that everyone who investigates *carefully enough* and *long enough* will find them. This has been not only my own experience, but that of every person who has investigated this subject with an impartial mind for any length of time. As Sir Oliver Lodge said, in writing of this very question:

"The result of my experience is to convince me that certain phenomena, usually considered abnormal, *do* belong to the order of Nature, and as a corollary from this, that these phenomena ought to be investigated and recorded by persons and societies interested in natural knowledge."

Based on this conviction, Sir Oliver Lodge wrote, as far back as 1894, in a paper entitled "On Some Appliances Needed for a Psychical Laboratory":

"If the investigations are to go on easily and well, special appliances must be contrived and arranged conveniently for use, precisely as is done in any properly fitted laboratory. It has already doubtless been realized that one of the needs of the future is a *psychical laboratory*, specially adapted for all kinds of experimental psychology and psychophysics. . . ."

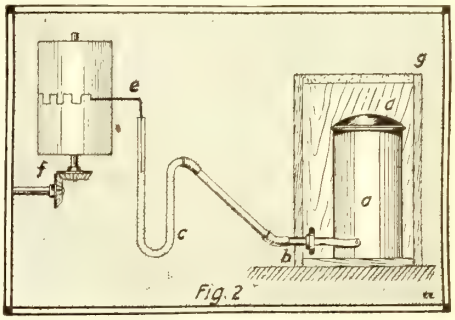
Sir Oliver Lodge suggested at the time, among other necessary appliances, a delicate registering balance,—so adjusted that it would record the medium's weight, unknown to her, at all times during the séance—the fluctuations in weight, if any, to be recorded on a revolving drum. Means ought also to be provided for studying the temperature, pulse, muscular exertion, breathing, etc, etc. The lighting of the room should be carefully attended to and capable of the slightest gradation. Means should be provided for obtaining moving pictures of the séance from without the room, unknown to the medium. Were the sittings held in complete darkness, these photographs could be obtained by means of ultra-violet light, with which the room might be flooded. In addition to these devices, we may add others—such as X-ray tubes, high-frequency currents and a delicate field of electric force,—while instruments for testing the ionization of the air (if it exists) in the immediate vicinity of the medum, during a séance, should also be employed,—together with the more strictly psychical instruments and devices which have been utilized of late years.



A Sample of the Tracings Obtained By Psychic Powers Acting On the Apparatus Shown At Fig. 2.

Electrical apparatus *has*, in fact, been utilized on several occasions to test so-called "psychical mediums" in the past. Italian investigators, particularly, have excelled in this. In a series of séances conducted in Naples, the following apparatus was employed. (Fig. 1.)

A telegraphic key (b) was connected by wires (a,a) to a battery (d) and to two screws, connecting them with an electro-magnet (e) to the opposite end of which was attached a needle. The point of the needle touched a revolving drum (f), with a smoked surface, driven by two interlacing, cogged wheels. The whole of this registering apparatus was enclosed under a glass bell-jar (g). The telegraphic key itself (b) was covered by a cardboard box (c). The "powers" manifesting were asked to press the telegraphic key *without* tearing the cardboard box (that is, *thru* it). When the key was deprest, this would be instantly communicated to the electro-magnet, and cause the needle to oscillate,—these oscillations being marked upon the smoked surface of the revolving drum. A number of successful tests were conducted by means of this apparatus.



Another Form of Psychic Force Recorder. Here the Pressure Exerted On the Rubber Cap "d", Thru the Cloth "g", Caused the Liquid in Cylinder "a" to Move Downward and Actuate the Manometer Needle "e", Which Traced the Variations On a Revolving Drum "f".

A variation of this was then employed (Fig. 2). A cylinder filled with water (a) was connected by means of tubing (b) to a U-tube, or manometer (c), filled with mercury. Upon the further side of this tube floated a bent wire (e) inserted into a small cork. The point of this wire, again, was so adjusted as to come into contact with the smoked surface of a revolving drum (f), driven as before. The top of the cylinder (a) was covered with a rubber cap (d), and this whole apparatus was inserted under a wooden box (g) having a cloth top.

Now, if the rubber covering (d) were prest upon, this would force some of the water, in a, along the tube, b, and the added air-pressure would depress the column of mercury in the manometer, causing the floating needle to rise on the opposite side, and scratch upon the revolving drum. Fig. 3 shows some of the tracings which were obtained in this way—the force acting thru the cloth top, g.

The instruments thus recorded a *definite physical, intelligent force.*

It may interest my readers to know that, at the time of his death, M. Curie,—who had been completely

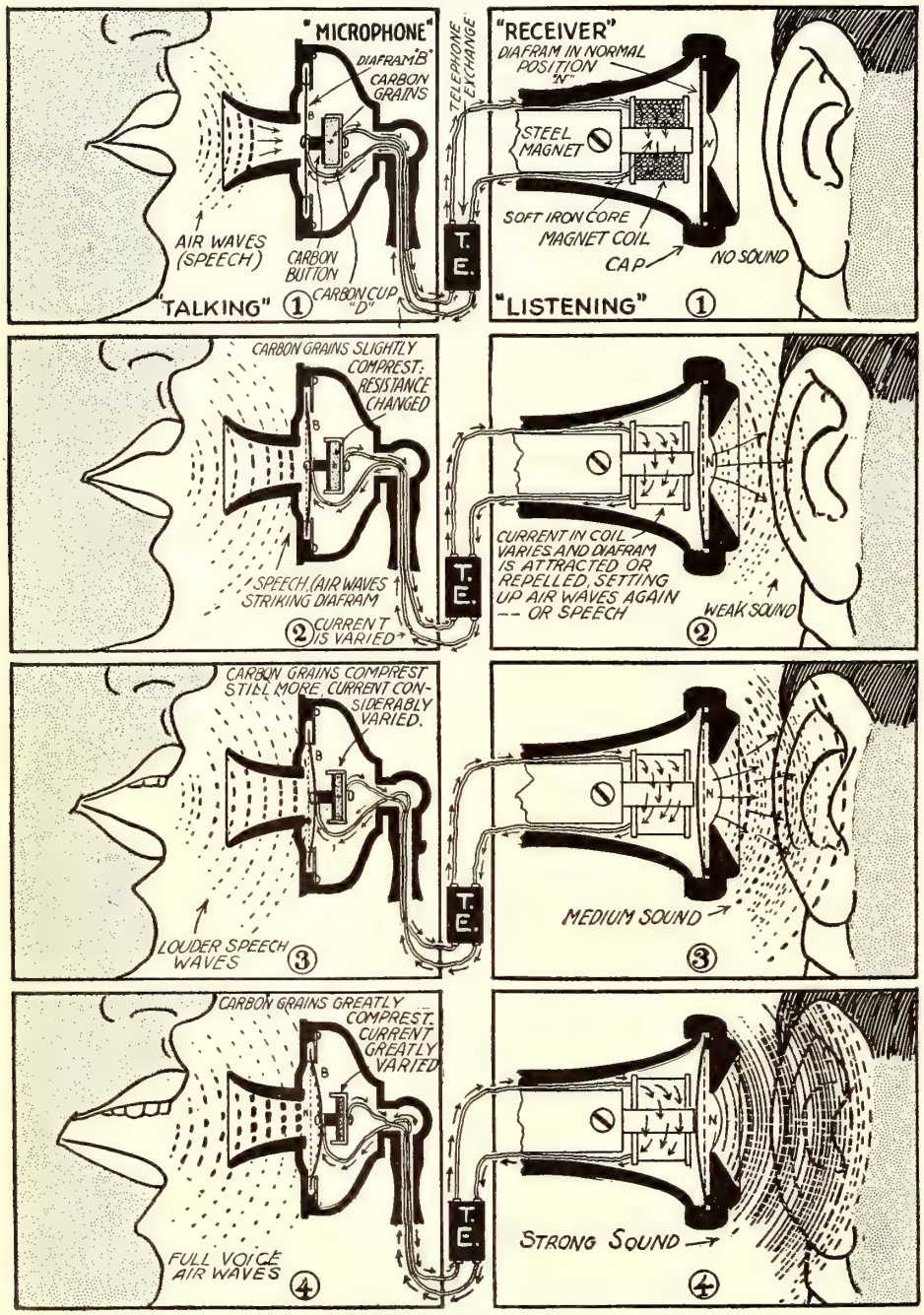
(*Continued on page* 566)

How the Telephone Talks

ALMOST all of you use a telephone constantly and give very little thought as to the actual working of it. Just how many people know what happens when you throw your voice into the transmitter of the modern telephone? Very few, I'll warrant. By means of the drawings, the transmitter is very clearly shown in detail, and the voice may be traced from the time it leaves the mouth until it goes into the line thru the transmitter. The whole operation, of course, takes place almost instantly.

Fig. 1 is the detailed construction of the transmitter. A is the mouthpiece; B is a very sensitive iron or mica diafram; C a carbon button and disc attached to the diafram B; D is a small box filled loosely with carbon granules.

When you speak, the resulting air waves set up by your voice impinge against the diafram B, which vibrates in exact tune with the air waves. The carbon disc C, being attached to B, also vibrates in syntony with the air vibrations, and therefore the contact between the carbon granules and the carbon disc varies in proportion to the force of the air waves striking against the diafram. As a consequence of this action, the electrical resistance between the carbon disc and the carbon granules varies with the strength of the air waves.



"How the Telephone Talks" Is Here Illustrated in Diagram and Picture. This Shows, of Course, Only a Few of the Actions Occurring in "Telephoning"—In Fact the Action Here Taking Place Occupies But a Fraction of a Second.

Consider Fig. 1, which shows schematically the telephone transmitter or mircrophone as well as the receiver, reproducing the spoken word, and which was employed in the manner shown by the Bray Studios in making an animated film story entitled "How the Telephone Talks."

Fig. 1 shows the exact instant that the mouth starts to open when a vocal air wave is set up as indicated by the curved dotted lines. The air waves tend to expand spherically whenever possible, and the vibrations or rings representing the air waves expand rapidly (the velocity of sound thru air being about 1,100 feet per second), and, as will be evident, the expanding air wave will, in the fraction of a second, reach the tightly stretched microphone diafram just inside the mouthpiece, to which is attached one of the carbon electrodes forming the carbon granule chamber. This stage of events in the story of the telephone is illustrated at Fig. 2. Here the first ripple of the expanding air wave propagated from the vocal organs and mouth of the speaker, is just impinging against the diafram and causes it to bend inward as shown. When the mouth first starts to open, Fig. 2, the air waves are quite weak. The movement of the microphone diafram and the carbon electrode attached to it is consequently slight, as well as the change in the current thruout the circuit to the receiver at the other end of the line. At this stage it is well to look at the receiver, Fig. 2, in which we see that the diafram has been attracted inward, or toward the electro-magnet core, by the increased strength of current caused by the reduction in the resistance of the carbon granules in the microphone. Simultaneously an air wave corresponding in frequency and pitch to that originated by the speaker at the transmitter end of the circuit, is thus produced by the movement of the receiver diafram. As becomes evident, the strength of the reproduced sound or air waves which eventually leave the receiver diafram, causing the mechanism of the ear to respond in the well-known physiological manner, will be exactly proportionate to the strength of the original sound or sounds at the transmitter.

At Fig. 3, the speaker's mouth has, a few seconds later, opened wider and the speech waves are louder and more powerful. These stronger air waves strike the microphone diafram thru the mouth-piece and cause it to move in a still stronger manner, which in turn causes a greater compression of the carbon grains, as shown in Fig. 2, and the receiver diafram is attracted or repelled with proportionately greater effect. If a medium strength sound is produced by the speaker at the transmitter end of the circuit, then the sound reproduced at the listening end would be a medium strength sound also.

Fig. 4 shows one case of a full, loud voice condition on a telephone circuit. The full vocal power air waves set up by the speaker opening his mouth to the normal maximum strike the microphone as shown. The carbon grains are in turn compress to a greater extent, more so than in Fig. 3, and the current in the circuit is now intensified decidedly, owing to the porportionately greater change in the resistance of the carbon grains, and the receiver interprets these changes very faithfully. The greater variations of the current in the transmitter-receiver circuit affect the receiver magnet by passing around the coil of wire wound on the end of the magnet as shown, and these powerful changes are instantly communicated to the diafram, attracting it with great vigor, so that it almost touches the magnet poles in some cases. The diafram now vibrates back and forth with maximum movement, giving forth sonorous air waves corresponding to the waves originated at the transmitter. The human ear held close to the receiver interprets the air wave vibrations in the well-known manner, and thus we hear once more the voice of the speaker transmitted perhaps over several hundred or several thousand miles of telephone wire, reproduced in our very presence, mysteriously—yet very simple, when you know how it is done.

A New Era Electric Auto

A New Combination Gas-Electric Car

THE new Dey Electric Automobile here illustrated created a mild sensation some time ago, and in an interview with Dr. Charles P. Steinmetz, the latter made the statement that Mr. Dey had solved the problem of the



The New Gasoline-Electric Automobile Which Its Inventor—Harry E. Dey, Seen at the Wheel,—Expects to Sell at $500.00. At the Left—Dr. Charles P. Steinmetz, the Famous Electrical Engineer, Who Believes Mr. Dey has the Best Idea Yet in Electric Automobiles. The Storage Battery is Charged While Running.

$500.00 electric automobile. This car has many points of novelty over other vehicles. It naturally follows that such must be the case in order to cut the weight and cost of the lightest and cheapest electrics now on the market in half; and at the same time not reduce the factor of safety, or the size of the car, which has the same dimensions as the Ford.

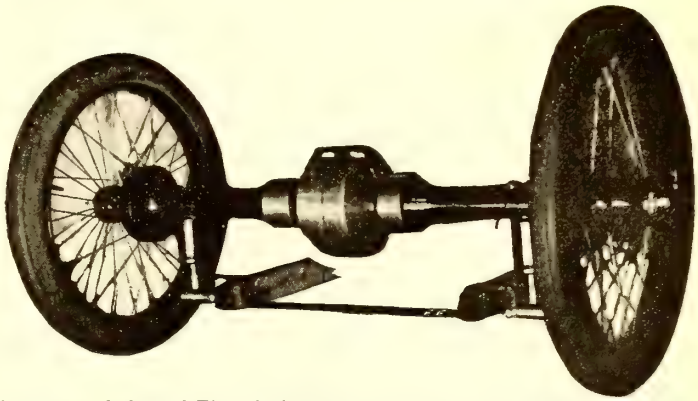
Its most revolutionary feature is the motor, which has *both its armature and field magnet rotatable;* one element connecting with one driving wheel thru a pair of reduction gears, while the other element connects in a similar manner to the other wheel. This arrangement produces a perfect *differential* substitute; and, in addition to saving the cost and weight of this complicated piece of mechanism, *it increases the capacity of the motor* 100 *per cent* for a given rotative speed, for the parts revolving in opposite directions *cut the magnetic lines twice as fast,* thus producing the results of a motor of double the velocity; besides this also adds to the electrical efficiency. The weight of this motor is still further reduced by turning it inside out, as it were; the armature, which is a toothed Gramme ring, encloses its field which has six poles, all energized from one coil. The field design is ideal for low field losses and light weight; its total weight, with shaft, being less than 20 pounds. Its iron portion is well adapted for drop forging. The total weight of the motor, which has a capacity equal to the standard automobile motors weighing 150 pounds, and upward, is but 51 pounds.

The motor is centered on the center line of the axle. An eccentric, of 7/32 inch throw, is fixt to the outer end of each shaft; an internal gear is carried by, and rotates upon, the field shaft eccentric, a roller bearing taking care of the friction. An external gear, concentric with the shaft, is keyed fast to the stationary housing and meshes with the internal gear; the latter connects by means of a flexible jointed shaft, practically a floating axle, to the wheel hub. It will be noted that only one of the gears is rotatable, the other one being held absolutely rigid. At the armature shaft end the construction differs by mounting the external gear, instead of the internal one, upon the eccentric, and keying the internal one to the housing. From this point the construction duplicates the other end. When the internal gear is the rotative element, as at the field shaft end, the direction of rotation remains unchanged between the motor and the wheel; but with the external gear as the rotating member, as used at the armature end, the direction is reversed. The opposing directions of the armature and field magnet are thus rectified without recourse to intermediate gears. The internal gears are 3½ inches pitch diameter and the external 3 1/16; this gives a reduction ration of 7½ to 1.

This car can well be termed the *nutless* car, there being so few used in its construction; all the surfaces are free of any bolt head projections. As the current is taken into the motor by means of slip rings there is no necessity of disconnecting wires when removing motor.

The experimental car was designed with a hand operated control and wheel steering. It was found in testing this out in heavy traffic, however, that hand control and wheel steering do not make a desirable combination, for in an emergency both hands are required upon the wheel; and in addition there is a time element involved in shifting the hand from the wheel lever that cannot be permitted. In the latest design the control is very similar to that of a gas car, with the shifting of gears left out. For speed variation a foot lever is used in a manner identical with that of the clutch lever; when the foot is removed the car runs at full normal speed; a slight pressure inserts resistance, producing the equivalent of a slipping clutch; as the pressure is increased resistance is added by infinitesimal steps, until finally the current is completely shut off; further movement converts the motor into an electric brake, and an extreme movement applies the mechanical brake. There is besides an additional emergency brake and also the ability to reverse the motor, thru resistance, for that purpose. An accelerator pedal, acting upon the field, increases the speed to 30 miles per hour, or more. Another lever provides "Forward," "Reverse" and "Neutral"; it is interlocked with the speed control, so as to shift only when there is resistance in the circuit or the motor is entirely cut off. The ability to reverse while the power is still on (thru resistance) provides quick manipulation for "seasaw" work.

On down grades the motor will recharge into the battery at speeds as low as eight miles per hour; and the car speed will automatically *slow down* as the grade increases; thus making the driving unusually safe. An increase of speed may be obtained at any time, however, by means of the accelerator.

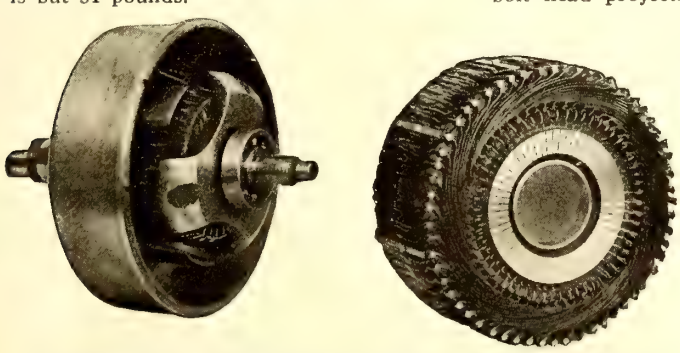


The Rear Axle and Electric Motor Propelling the New "Dey" Electric Vehicle. It is Twice as Efficient as the Ordinary Electric Auto, Owing to the Fact That Mr. Dey has Designed His Motor to Have the Field and Armature Both Rotate. This Doubles the "Torque Speed" and Reduces the Weight of the Motor. Also the Storage Battery Is Smaller Than in Any Other Machine.

The storage battery is carried beneath the floor, attached to the truss rod posts. This permits the body to be used exclusively for passengers and luggage; and also avoids all troubles due to spilled electrolyte. The method of suspension is such that the battery can be readily lowered to the floor by one person, and the top is accessible for adding water by lifting a trap door in the floor. This location is ideal for small power consumption, and gives a very low center of gravity that conduces to an easy riding and safe car.

While light weight has always been a hobby with the inventor, he does not believe in obtaining it at the expense of reliability or a limited sphere of action. One-half of the total weight of a car should be charged against the battery; this will provide power in excess of 100 miles per

(*Continued on page* 562)



The "Dey" Electric Auto Motor—at Left, the "Revolving Field"—at Right, the Revolving Armature and Internal Commutator.

"Jerry Up"

By CHARLES K. FANKHAUSER, JR.

Late of the 56th Regiment of Engineers, U. S. A., Only Searchlight Regiment in the A. E. F.

Did the German Airplanes Like the Allies' Searchlights? Yes They Did—NOT!

THE author wishes to state that the following is an account of some of his personal experiences with the 56th Searchlight Engineers during six months of active service in Flanders.

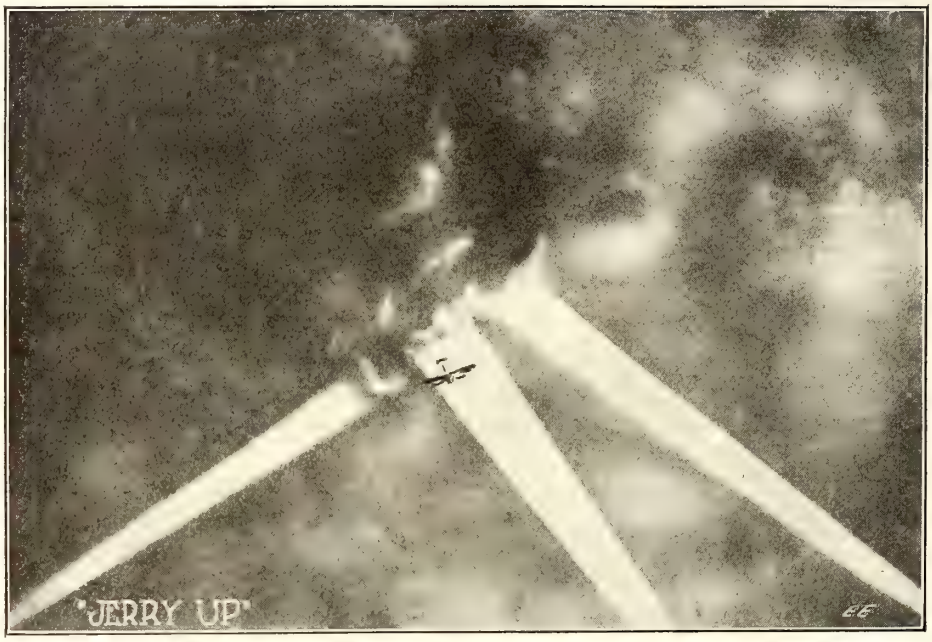
After the usual cross-country tour of France *à la box cars* (always labeled 8 *chevcaux,* 40 *hommes,* meaning 8 horses, 40 men), and a week's pleasant (?) sojourn in a rest (?) camp, Co. F. arrived at Champigny, near Langres. It was here that we were to receive our training in the gentle art of bagging Hun 'planes. Our searchlight "training" was merely a continuation of "squads east and squads west," punctuated at frequent intervals with the refreshing (?) pastime of manicuring France with pick and shovel.

But there is an end to all things. One fine afternoon early in August, 1918, found me, with six others from Co. F., at S.3., S.3 being the official title of one of a series of English searchlights strung along the "India rubber" line near Lille. There we learned what a searchlight really was for. We couldn't help it.

That evening, shortly after dusk, "Jerry" started over in his giant bombing 'planes to get the big steel plant just behind us. We wanted to leave the immediate vicinity *"toute suite,"* but no! We were informed by the hilariously amused "Tommies" in charge that we not only had to stay there, but had to shine a big sixty centimeter light right on "Jerry." We protested that he could hit us quite easily enough without our "advertising" our location. But once again—no! We had it all wrong. The sergeant ordered us to take action. We got the light on a big Gotha and immediately down came six bombs! Wang-o!! and then some. The jar of the first blew the arc out in the light and the rest blew out all our ambition and desire to be "defenders of Democracy."

After our first scare it wasn't so bad. We learned that a searchlight is a very poor target, even tho it is somewhat conspicuous. After that it was just a thrilling game. "Jerry" was an awful coward when it came to the limelight stuff. He preferred to work in the dark. Just as soon as we got him into the beam he invariably dropt his presents and made tracks for home. That is, he tried to. He did not always succeed. Our three-inch A.A.'s sometimes interfered. (A.A. in plain United States means "anti-aircraft.")

The three-inch guns were another little diversion for us. We had frequent practical illustrations of the law of gravity much in the same manner that Newton first observed it. Only our apples were made of *steel.* Said apples being originally intended for "Jerry." He being directly over our heads, and aforesaid steel failing to reach its objective, it returned to us by the shortest possible route. A straight line. (Business of digging out tin lids in a hurry.)



Actual Photograph of a German Bombing 'Plane Caught in the Shafts of Allied Searchlights. This Photo Was Taken From an Allied 'Plane. "Jerry" Was Tickled Silly to Have His Path Illuminated; Yes, He Was—and Showed It by Dropping 100-Pound "Forget-Me-Nots" on the Searchlight Crews—Fine, Only They Made Such an Awful Noise When They Landed.

Our parabaloid sound locators would tell us when a 'plane was coming and give us the bearing, then I, being wheel man, would send the long finger of light searching out into the blackness, looking for "Jerry."

The alarm was always given "Jerry up," and when we heard that, there was "action" and lots of it. I'll say so.

Each light had quite an elaborate telephone system, with lines running to several "spotting" posts and connected with all the other lights and gun sections thru a central telephone exchange.

This telephone system was a fine idea. The only thing wrong with it was the fact that the French farmers had a strange fondness for double-strand, cotton covered field telephone wire, and we never could convince them that we did *not* put the wire down for them to play with or build fences with. Otherwise the system was fine, and gave us many hours of diversion repairing it. Especially after a line had been plowed, harrowed and scraped for an afternoon or so.

The third night out I bumped up against the real English alphabet. I was on duty at the 'phone board. S.4 rang in and this is what I got: "Esses 3? Message to Lieutenant ——. Ac-ac-esses 4. Eight pip-emma, eight oblique fifteen oblique eighteen. Esses-e-n-don emma-e-esses-esses-ac-g-e t-a-ac-don-j-u-t-e-n-t——"

That was enough for me. I thought the whole B.E.F. was shell-shocked. I went for help. My mistake. It was only the usual "Pip Emma" system. The system of spelling used in all telephone communications in the B.E.F. Certain letters that are apt to be confused with others are given a special pronunciation as, s is pronounced "esses," p is "pip," m is "emma," d is "don," b is "beer," a is "ac."

I finally got the main idea of the thing, but never used it. When we "Yanks" used the 'phone we talked United States, not English.

But taking it as a w(hole) an A.A.S.S. emplacement isn't half bad—providing it doesn't rain and there are no rats and no cooties, and you don't mind sleeping in mud and—oh, well, if you like that sort of thing and don't care particularly whether you sleep or not.

SEARCHLIGHTS AND SOUND DETECTORS IN THE A. E. F.—A CORRECTION.

We publish herewith a correction from the War Department, office of the Chief of Engineers, Washington, D. C., concerning our article on page 310 of the ELECTRICAL EXPERIMENTER for August, 1919, entitled "Locating Airplanes in Night Fighting." To quote Captain James O. Jensen, Corps of Engineers, U. S. A., in his communication: In the third column it goes on to say:

These powerful searchlights, besides being available for enemy spotting, are also much used as a means of signalling. This is one branch of **the Signal Corps'** *work which has proven one of the big factors in helping to win the war.*

The particular work described in the article is a function of the Corps of Engineers, and was not and is not handled by the Signal Corps.

The 56th Regiment of Engineers constituted all the searchlight personnel in the A. E. F., and was the only organization engaged in using searchlights and sound detectors to combat enemy night flying 'planes.

EX-SOLDIERS, ATTENTION!

We want to publish some more articles similar to that appearing on this page by Mr. Charles K. Fankhauser, Jr., describing personally some first-hand experiences with the American Expeditionary Forces. Of course such articles intended for publication in the ELECTRICAL EXPERIMENTER should deal with more or less scientific phases of military life in France. Not only do we extend this invitation to all ex-military men, but also to the sailors of the sea. There is many a good tale to tell based on facts, we are certain, from the many personal experiences we have heard related by our friends who went overseas from time to time.

Good Day! Mr. Mars, said Prof. Todd

A SERIOUS attempt to get into communication with the planet Mars was made at Fort Omaha on Sunday, July 13, when Prof. Avis Todd of Amherst, accompanied by Capt. Leo Stevens, head instructor of the balloon service of the War Department, tried to send a balloon to the highest point ever reached. Capt. Stevens holds the world's record of 29,500 feet, made at Franklin, Pa., in 1912.

Prof. Todd has perfected instruments upon which he has been working for years, is the report from Fort Omaha, and with these he hoped to get into communication with the people of Mars, providing he could get far enough away from the earth's attraction.

Six years ago Capt. Stevens took Prof. Todd to a height of 22,000 feet, but his effort then to communicate with Mars failed. Five years ago Prof. Todd went to the Andes in South America for the same purpose but failed again.

One of the Government's big spherical balloons was used.

WHAT SIR OLIVER LODGE SAYS.

Communication with other planets by wireless telephone is not regarded by Sir Oliver Lodge, one of Britain's most eminent scientists, as a possibility too fantastic to be summarily dismist by savants.

Projection of a stream of electrons across the spaces of infinity by employing the vacuum relay or "audion" and utilizing ultra-violet light or the X-ray—these and other equally marvelous visions are conjured up by Sir Oliver in an article in *The Mail,* of London, under the caption of "Shall We Talk to Other Planets?"

Sir Oliver Lodge is inclined to believe that some simpler and more direct mode of transfer of ideas will be developed, but he does not censure William Marconi for his enthusiasm as to the possibility of interplanetary communication by wireless telephony.

"The wonders of wireless telegraphy and wireless telephony," says Sir Oliver, "are the outcome of researches in pure science which were originally initiated and pursued with no thought of practical application.

"By combining all that was known about oscillating electric circuits and about the emission of electric waves in accordance with Maxwell's theory, the problem of tuned or selective wireless telegraphy was solved, let us say, in 1897. Researches initiated by Crookes, and others, and developed by J. J. Thomson, have been prest into the service; and, first by Professor Fleming and then by others, have greatly improved the receiving capacity to wireless stations, so that it is possible in America, with quite a small receiving area, to hear the great high powered radio stations in Europe. And recondite mathematical investigations have proved that hearing at the Antipodes is far from theoretically impossible.



Prof. Todd, U. S. A., Sailed Martian-ward Some Moons Ago in a Large Army Balloon, in Order to Try Out Some of His Newest American-Marsotonian Wigwags on the Inhabitants of that Planet—

THE EFFICIENT AUDION FOR INTER-PLANETARIAN RADIO.

"In free space there are no such disabilities as are met with in the cramped space of a submerged cable, and speech, said to be of remarkable distinctness, can be reobtained from electric oscillations which have encountered nothing more perturbing than the air. Air does not help—so far as it acts it hinders; vacuum would be better, but the ether is sufficiently forcible to overpower minor obstructions, and it is found capable of transmitting securely and squarely whatever is ingeniously given to it and still more ingeniously received.

"The main instrument made use of for this purpose is the vacuum relay (audion); and the essential power which has been harnest both for sending and for receiving, is the extraordinary mobility and tractability of the little electric units or *electrons* which are given off by matter under certain conditions in great numbers, which fly with incredible speed approaching the velocity of light, and which in a sufficiently high vacuum are beautifully amenable to control.

"Electrons in motion constitute an electric *current* and a stream of them can be deflected either by a magnet or by an electric charge brought near them. Suppose, then, that an oscillating electric charge, oscillating in correspondence with the vibrations of the human voice, is brought into the neighborhood of a stream of electrons, this stream can be made to vibrate in unison. It can be laterally deflected or waved to and fro if that is what is wanted; or it can be alternately encouraged or retarded if that is preferable. It responds to every impulse, and it responds instantaneously.

ELECTRONS FROM A HOT WIRE.

"To get such a stream of electrons many ways might be employed. Ultra-violet light falling on a metal is one method. The X-ray is another. But the simplest plan is to employ a hot wire. A suitable wire can be kept hot by an electric current, and it can be made one of the poles of a battery so that a stream of electrons constantly emerges from it. This stream can then be controlled, as has already been vaguely indicated, by a multitude of devices, some of which have been already described and used—used very effectively—but none of which is as yet likely to have reached perfection.

"That is the principle. The rest is detail. *Fine and ingenious detail,* but detail which can take many forms; and those forms are more suitable for description in the technical press. Suffice it to say that such a device if talked into can supply a current varying with all the tones of the voice; and this varying current can be used to transmit electric waves after the usual methods adopted in wireless telegraphy.

"Then at the other end an ordinary wireless collector can receive them, can reproduce feebly the varying electric currents which originated them, and can then hand them over to a vacuum relay supplied with local energy, where they will modify an electron stream in the way above indicated. The feeble received current can, in fact, so control the stronger electric current which the relay is emitting from a local battery that every fluctuation can be imparted to that stronger current. This electron derived current, relayed again if desired, can then be applied so as to be heard in an ordinary telephone—the marvelously simple and familiar instrument that translates varying electric currents into articulate sound and applies it to the human ear.



—But History Does Not Recordeth What the "Martians" Thought of the Yankee Professor's Signs. Perhaps They Don't Believe in Signs Up There; Anyway, You Probably Locate the Nearest "Near-Beer" Sky Garden by a Mental Telepathic Wave Shot Out Broadcast by the Enterprising "Bevo" Dispenser.

"What the ultimate outcome of this power of long-distance telephoning may be I will not attempt to prophesy.

"The ether waves, once generated, are quite independent of matter. Matter is employed at the sending and at the receiving end, but in all the space between the efficient and necessary transmitting medium is vacuum, ether, the space between the worlds.

"I do not wonder that Mr. Marconi, in his enthusiasm of the power of speech-transmission which is thus coming into being, speaks of possible communication with other planets. Every one, including himself, must foresee immense difficulties about that; and for myself, I venture to anticipate that science will recognize a simpler and more direct mode of interchange of thoughts and ideas, tho perhaps not with dwellers, if there be any, in other planets, before a physical process of transmission from world to world, in the complicated code called *language* is feasible."

Popular Astronomy

By ISABEL M. LEWIS
Of the U. S. Naval Observatory

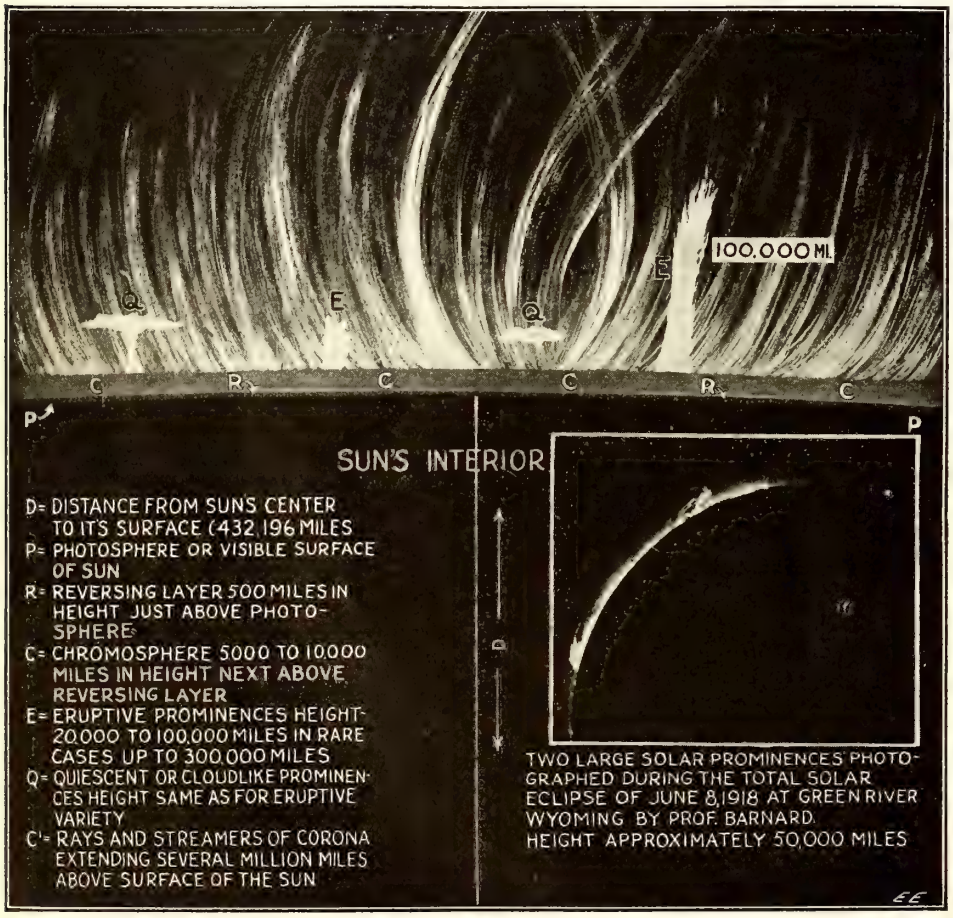
The Surface of the Sun

SUN'S ENERGY UNEXPLAINED MYSTERY.

THE source of the radiant energy of the sun is one of the unexplainable mysteries of the universe. For millions of years the sun has been pouring forth its light- and heat-giving rays at a most prodigal rate without the slightest sign of decreasing strength.

As seen from the sun, the earth is not much more than a point on the celestial sphere, appearing very much as one of the nearer planets, Venus or Mars, does to us.

The amount of the solar energy that is intercepted by the earth must be, therefore, almost infinitesimal compared with the total amount poured forth from the surface of the sun. It has been estimated, in fact, that all the planets together receive less than one one hundred millionth (1/100,000,000) of the total radiant energy of the sun in the form of light and heat, the remainder passing on to the stars beyond at the rate of 186,000 miles per second.



Yet the almost inappreciable amount of energy that our own little planet Earth receives from the sun as compared with the total output is, in reality, *one and a half horsepower per square yard,* or 230,000,000,000,000 horsepower for the whole earth!

It is this seemingly inexhaustible supply of energy that is behind all forms of terrestrial life and activity and if it should fail us the earth would become a barren and lifeless planet in less than one year.

7000° CENTIGRADE.

The surface temperature of the sun is, according to Abbot, at least 6,000°, and may be as high as 7,000°, absolute centigrade, which is 3,000° hotter than the hottest terrestrial source, the electric arc, which is considered to be at a temperature of 4,000° C.

Since all terrestrial elements vaporize in the electric arc, it is concluded that no known element could exist at the surface of the sun except in a gaseous condition. As to the condition of the sun's interior, whether it is entirely gaseous or partly fluid, there is some doubt. The low density of the sun, only one and four-tenths the density of water, precludes a solid interior, and it is now generally considered that the sun is entirely gaseous thruout, tho the tremendous pressure and temperature that must exist far beneath the upper radiating gaseous strata of the sun may produce changes in the elements beyond human comprehension and understanding. *It is even possible that the continual and mysterious replenishing of the solar energy that is poured forth so extravagantly may be brought about by a breaking down of the atoms within the sun's interior and a release of all the sub-atomic energies in a manner analagous to the action of radio-active substances.*

Since we cannot reproduce terrestrially the abnormal conditions of temperature and pressure existing within the sun's interior, we can only speculate as to the nature of the forces at work therein.

When we consider the surface of the sun, however, we are more in a position to understand and interpret correctly the evidence that is furnished us in abundance and in the greatest detail and an understanding of the nature of the forces at work at the surface of the sun and in its enveloping atmosphere may lead later to an explanation of the forces at work far beneath.

THE PHOTOSPHERE.

The visible surface of the sun is spoken of as the *photosphere.* Even the smallest telescopes will show its peculiar "rice-grain" structure, consisting of intensely brilliant flecks or nodules about 500 miles in diameter, which are resolvable by the higher power telescopes into smaller elements averaging 100 miles in diameter, against a darker background. It has been estimated that these bright nodules or rice-grains occupy only one-fifth of the total surface of the sun, yet radiate three-fourths of the total light.

Most astronomers believe that the "rice grains" are the summits of highly heated columns of gas, convection currents arising from the sun's interior, and that the darker portions between are due to cooler descending currents.

It is well known that the photosphere or visible surface of the sun appears to be much brighter in the center of the disk than near its circumference. This is due entirely to its gaseous nature and to the fact that it is surrounded by an atmosphere of dense enveloping cooler gases. Rays from the center of the disk travel a shorter distance thru the sun's atmosphere than the rays from the rim and therefore suffer less absorption by surrounding gases. We look further down into the sun's interior near the center of the disk than in the direction of its circumference.

The photosphere is the region where sun spots appear and they are found in zones extending from 8° to 35° on either side of the solar equator, never appearing exactly at the equator or near the poles.

SUN-SPOTS ARE SOLAR CYCLONES.

The disturbances that produce sun-spots and many allied phenomena occur cyclically in periods of approximately eleven years. The first outburst of the disturbance is manifest in the appearance of sun-spots in high solar latitudes. These break out and disappear and break out again with increased vigor, working gradually downward toward the solar equator. The maximum spottedness for a given period occurring in latitude about 16°. The disturbance finally dies out within 8° or 10° of the equator, but even before one cycle of disturbance has entirely passed away a new cycle has broken forth in high latitudes. So during the period of minimum spottedness there are four distinct belts, two in low latitudes, due to the dying disturbance, and two in high latitudes, due to the new disturbance. At sun-spot maximums there are two well-marked zones of great intensity, approximately 16° north and south of the sun's equator.

Sun-spots are solar cyclones, occurring usually in groups, tho large single spots appear less frequently. Each spot is quite sharply divided into an umbra* and a penumbra.† The umbra is the darker central portion, the funnel of the whirling cyclone, and the penumbra is composed of the outspreading gases. The peculiar "thatch-straw" structure of the penumbra is due, it is believed, to the fact that the

* The dark central part of a sun-spot.
† The boundary of light and shade of a sun-spot.

columns of gases that usually rise vertically from the sun's interior and from the "rice grains" of the photosphere are drawn into a horizontal position in the penumbral regions of a sun-spot and therefore we get a longitudinal rather than a cross sectional view of them.

The umbra of a sun-spot is anywhere from a few hundred miles to fifty thousand miles in diameter, frequently exceeding the earth in size, while the penumbra occasionally reaches a diameter of two hundred thousand miles.

The darkness of sun-spots is only relative to their more brilliant background. Owing to the rapid expansion and cooling of gases the temperature existing in sun-spot regions is far below the normal solar temperature and lies between 3,000° and 4,000° C. At this temperature it is possible for the more refractory chemical compounds to form, the oxides and the hydrides, and the spectra of sun-spots reveal the presence of titanium oxide and magnesium and calcium hydride. At the higher solar temperatures prevailing elsewhere over the photosphere and in its overlying gaseous envelopes all chemical elements occur in a free state, intermingling as incandescent vapors without the formation of any chemical compounds.

Strong magnetic fields exist in sun-spot regions and the sun-spot cycle is attended by marked magnetic changes, not only on the sun, but in the earth's atmosphere as well.

THE SUN'S RADIATIONS.

A most interesting discovery has been made in recent years in regard to the nature of the radiations of the sun. It has been found as a result of continuous measurements of the value of the constant of solar radiation by the observers of the astrophysical observatory of the Smithsonian Institute that the sun's radiations are variable with a two-fold period. One of these has a range of about three per cent during the sun-spot cycle, and the second is an irregular variation with a period of several days, weeks or months and a range that is usually about three per cent, but occasionally runs as high as seven or ten per cent.

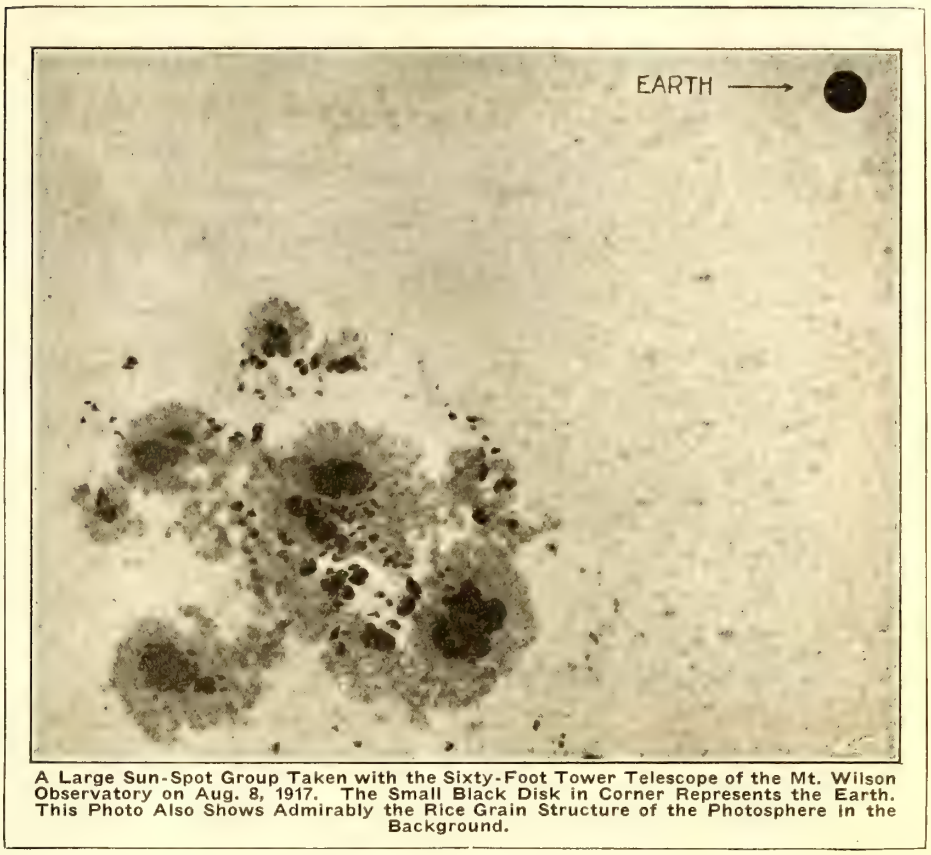
These variations in the solar radiation are considered very important and are now receiving considerable attention since they appear to be attended by appreciable changes in the earth's temperature and weather conditions.

The Smithsonian Institute hopes to establish in the near future a number of stations in widely separated rainless districts of the globe for the purpose of obtaining more accurate determinations of these variations with a view also to making available data for the more accurate predictions of weather changes in various parts of the world.

THE MYSTERIOUS REVERSING LAYER.

Directly above the photosphere of the sun lies the "reversing layer," which is about five hundred miles in depth and is composed of the incandescent vapors of all the chemical elements that are known to exist in the sun, which are also the same familiar elements that exist on the earth. With the exception of coronium, the unknown element in the solar corona, there is no element in the sun that has not been found on our own planet.

The "reversing layer" receives its name from the fact that it reverses the solar spectrum. It produces the dark absorption lines found in the spectrum that serve to identify all the elements existing in the sun, and during the time immediately preceding and following a total eclipse of the sun it produces what is known as the flash spectrum. When the photosphere, which gives the bright continuous background of the solar spectrum, is concealed by the moon the normally dark lines of the reversing layer—dark only by contrast with the bright background—become momentarily intensely bright lines against a dark background. The flash spectrum only lasts a second or so, as the reversing layer itself is soon covered by the moon.



A Large Sun-Spot Group Taken with the Sixty-Foot Tower Telescope of the Mt. Wilson Observatory on Aug. 8, 1917. The Small Black Disk in Corner Represents the Earth. This Photo Also Shows Admirably the Rice Grain Structure of the Photosphere in the Background.

THE CHROMOSPHERE.

Just above the reversing layer lies the *chromosphere,* which is between five thousand and ten thousand miles in depth. Many of the gaseous vapors of the reversing layer are found in the chromosphere, thrown there continually by the vast upheavals of gases that are constantly disturbing the surface of the sun. The greater the solar activity the more is the chromosphere charged with the vapors of the lower strata of the sun's atmosphere. The gases that are most characteristic of the chromosphere, however, are the incandescent gases of hydrogen and calcium, which give it the pink or reddish tinge so noticeable during total solar eclipse. Helium is also found in great abundance in the solar chromosphere.



This Photograph Shows the Distribution of Calcium Over the Surface of the Sun. It was Taken with the Spectro-Heliograph, an Instrument for Photographing the Sun in the Light of a Single Spectral Ray. The Brilliant White Patches Are Intensely Hot Clouds of Incandescent Calcium Vapor, Referred to as "Calcium Flocculi," Surrounding Sun Spots. The Flocculi Show the Same Peculiar Mottlings or Rice Grain Structure that Is Visible in the Photosphere.

Rising from the photosphere with the tremendous velocity of 100 or more miles per second, it can be seen at all times by properly screening off the light from the photosphere the vast solar eruptions known as the *prominences.* These are composed chiefly of hydrogen, tho other elements also appear, especially near the bases of the prominences. They are of two varieties, the quiescent, or cloud-like prominences, that float high above the solar surface for days at a time in some instances, and resemble terrestrial clouds in form, and the eruptive, or metallic prominences, that dart up from the surface of the sun in an infinite variety of forms that may be entirely changed in the short interval of fifteen or twenty minutes.

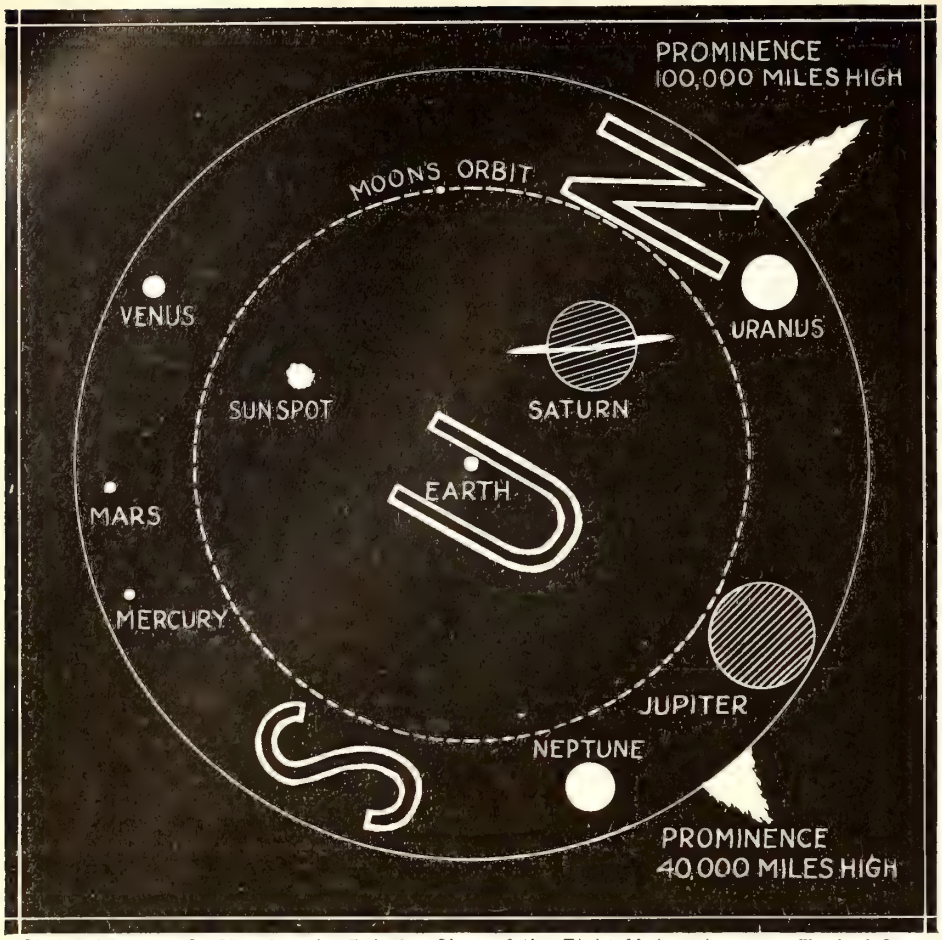
PROMINENCES 300,000 MILES HIGH.

These eruptive prominences usually attain heights of thirty or forty thousand miles on the average, but *exceptional prominences reach heights of more than one hundred thousand miles and in a few rare cases have reached elevations of nearly three hundred thousand miles, or one-third of the solar diameter.*

They are one of the most spectacular and beautiful of all solar phenomena, only second in interest to the solar corona, which is the outermost of all the solar envelopes and also the most tenuous. The extent of the corona is enormous. Its outer streamers extend usually to distances of several million miles from the center of the sun. Measurements of the coronal light during total eclipses of the sun have shown that its intensity is only about one-half that of full moonlight, and it seems almost impossible to devise methods for detecting it, except during total eclipses, on account of this extreme faintness of its light. Experiments along this line are now being undertaken by means of the photo-electric cell, however, and astronomers have not yet given up all hope of detecting the corona in full daylight.

SUN'S CORONA OF ELECTRICAL NATURE.

The corona is largely electrical in its



Sketch Diagram 2—Showing the Relative Sizes of the Eight Major Planets, a Typical Sun-Spot and the Visible Surface of the Sun with Prominence at Edge. (The Planets Appear Projected Against the Disk of the Sun.) The Earth Marks the Position of the Center of the Sun's Disk.

nature, but it shines also partly by reflected sunlight from widely separated particles of matter and partly by light of incandescence, as well as by electrical excitations. The nature of the unknown element coronium has not yet been determined, but its wave length was accurately measured during the eclipse of June 8, 1918, as well as the positions of several other unknown lines in the coronal spectrum, which will greatly aid in their future identification.

The relations existing between the sun-spot cycle and the change in the form of the corona, which is very pronounced, is not yet clearly understood.

The sun, it is now known, is in the midst of a strong magnetic field. Also strong magnetic fields exist in sun-spot regions and the cycle of sun-spot change is attended by marked changes in many forms of solar activity. The frequency of eruptive prominences, the brightness and form of the corona, magnetic storms and weather changes on the earth are all closely associated with the sun-spot cycle.

The cause of this sun-spot cycle, with all the attendant changes in the general solar activity, and the source of the radiant energy of the sun still remain the two chief unsolved secrets of the sun.

QUESTIONS AND ANSWERS.

Question 1. How much would a man weigh on one of the smaller asteroids?

Answer. Most of the asteroids are simply huge mountains of irregular shape but assuming that the average asteroid is approximately spherical in form and ten miles in diameter its surface gravity equals its mass divided by its radius squared, or $g^1 = \frac{m^1}{r^{1\,2}}$ in which all quantities are expressed in terms of the corresponding quantities for the earth.

To find the asteroid's mass m^1 in terms of the earth's mass its volume, in terms of the earth's volume, is multiplied by its density in terms of the earth's density.

It is generally believed that the density of the asteroids is approximately the same as the density of the moon or six-tenths of the earth's density, therefore

$$m^1 = .6v^1 = .6\left(\frac{5}{4000}\right)^3 \qquad \left(\frac{5}{4000} = r^1 \text{ is radius of asteroid in terms of earth's radius}\right)$$

and $$g^1 = \frac{.6v^1}{r^{1\,2}} = \frac{3}{4000}$$

in which g^1 is the asteroid's surface gravity expressed in terms of the earth's surface gravity.

If a man weighs 160 pounds on the earth he would therefore weigh three four-thousandths of 160 pounds on an asteroid ten miles in diameter—*or about two ounces.*

It can also be shown that if he should throw a stone from his hand with a velocity exceeding three feet a second it would never return to the asteroid but would revolve around the sun in an orbit of its own.

Question 2. Will you please explain what the "celestial sphere" is? Why do astronomers refer repeatedly to the "celestial sphere" and yet say that the form of the star system is flattened in the direction of one plane—the Milky Way—and may be a spiral?

Answer 2. The celestial sphere does not actually exist. For convenience in computing the relative positions of all celestial objects such as the sun, moon, planets and stars it is customary to consider that the earth is at the center of a sphere of infinite radius and that the positions of the heavenly bodies are projected upon the surface of this sphere.

The celestial equator, for instance, is simply the intersection of the earth's equator with this imaginary celestial sphere and the Right Ascensions and Declinations of the stars give their positions on this celestial sphere with reference to the celestial equator just as longitude and latitude on the earth give the position of some terrestrial point with reference to the earth's equator.

The ecliptic is the intersection of the plane of the earth's orbit with this imaginary celestial sphere of infinite radius.

The problems of astrophysics dealing with the nature and form of the visible universe are associated with the *actual* relative positions and motions of the heavenly bodies thru space and not with their projected positions upon the celestial sphere of infinite radius.

Question 3. Are sun spots holes in the surface of the sun thru which one sees into the sun's interior? I have seen this view expressed in some text book.

Answer. No. This view was held by some astronomers fifty years or so ago but it is now known to be erroneous.

Sun spots are solar storms or cyclones of a periodic nature with periods of maximum and minimum frequency of appearance. Highly heated gaseous material rises from within the sun to its surface in cyclonic whirls and spreads out over the solar surface, cooling rapidly by expansion. Into the vortex of this whirl are drawn down overlying gases, chiefly of hydrogen and calcium. The darkness of sun spots is due to the fact that the rapid expansion and cooling of the gases in these regions lowers the temperature in sun spots far below the temperature of the normal solar surface and they therefore appear dark in contrast to the more highly heated neighboring surface.

WHAT THE SUN DOES.

It is estimated that the earth receives every second from the sun enough heat to raise 600,000,000 tons of ice water to the boiling point, or to melt 480,000,000 tons of ice without change in temperature. If this is the amount that the earth receives, think of the amount that must be passing off into space and other planets. This amount has been computed to be 2,200,000,000 times as great as that which the earth receives.

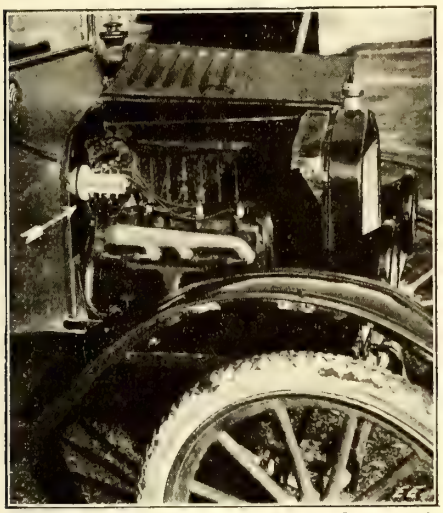


An Exceptionally Large Solar Prominence, 280,000 Miles High, Mar. 25, 1893, by Yerkes Observatory.

. . . AUTOMOBILE NEWS . . .

A NEW IGNITION ALL-SPARK DEVICE.

There is a new device in the auto world that does some remarkable things, according to its makers.



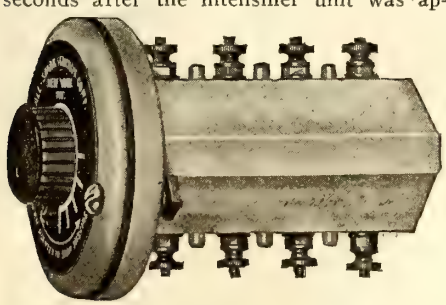
Ford and Other Four Cylinder Cars and Trucks Can Be Improved for All Around Running by the Addition of This New Spark Intensifier Indicated by the Arrow.

The object of this device is to eliminate all spark-plug troubles on Fords and other four-cylinder cars and trucks, and prevent the constant cleaning and buying of new spark plugs.

The most important feature is that it will not be necessary to change plugs on trips—when you want to get somewhere in a hurry, or it is raining and cold—in the middle of the night.

The device can be attached quickly, and only needs an extra set of plug wires run to it; it is placed on the dash panel, as the illustration shows. This device, which may be attached to the dashboard or any convenient place on any car, is really a *spark intensifier*. The device is so designed that the secondary current passing thru it is increased in voltage to such an extent that it will leap across practically any ordinary spark gap.

A great number of government tests were made with this unit installed upon government trucks as well as upon Ford automobiles. The illustration shows this device installed upon a Ford car. The plugs had previously been discarded as worthless, yet by the use of the new spark intensifier unit, the engine functioned perfectly. Shortly after this test a second was conducted in which the crankcase was filled with 23 quarts of oil. Without the unit the engine was run until all the plugs were sooted to such an extent that except for one cylinder, they ceased to fire. Within a few seconds after the intensifier unit was applied, however, the engine functioned properly and continued to do so until the oil in the crankcase fell back to its normal amount.



Close-up of the New All-Spark Intensifier for Four Cylinder Cars—Government Tests Have Shown Its Distinct Efficacy.

ELECTRIC INTAKE HEATER ENDS STARTING TROUBLES.

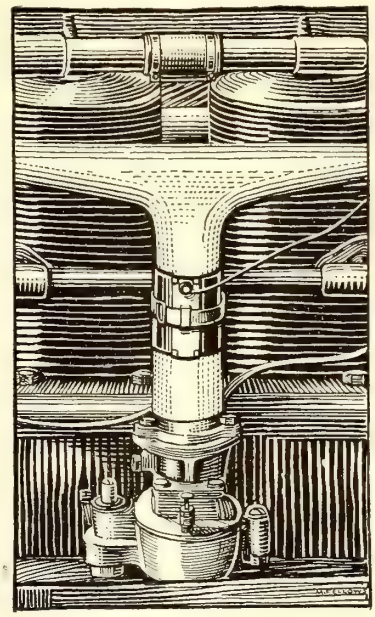
An electric intake heater is the simplest, most logical and surest device offered to automobile owners to assure easy starting of the motor in cold weather. It heats the intake manifold or carburetor by means of an *electric resistance coil*. This heats the air in the pipe and when the throttle is opened the gasoline mixes with the warm air, giving a vapor which ignites immediately.

This electric intake heater will start a motor in *one minute on the coldest day*.

This device can be installed by anyone. It consists of a resistance coil confined in a brass shell which is attached to a brass strap. It is operated from the storage battery by means of an electric wire and is controlled by a button on the dash.

In one minute or less, it heats the intake pipe or carburetor sufficiently to provide a highly combustible mixture which ignites instantly when the motor is turned over. This heater not only makes starting easy, no matter how long the car has stood in the cold, but it overcomes the disadvantage of priming with raw gasoline.

The device also reduces carbon, and most important of all, it saves the battery, as it uses only the same amount of current as the head and tail lights. The intake heater is made for both 6 and 12 volt batteries, single or double wiring system, and can be made to fit any car.

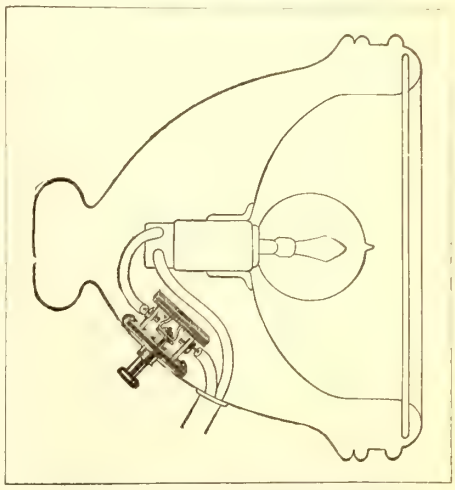


This New Electric Intake Heater Is Claimed to Start the Motor in One Minute on the Coldest Day. It Works on Batteries.

THIS SPOTLIGHT HAS SWITCH.

One of the new developments in auto specialties is a push-and-pull spotlight switch, made for mounting within the shell of a spotlight. Many years' experience in making switches for the automobile trade has proven that such a switch must have large *wiping* contact surfaces to prevent excessive contact resistance, and that the contactor must *float* on the operating shaft, so that vibration and side strain on the button will not cause the lights to flicker.

The insulating parts are made of fiber, the frame of stamped steel, the contacts of brass, and the contactor of phosphor bronze. These parts are riveted together into one solid unit which does not loosen or change alignment when subjected to vibration or strain. The mechanism is not enclosed because this switch is installed inside of the spotlight shell with the button protruding. Either rivets or machine screws can be used to fasten the switch to the shell. No plate is required; drilling one hole the size of the button and two for the rivets or screws permits mounting the switch as shown in the accompanying illustration.



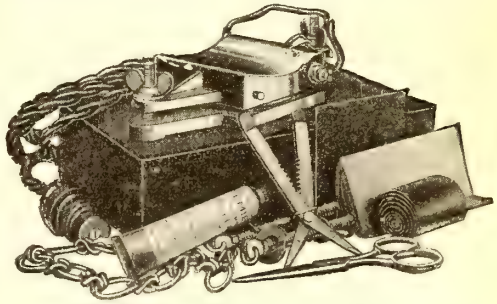
Showing New Electric Spotlight Switch Mounted in Shell of Spotlight, and Wiring Connections.

ELECTRIC VULCANIZER WORKS ON CAR BATTERY.

Never let the little cuts or sand blisters on your tires develop into blowouts. Use an electric vulcanizer like the type here illustrated and repair them. Clean the cut, fill in Para rubber according to directions, apply the vulcanizer and press the red button.

When complete vulcanization takes place, the button automatically "pops" out and the device then cools off. It represents a distinct advance for the motorist in caring for his tire troubles.

This handy little electric vulcanizer, which can be used on casings and tubes, is claimed to be absolutely automatic in operation and connects to battery or lighting circuit. These vulcanizers are furnished to operate either from 110-volt lighting circuit or storage batteries. The standard voltages of the latter type are 6-12-18-30 volts, and when operated direct off the storage battery on your car are positively guaranteed not to damage the battery in the least nor to interfere with its efficiency for starting, lighting or ignition. The 110-volt type will operate from both alternating and direct current. A smaller model of this vulcanizer is made by the same concern which is adapted to repairing tubes only.



Efficient Electric Vulcanizer for Casings and Tubes—It Operates on 110 Volts or Batteries When so Specified.

Legless—He Drives Auto Skilfully

SHOULD you ever be wandering in the streets of New York, or any other large city in the United States, and come across an immense crowd, larger than any ever gathering around an automobile with punctured tires or engine trouble, you will know that the owner of this auto is Mr. Fred Hammel, America's greatest "legless" traveler and autoist. At first one sees absolutely no reason for an immense gathering at a stalled auto. But upon closer inspection it is apparent that even more people might sensibly be gathered there, for Fred Hammel is a cripple. But there is nothing unique in cripples. One sees hundreds of them on the streets of our big cities every day. There is, however, something very unique in Mr. Hammel's skill. His inventive ability coupled with ingenuity have enabled him to build a device by which he can control his automobile, even tho legless from the knees down. To watch him make repairs on the road is a wonderful sight. It seems as tho Dame Nature endowed him with some supernatural ability, inasmuch as he uses his two short legs and his hands, climbing about on all fours with greater ability than we can use our hands and legs. He scrambles over the machine, up at the top of the roof and down again, with the agility of a cat, never missing his foothold or slipping, and at times it seems as tho he is flying in pursuit of his troubles.

A "joy-ride" with him is all that the word implies—and then some. The writer had the opportunity of making a trip thru the crowded streets of New York, across the Brooklyn Bridge to South Brooklyn and back again, being stopt by traffic cops at almost every street crossing, and starting out among the first of those who dart out immediately after the traffic director's whistle blows. Occasionally, some poor fool would step out in front of the machine, and then it seemed as tho one's heart were in his throat, either to swallow it again, or—. But Fred lets his hand glide to the brake lever on his car with absolute calmness, and exerting a slight pressure on this lever causes the car to be brought up to within a few feet of the passer-by. One would think that fifteen or twenty minutes of this kind of excitement would inure one to it. However, this was not the case. Shooting across the Broklyn Bridge at about 45 miles an hour on a down-grade, we suddenly loomed upon an Army truck. Unfortunately, some individuals were working in front of this gigantic truck, when the chauffeur of the truck noticed them almost too late, and jammed on his emergency brakes. About forty feet behind we were sallying forth at 45, and you can just imagine how it must feel for a passenger to be riding on this auto, knowing the chauffeur to be handicapped inasmuch as he cannot apply his feet to the brakes. Again Mr. Hammel's coolness prevailed. With one hand going to the lever, and a pressure ever so gentle, as tho he did not care whether the machine stopt or not, we "fetched" up, so to speak, to within about *five inches* of the truck in front of us. I already saw a smashed radiator and myself being dashed off to the hospital—but not so. The brakes were loosened, and we were on our way again.

Now a word about the machine and its fittings. The photographs clearly depict the appliances used. The three hand levers are of his own design and construction, so adapted that each one controls a distinctive pedal. When it is desired to apply the brakes, it is only necessary to pull its respective hand lever. On the brake lever likewise is a button for the electric horn. On

(*Continued on page* 564)





Without Legs Fred Hammel Drives His Car About the Largest Cities With as Great a Certainty as Any Autoist Possest of All His Limbs. The Hand Levers and Electricity Do the Trick.

Electricity Steers Blind Man

When a young man of Seattle became blinded early in the summer of 1918 he at once set his inventive genius to work to develop an electric direction indicator which would enable him to get about without the use of a cane. As a result of his labors, he holds a patent on a device which not only enables him to get about without a cane, but one that has great possibilities as an aid to navigation on the seas or in the air or as a self-acting course indicator for timber cruisers, surveyors, explorers, prospectors and men who follow similar callings.

The device, as shown in the picture, is attached to the belt of the wearer. It contains two buzzers, wired to points which come in contact with the needle of a specially constructed compass when the wearer digresses from the set course, and indicates the direction to take.

The mechanism is composed of the compass and two buzzers. A signal is given when the wearer deviates from a set course. The signal is the result of a movement of the compass needle when it touches either of the two pins suspended from the cap of the compass, which closes a circuit and rings the buzzer on the side of the course on which the wearer is digressing.

(*Continued on page* 599)

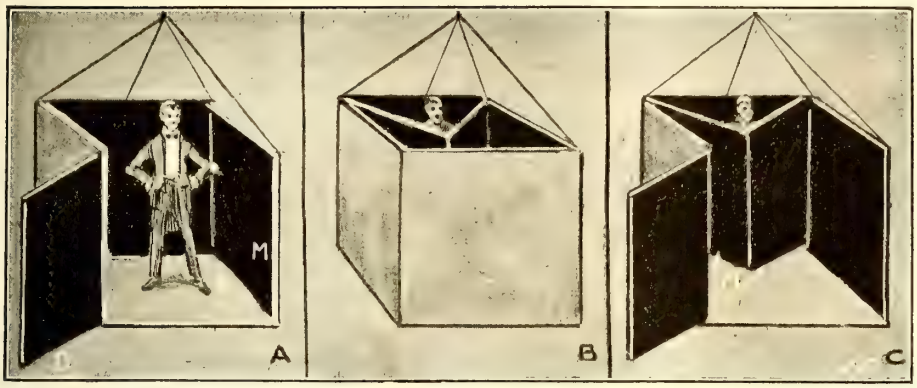


The Electric Direction Indicator, Worn by Its Blind Inventor, Who Developed It to Enable Him to Get About Without a Cane. The Specially Constructed Compass Is Worn in Front. The Two Metal Projections, One on Each Side of the Compass, Are the Buzzers. Clasps at the Sides of the Belt Hold Two Triple Cell Batteries, Which Supply the Current for the Device.

Experiments in Physics

By JOHN J. FURIA, A. M.
DEPARTMENT OF PHYSICS, N. Y. UNIVERSITY

3--Illusions

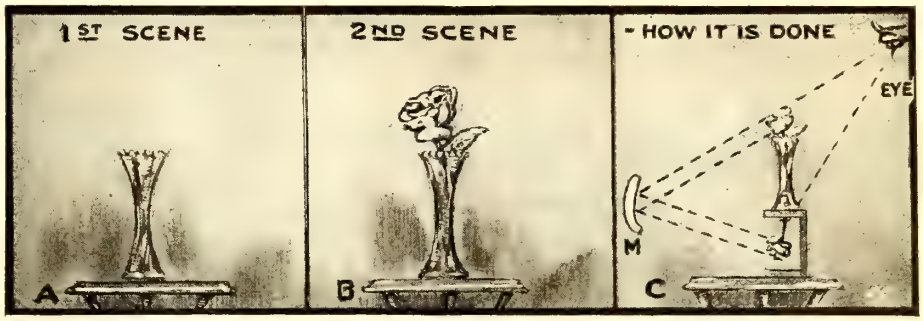


How the "Magic Cabinet" Trick is Often Performed. First the Person Steps Into the Cabinet at A; the Door is Closed and the Box Hoisted Up. The Person in the Cabinet Pulls the Two Hinged Mirrors "M" Together; Next the Door is Opened and—Presto! the Man Has Disappeared—Apparently! Fig. 5.

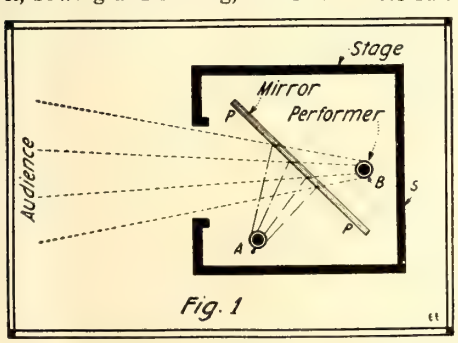
THE optical type of illusion, which is the main type and most elaborate, can be divided into two general classes: (1) The virtual image class, and (2) the real image class. By a *virtual image* we mean an unreal image, one which is caught on a screen. The images we see in the ordinary mirror or "looking glass" are of this type. By a *real image* we mean an image which actually can be touched and caught on the screen. The stereopticon, magic lantern and motion picture machine images are real (caught on the screen). The image formed by a camera lens on the plate or film or ground glass is, of course, a real one. *The eye is capable of seeing both the real and the virtual images,* and this forms the basis of all optical illusions. A plane mirror, highly polished plate glass or other plane surface, always gives a *virtual image.* Because of the possibility of being able to see an actual object thru plate glass and semi-silvered glass, they are almost universally used for feature illusions on the stage.

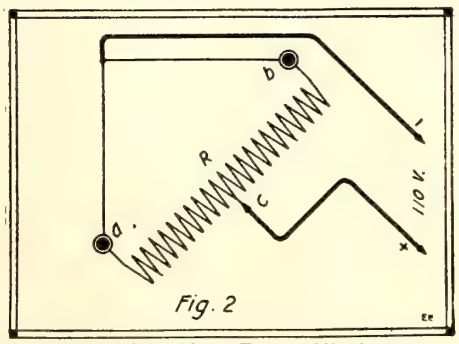
Figure 1 represents the top view of a simple theater stage and illustrates how eminent magicians like Kellar and Thurston made their transformations. The performer stood before the audience while the stage gradually dimmed, and brightened, and lo and behold, the smooth-faced performer changed before the eyes of the audience into a devil. The stage dimmed and brightened again, and the devil was transformed into a skeleton. Then, as an added attraction to the bald-headed first-rowites, the skeleton transformed into a scantily clad chorus girl or a bathing beauty. Finally the audience saw before it, bowing and smiling, in his full-dress suit —the performer. The effect on the audience was immense; the principle and *modus operandi* of the illusion is ridiculously simple. In figure 1, s are the walls of the stage draped in black velvet, p is a piece of highly polished plate glass perpendicular to the floor and arranged at an angle of 45° to the audience. The performer stands at B, in the direct view of the audience. His confederate stands in the wings at A, out of view of the audience. Since the stage is black, neither the performer nor the confederate will be visible *except when illuminated.* A and B are illuminated by a dimming device diagrammed in figure 2. R is a variable high resistance, a and b are lamps connected in parallel illuminating the performer and his confederate at A and B, respectively. As the variable contact is moved to the left, a becomes brighter and b darker, so that when c reaches the extreme left b is practically extinguished. Similarly, as c moves to the right, b becomes brighter and c extinguished. Referring to figure 1 again, when B is illuminated and A dark, the audience sees the performer directly thru the glass. When B becomes dark and A bright, B cannot be seen and A is seen by reflection from the polished surface of the plate glass. Thus as B becomes dark and A light, the performer disappears and changes into a devil (the confederate at A). In the meantime B, being invisible, the performer walks off the stage, makes up as a skeleton and returns to his position. As A is darkened and B brightened, the devil changes into a skeleton. This procedure is followed until finally the performer appears again before his audience to receive his applause. See figure 3.

Figure 4 illustrates the type of illusion making use of the 45° mirror. T represents a revolving table hidden behind the scenery s, P is a good quality mirror placed at an angle of 45° with the vertical. I is the reflected image of the person lying on the revolving table. The person appears suspended in mid-air. If the table is moved along the floor the person appears to move along in mid-air. If the table is revolved the person appears to spin around in mid-air as if pivoted thru his middle. If the person on the table moves his arms or feet the image suspended in mid-air appears to do this also. It is obvious that the person may be made to appear to be flying about, and by interposing a plate-glass tank of clear water in front of the tilted mirror the person appears to be swimming, eating, etc., in the tank of water without having to come up for air. All sorts of variations have been introduced in connection with this simple illusion.



The "Magic Flower Vase." Viewed From a Certain Angle You Apparently See a Flower in the Vase—Can Even Smell it! Advance and Examine the Vase—It's Empty! Figure "C" Explains the "Magic" Paraphernalia. Fig. 6.





How the Magician Changes Into a "Stage Devil" Before Your Very Eyes. His Image as Well as That of His Assistant Can Be Flashed Up Alternately, on the Glass Sheet PP. The Diagram, Fig. 2, Shows the "Dimmer" Used to Switch the Illumination from Image A to Image B, Gradually.

The disappearing cabinet or cage is another of the popular feature stage illusions using tilted mirrors. A man steps into cage or cabinet while the door is open. The cage or cabinet is hoisted up midway between the stage floor and the ceiling. The man shuts the door on himself. The cage or cabinet is let down within a few feet from the floor, the door is opened and the occupant is found missing. The door is closed again, the performer fires a smoky shot. The door is again opened and—presto! the occupant is again seen in the cabinet. One has but to refer to figure 5 to see how simple this illusion is. In figure 5-A P is the performer, M and M are mirrors tight against the sides, D is the door.

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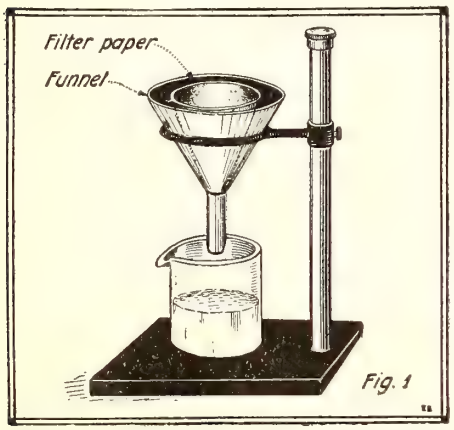
Practical Chemical Experiments

By ALBERT W. WILSDON

Composition of Fruits and Their Food Values.

AT this time of the year, fruits are utilized as a very important part of our daily foods and a little knowledge of their composition and value will not be superfluous. "Fruit" in the restricted sense, includes the pulpy substance enclosing the seeds of various plants, and especially those which are edible in the raw state.

A *green* fruit does not differ very materially from the leaf in composition, but in the process of ripening, under the influence of sunlight, the fruit undergoes a remarkable change in color, texture, composition, and flavor. During this change period it ceases to act on air like a leaf, but to the contrary, *begins to absorb oxygen and liberate carbon dioxid gas.* As the process of ripening goes on, both the *invert sugar and the sucrose increase and the starch and free acid decrease.* Following the disappearance of the starch the sucrose disappears quite rapidly on account of its change to invert sugar. Malic acid appears to decrease, but this phenomenon is largely due to the fact that it is formed

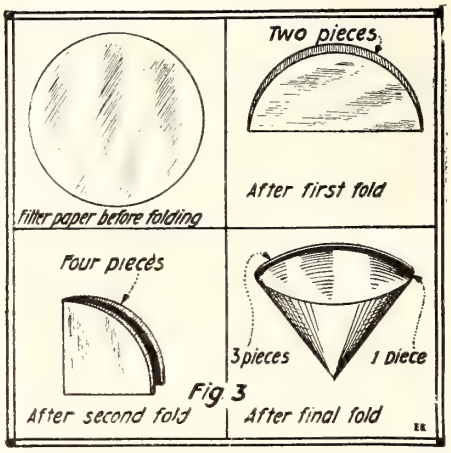


This Form of Filtering Stand May Be Used for All Experiments Requiring Filtering. Fig. 2 Depicts a Convenient Method Which Is Adaptable in Every House.

in the early history of the fruit, and becomes diluted by its growth. It is supposed that while ripening the insoluble pectose changes into pectin and secondary substances of a gelatinous nature. The tannin that made the fruit astringent also disappears. *As the fruit becomes over-ripe, some of the sugar and acid is oxidized, and the fruit in consequence loses its agreeable flavor.* On cold storage this latter condition is deferred, owing to the low temperature, but a very short exposure to air, at ordinary temperature, causes the fruit not only to appear over-ripe, but to decay quite rapidly. Thruout the process of decay, which is assisted by fermentation, carbon dioxid and alcohol are at first formed from the sugar, and later the alcohol is oxidized to acetic acid, and finally in the decayed fruit the seed is set free, ready to start a new plant.

WHAT GIVES TASTES IN FRUITS.

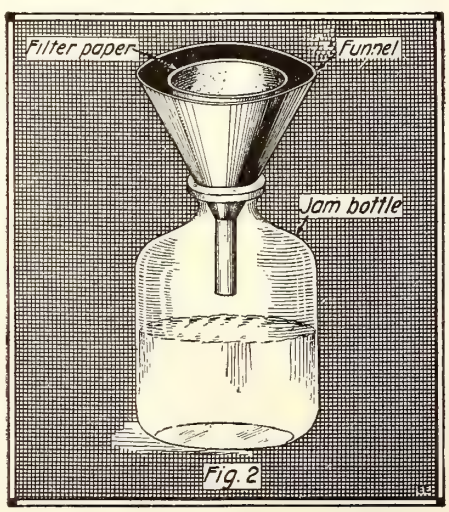
The agreeable tastes possest by fruits are due to the right proportions of the constituents mentioned in the foregoing test, and also to the compound ethers and essential oils which may be present. These flavoring substances are, many of them, present in such small quantities that they are not mentioned in the analysis. Some fruits



Notice that When Finished, the Paper Filter Will Be Conical in Shape and Will Have Three Folds on One Side and One on the Other.

which seem to "melt in the mouth" really do contain considerable soluble matter. It is a well-known fact that sugar disguises acids, and that an agreeable taste in preserved fruits is often due to a judicious mixture of the acid and the sweet. The most important nutritive material in fruits is in the carbohydrate group. Altho starch is present at cetrain stages of growth, sugar is the most abundant of the carbohydrates. This is usually invert sugar, but *apricots, pineapple, and apples contain also cane sugar.* This fact has an important bearing on the dietetic use of fruits, as invert sugar is, in some diseases, as diabetes, more easily assimilated than cane sugar.

The pectus bodies above referred to are not very well understood, but are supposed to be related to the carbohydrates. The insoluble glacto-araban is supposed to give the property of hardness to unripe fruits and vegetables, and is the basis of making jelly. The statement has been made that as the fruit becomes riper the pectose is changed by the action of acids into pectin, a vegetable jelly, which causes the juice, after boiling, to gelatinize when cooled. *This may be noticed in the juice that exudes in the baking of apples.* It is supposed that by boiling too long these



A Clean Ordinary Jam Bottle Will Be Found Efficient as a Filtering Stand When a Funnel Is Used Which Is Sufficiently Large to Rest on the Mouth of the Jam Bottle. If the Stem of the Funnel Is too Long It May Be Cut with a Triangular File.

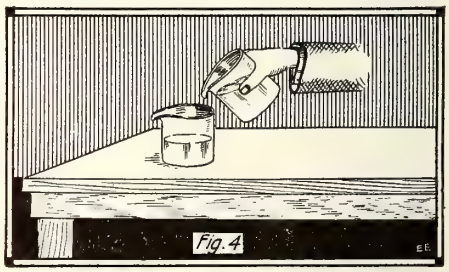
pectous compounds are concentrated into a more soluble modification, and, if this is true, it may serve to explain the fact that sometimes fruit juices that have been boiled for a long time become thick and viscid, but do not form a true jelly. *A partially ripe fruit is better adapted to making* jelly than is one that is fully ripe.

From the foregoing it is evident that pectin bodies are substances of undetermined function very widely distributed in plant tissues. They occur both in soluble and insoluble forms.

In the studies of these bodies the most important problem appears to be the quantitative determination of the pectin bodies occurring in a given tissue, because such a method could be used to determine the function of the material in plants; whether for example, it is a reserve material, a by-product, is used for structural purposes, or has all three functions or two of them; whether the nature of the pectin body changes with the growth of the tissue, or possesses a practically constant composition; whether the pectin bodies obtained from the different sources are identical, are mixtures of the same substances in varying proportions, or are inherently different.

EXPERIMENTS.

Experiment No. 1. To the filtered apple



The Addition of the Various Reagents Mentioned Will Produce the Results Mentioned in the Text. If Possible, It Is Advisable to Use Either Beakers (Lipt) or, if Not Available, Ordinary Drinking Glasses Will Answer the Purpose. These Permit Easier Handling to Those Performing the Experiments.

juice of a ripe apple add an equal bulk of alcohol, and a gelatinous mass consisting largely of pectin will be precipitated. This may be dried, and it will be found that the powder thus obtained is soluble in cold water.

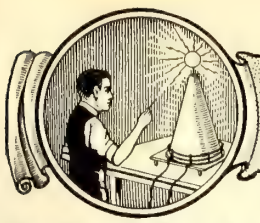
Experiment No. 2. Stew a handful of cranberries, filter the juice, and allow to stand till cold, when an abundant jelly is obtained.

Experiment No. 3. Test some green fruit, a persimmon or banana, for tannin by extracting the juice, filtering, and adding a small quantity of ferric chlorid. The production of a black, or greenish-black, color indicates tannin.

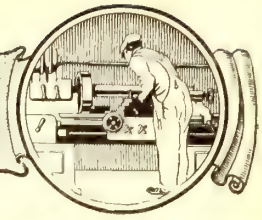
The acidity of fruits is due to the presence of the free acids, Malic, Citric, Tartaric, or their acid salts. They not only have an agreeable acid taste and serve as appetizers, but when oxidized in the body are converted into the corresponding carbonates, and these help to render the blood more alkalin and the urine less acid.

Experiment No. 4. Add to a solution of Malic acid, calcium chlorid, ammonium chlorid, and ammonium hydroxid in excess. There should be no precipitat, but upon adding to this three volumes of alcohol, calcium malate should separate out as a precipitat.

(*Continued on page* 578)



THE CONSTRUCTOR



Making a Machine for Telegraphing Pictures

PART II

By LEROY J. LEISHMAN
Expert in Telephotography

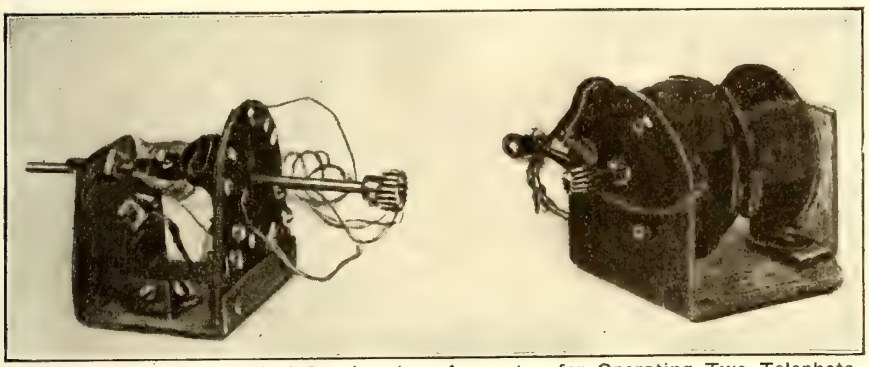


Fig. 3—A Simple Electrical Synchronizer Apparatus for Operating Two Telephotographic Machines. The Commutator of the Motor is Used at the Transmitter and the Motor at the Receiver.

WE can use a rod connection, or one of several different electrical schemes which permit the machines to be operated at long distances away from each other. However, only two electrical synchronizers will be explained. The simplest and least fascinating way to synchronize the machines is by a rod connection H (Fig. 1), with the instruments only a few feet apart. A few rods, such as those used for shafts, can be connected with couplings and one machine placed at each end with the cylinder rods toward you. Make two or more supports for this connecting rod to hold it at the same height as the cylinder shafts, to which it runs at right angles. Place a crown gear I (Fig. 1) or K (Fig. 2) on each cylinder rod, with the teeth turned *toward* you on one machine and *away* from you on the other. Now slip an upright on both ends of the synchronizing rod and place a small gear J (Fig. 1) flush with each end to mesh with the crown gears.

Fix the uprights or supports in place so that the proper connection is maintained and so that both machines run together, regardless of which cylinder is turned. The machines may be operated by a crank attached to the end of one of the cylinder rods, or by a motor properly geared down.

The cylinders themselves must turn at about *one revolution in three seconds.* This may seem quite slow; but it must be remembered that this is a very inexpensive home-made set, and that T. Thorne Baker and Dr. Korn operate their cylinders at only one revolution in two seconds, and that the most delicate sets for one of my systems utilize drums operating as slow as a revolution in one second. Faster work can be done with some of my latest apparatus; but the system is far different from the one for which these machines are used, and the machines are too costly and complex for the average experimenter to build. So let us be content with one revolution in three seconds.

A Simple Electrical Synchronizer.

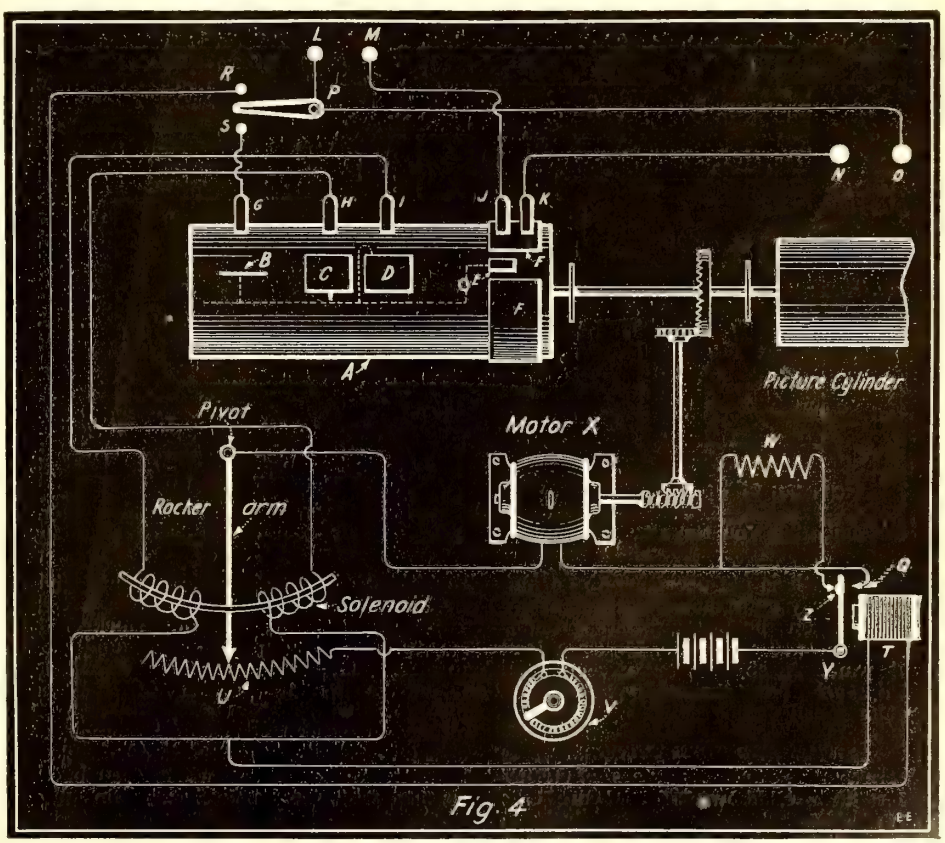
A simple electrical means for synchronizing the two machines utilizes a motor for one machine and its commutator for the other. (See Fig. 3.) The armature of the motor is separately excited and has but two poles; while the field has three poles connected in series, with the connections tapt between the magnets for the three wires which extend to the three segments of the commutator of the other machine. Two diametrically opposite brushes rotate against this commutator and cause the field to rotate in synchronism. The current can be supplied to the brushes by collector rings. As before mentioned, the armature of the motor is separately excited.

The shaft supporting the brushes must be geared (nothing but gearing will do) to the sending machine, and the motor must be geared *in exactly the same manner* to the receiving machine. The sending machine can be operated by hand or by a motor as desired, and the receiving machine will then operate in exact synchronism.

An Automatic Electrical Synchronizer.

The most interesting and ideal synchronizer of all requires no extra wires whatsoever. The principal part is a wooden or other non-conducting drum A (Fig. 4), the shaft of which is connected to the shaft of the cylinder upon which the pictures are sent and received. B is the edge of a piece of metal electrically connected with the shaft. C and D are pieces of graphite connected on opposite sides to metal strips

(*Continued on page* 562)



Layout for Improved Electrical Synchronizer to Be Used for Operating Telephotographic Transmitting and Receiving Apparatus Here Described.

Building and Testing Small Transformers

By J. W. ESHNAUR

BUILDING a small transformer is not a difficult matter if you know the proper sizes and amounts of wire to use and the size and quantity of iron to put in the core. If you do not have this data at hand, you are pretty sure to meet with failure, and in the words of the funny paper ask, "How do they do it?"

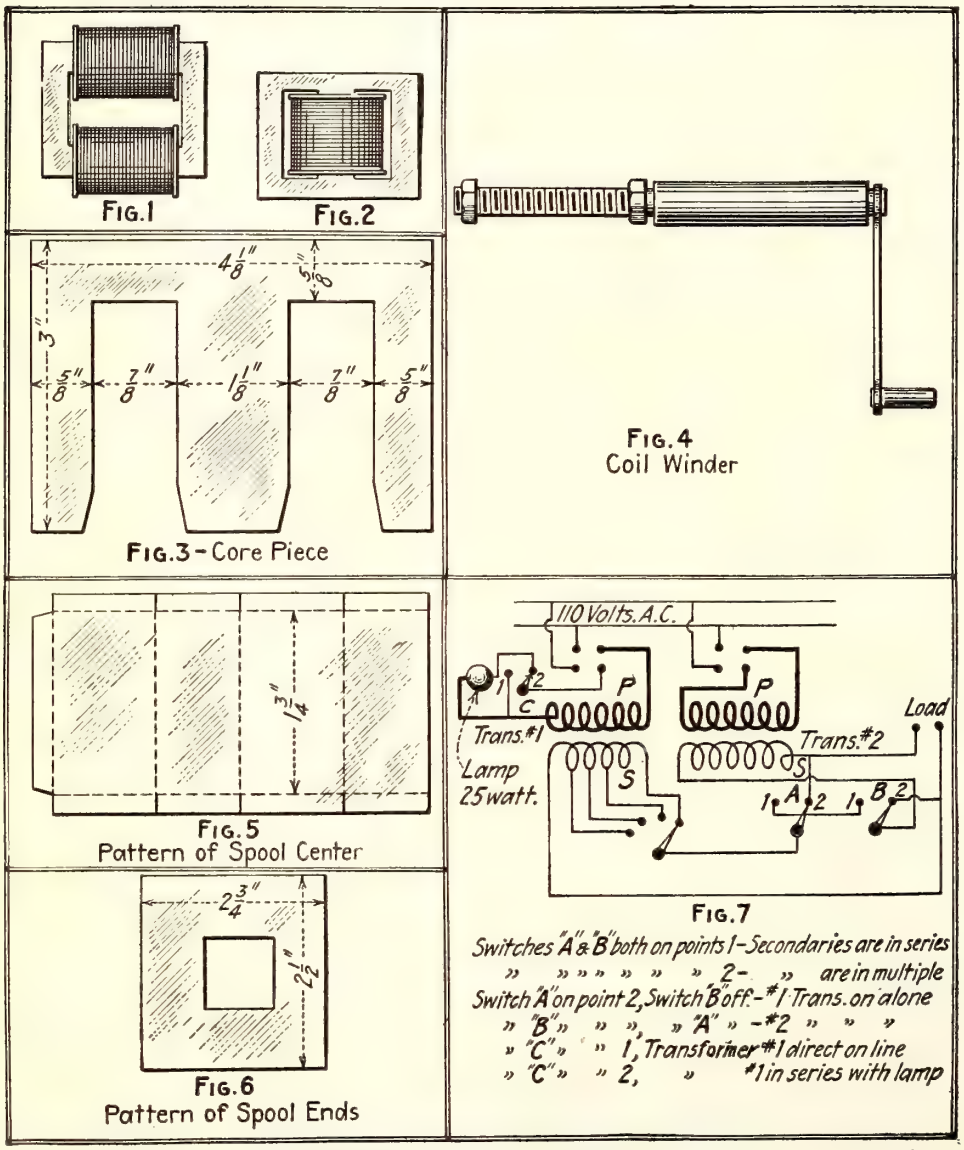
The principal trouble in a small transformer is its tendency to heat *when under no load.* This is caused by losses in the core and Primary winding, the technicalities of which it is not necessary to go into here. Properly constructed, a transformer may remain on the line indefinitely under no load and will not heat. Under a load it will warm up slightly, but excepting on a *dead short* of the Secondary, it will not get dangerously hot.

SHELL AND CORE TYPES.

There are two general types of transformers in use, known as the core type and the shell type, shown respectively in Figs. 1 and 2. The shell type is the easiest to construct and probably the most satisfactory in every way for the Amateur, therefore I will deal with it only. The following instructions are for a transformer to deliver voltages ranging from 2 to 20 volts, but further on I will explain how you may vary the size so as to obtain any voltage you may desire.

BUILDING THE CORES.

First prepare the annealed sheet-iron core pieces. These are made from very soft, thin sheet iron (tin-can stock has been used), and are cut in the shape of the letter E, the dimensions being given in Fig. 3. It is best to make a pattern from some slightly heavier stock being careful to get all parts square and close to size. When the pattern is finished, lay it on the iron to be used for the core pieces and with a sharp scriber mark out a piece. Cut this out, using a sharp cold chisel to cut along the back of the piece between the tongues which cannot be reached with the tinsnips. Lay this piece on the pattern, first one way and then the other, and if the lines all coincide you are all right, if not file the pattern in the spots which are out and try again until the pattern and the core pieces line up pretty close. Now cut enough core pieces to make a pile 7/8" high when tightly comprest. Put all the pieces in a pile with the tongues all in one direction line them up as closely as possible and clamp the back of the E in the vise and file the inside edges smooth. Do the same with the end and middle tongues. You need not file the outside edges unless you so desire, as it is only a matter of looks whether they are smooth or not, but the inside must be quite true or you will have trouble in entering them into the spool.



Here's Something You Have Wanted for a Long Time—Data and Instructions for Building and Testing Small Transformers

WINDING THE COILS.

In order to wind the coils evenly, it is necessary to have some form of winding apparatus. If you have no lathe, you can easily make a winding machine as shown in Fig. 4. A 3/8" bolt about 10" long, with threads cut down about 6"; a piece of 1/4" pipe 1/2" longer than the width of your vise jaws, and a couple of 3/8" nuts are about all that is necessary. Saw the head off the bolt and put on a handle. Slip the pipe on the bolt and run one of the nuts down close to the end of the pipe, leaving just enough end play for the bolt to turn easily. Put the pipe in the vise and this part is ready. Now take a piece of wood, slightly larger in dimensions than the middle tongue of the core piece, and bore a 3/8" hole thru the center lengthwise. Then plane it down taking care to keep the sides as near parallel to the hole as possible, until it is 1/16" larger than the core or 15/16" x 1 3/16".

The spool is made from good, stiff cardboard. Lay out a piece as shown in Fig. 5. Cut on the (solid) lines and bend on the (dotted) lines. It is best to form this part of the spool right on the block you have just finished. The end pieces are shown in Fig. 6. Cut the hole in the center just large enough to fit snugly over the center form. Bend up the short ends and glue them in place. Place the completed spool on the block, slip the block on the spindle of the winding apparatus, lock it in place with a nut, and when the glue is dry you are ready to wind the coils.

THE SECONDARY WINDING.

The secondary winding is put on first. It consists of four layers of No. 18 enameled magnet wire with a tap taken off each layer. Punch a hole in one end of the spool, put the end of the wire thru about 4" and proceed to wind the wire on evenly until the first layer is complete. Cut the wire, leaving about 4" beyond the end of the layer. Punch a hole in the end of the spool and push the wire thru. Put the end of the wire remaining thru the same hole and solder the two together, just outside the spool. Cover the layer of wire on the spool with a layer of paper and wind on the second layer, taking a tap off at the end in the same manner as before, and so on to the end. Number each tap as you take them off and cover the completed secondary with several layers of paper, or, better still, with two layers of Empire cloth (oiled linen).

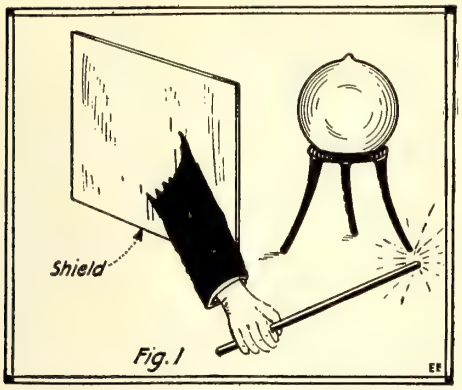
THE PRIMARY.

The primary consists of twelve or fourteen layers of No. 28 enameled or silk-covered magnet wire. Solder a piece of No. 18 wire to the end of the No. 28 wire, make a full turn of the No. 18 around the

(*Continued on page* 580)

Explosions Caused by Light

By H. J. Gray



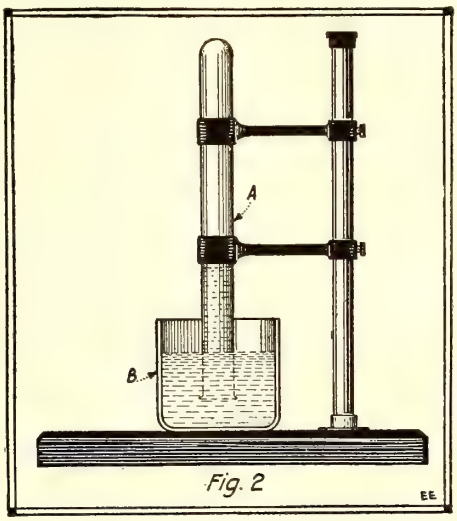
A Mixture of Chlorin and Hydrogen Gases, If Sealed up in a Glass Bulb, Will Combine in Diffused Light to Form Hydrochloric Acid Gas. Exposure to Direct Sunlight or Burning Magnesium Wire Ignites Forcibly the Gas so Formed.

THAT photographs are taken by virtue of the chemical properties of light is a fact that is familiar to everyone, and is indicated by the very word *photography*. But there are many other interesting examples of the action of light in promoting chemical action which have no bearing on the photographic art. Under the influence of the *actinic* rays in sunlight, and the light of magnesium, the electric lamp, etc., elements are made to combine and compounds are decomposed into their elements or broken down into simpler and more stable compounds, while certain of the chemical elements are converted into a different form or allotropic modification.

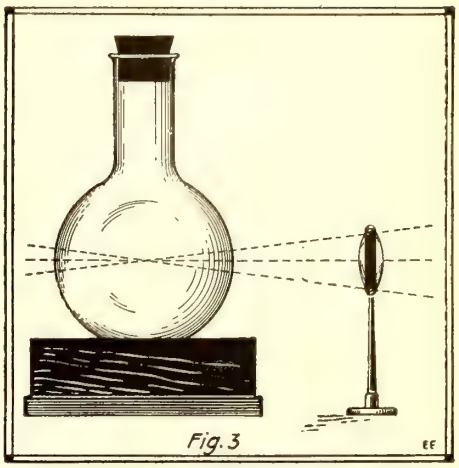
Octahedral sulfur (the form in which native sulfur crystallizes) can be readily dissolved in carbon disulfid. If such a solution is prepared and exposed to a beam of very strong light the clear liquid becomes turbid by formation of insoluble white amorphous sulfur. Yellow phosphorous is also altered by exposure to light.

If a mixture of chlorin and hydrogen gases is sealed up in a glass bulb and exposed to diffused daylight, the gases gradually combine to form hydrochloric acid gas, but the combination does not take place in the dark. Exposure to direct sunlight causes the gases to combine at once with an explosion that shatters the bulb. The same effect is produced by burning a piece of magnesium wire, as in Fig. 1, the experimenter being shielded by a suitable screen.

Another example of chemical synthesis brought about by the action of light is the combination of chlorin and marsh gas (or methan) to form methyl chlorid. Let a tall and wide glass tube, A, Fig. 2, be filled with strong brine and inverted over a vessel, B, containing the same solution, the tube being supported with its mouth beneath the surface of the liquid. One-third of the tube should be filled with chlorin by bubbling the gas thru the brine—in which it is much less soluble than in pure water—and then another third of marsh gas introduced in the same way. The tube must not be exposed to direct sunlight or the gases will combine with explosion but if left in diffused daylight for a few hours the liquid will be found to have risen in the tube which now contains only methyl chlorid. The hydrochloric acid produced at the same time will have been absorbed by the brine, and the resulting vapor will occupy only about one-third the original volume.



The Combination of Chlorin and Marsh Gas Under the Action of Diffused Light, Giving Methyl Chlorid, Which Explodes When Exposed to Direct Sunlight.



The Glass Vessel Contains Sulfur Dioxid Gas. A Strong Electric Light Beam Is Focust on It Thru the Lens Shown, Causing a Mist to Appear and Finally a Fog Which Fills the Bottle. Removing the Light, the Fog Disappears.

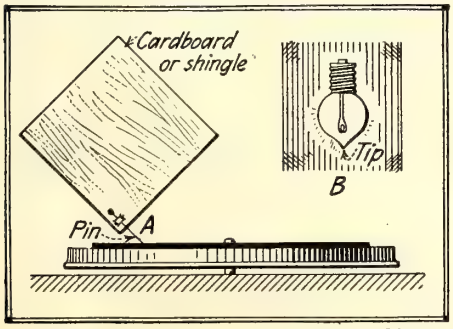
Examples of decomposition by light action are more numerous. Mercurous oxid has to be kept in the dark if required in a laboratory, because it is gradually decomposed by exposure to light, forming mercuric oxid and mercury. Many other metallic salts are similarly reduced by light, hence their use in photography. Those of silver and uranium are particularly sensitive. Glue or gelatine containing a little potassium bichromate is rendered insoluble and leathery by exposure to light, a property that is made use of for rendering glued joints watertight.

If a large clear glass flask is filled with sulfur dioxid gas and closed with a rubber stopper, a further experiment can be made if a strong electric light is available. The light should be concentrated by means of a lens, as shown in Fig. 3, and past thru the flask. In a few moments a mistiness will appear, and after a short time the vessel will appear to be filled with fog. This is caused by the decomposition of sulfur dioxid into sulfur trioxid and sulfur. Upon removing the strong light these products will soon reunite to form the original and invisible sulfur dioxid.

Novel Phonograph Reproducers

Procure a stiff piece of cardboard about 1 foot square and insert a needle into it so as to project from the corner of the cardboard in the fashion illustrated herewith. See Fig. A.

The projecting point is held on the revolving phonograph disc. Best results will be obtained if the cardboard reproducer be held in the fingers where the needle passes thru it. The music is surprisingly clear and can be heard at a distance of 30 feet. [Ed. Note: A wooden shingle gives surprisingly good results.]



Want Some Fun? Try One of These Phonograph Reproducers.

By simply placing the tip of an electric light bulb (see Fig. B) on the disc, the music can be heard about 1 foot away.

Contributed by RUSSELL H. ANDERS.

A SILENT ALARM CLOCK.

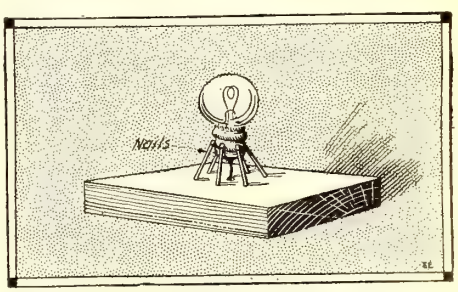
About the most gentle way in which to awaken a person is by the rays of the sun falling on the sleeper. This principle is incorporated in the silent alarm proposed herewith. A nitrogen tungsten lamp of high wattage is mounted within a reflector which is in turn mounted on either the headboard or footboard of the bedstead in an adjustable manner so that the light rays may be focust upon the pillow. This light is controlled by a time-switch or suitable alarm clock arrangement to turn the current on at a predetermined time; the circuit should be opened by a switch located at a point distant from the bed. It is also advised that a good lens be used to increase the strength of beam if necessary. After one is awakened, the flood of light will render the chance of dropping off into further slumber improbable, and you will be persuaded to rise and "douse the glim."

Contributed by J. A. WEAVER.

A Shoe-Nail Receptacle

First procure seven old shoe-nails an inch or so long and a piece of board. Drive six of the nails into the board in the form of a circle, ¾ inch in diameter. In the center of this circle drive the remaining nail, leaving all 7 nails protruding at least ½ inch. Next bend the six nails toward the central one until they will clamp a miniature base lamp. Drive the center nail down until, with the bulb in the improvised clamp, the base will just touch the center nail.

Contributed by E. C. PADDOCK.



Ever Want a Miniature Receptacle in a Hurry? Here's How to Make One From Old Shoe-Nails.

Experimental Mechanics

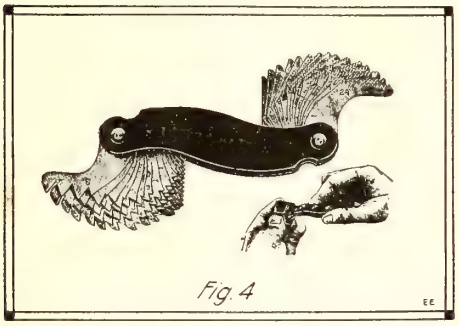
By SAMUEL D. COHEN

LESSON XV

IN the earlier lessons of this Course, the subject of "thread-cutting" was taken fully under discussion; the same being applied, however, to threads cut by means of the lathe only. The lathe is by no means the only method by which threads can be cut, either internally or externally. The most common method of cutting threads in metal or any other materials is by the application of taps and dies. The latter being used for cutting external threads, while the former are used for cutting internal threads.

There are various types of taps and dies that can be used for this work, and these depending upon the character of the work in which the threads are to be cut. The most common thread as obtained from a tap are those of the 60 degree "V" variety. This type of thread is the most commonly used and for this reason it is recommended for the novice. Taps and dies are most easily procured and you will find that very little effort is imposed upon the user of the tool in obtaining an accurately cut thread.

There are three principal types of *taps*, namely:—the *taper*, *plug* and *bottoming*. These three taps are indicated in Figure 1. The *tapering* tap being used for starting the thread, the *plug* tap being used for smoothing the starting thread obtained



To Ascertain the Pitch of the Thread on a Bolt or Nut, a "Thread Gage" of the Type Shown Here is Usually Employed.

by the taper type, and lastly, in finishing a thread, the *bottoming* tap is employed. The latter tap is also used in places where the depth of the hole is limited and it is desired to produce a sharp V-thread in said hole.

The difficulty encountered in attempting to use the bottoming tap first is that it is difficult for the body of the tap to grip the metal. This can be avoided by slightly chamfering the hole and applying a sudden twist on the tap. (See photo Fig. 3.) Should the hole wherein the thread is to be formed be long enough, it is then recommended at all times to use at least the plug tap as a starter, and not a bottoming tap.

It is strongly urged at all times when using a tap that plenty of oil shall be applied to the working surface. Standard commercial machine oil will serve the purpose. In brass, especially when tapping large holes, soluble oil should be applied.

Taps are usually held in *tap wrenches* as indicated in Figure 2. Do not use monkey wrenches or tools that have an L-shaped handle in operating a tap. This is an important rule to be remembered, as when using the latter type handle it is difficult to start the tap into the metal into which the thread is to be cut at exact right-angles to the tap. Often the tap is broken when utilizing such a tool. It is thus clearly seen

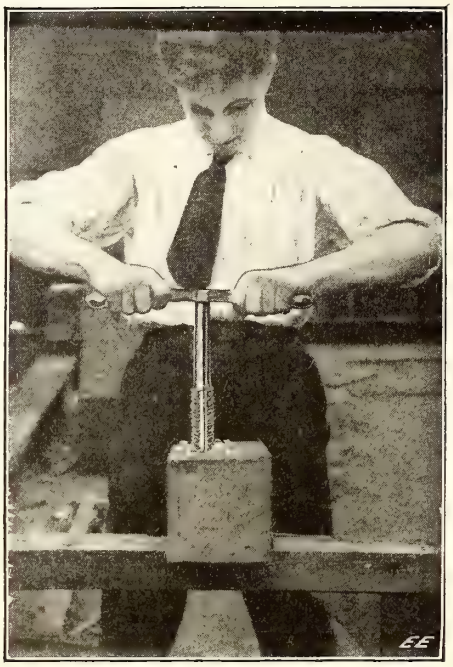
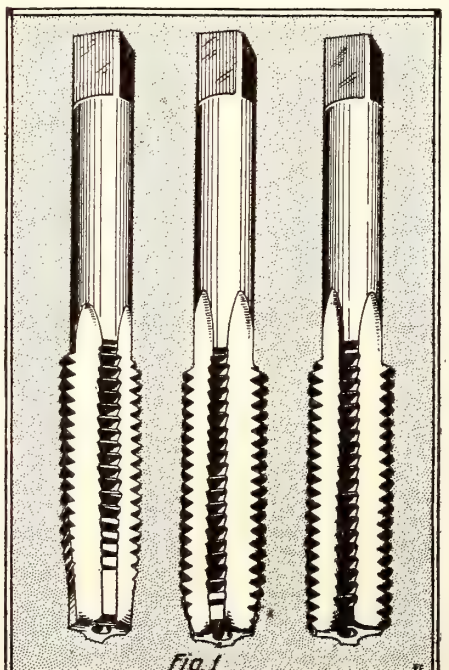


Fig. 3.—Don't Try to Run a Tap in With a Lop-Sided motion, as by Using a Monkey Wrench; Always Use a Balanced, Two-Handle Tap Holder as Here Shown.

the exact reason for using a tool having a T-shaped handle is that the applied force to the tap is uniformly distributed.

The following may be of assistance to the novice as regards lubrication for different materials which are commonly used. As previously mentioned—in brass work, the tap should be lubricated with soluble oil or standard machine oil. Same being applied in tapping bronze.

In copper and aluminum where tapping is most difficult, it is strongly recommended to use kerosene or turpentine as the lubricant.



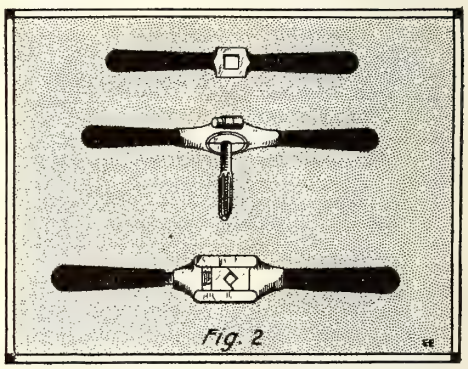
Left—Taper Tap. Center—Plug Tap. Right —Bottoming Tap.

In tapping these materials, it is urged that the tap be given a to-and-fro motion; this being necessary in order to eliminate any possibility of causing the metal to adhere to the tap and thereby preventing binding of the tap. At times it is also recommended to remove the tap from the threaded portion and remove all of the dust particles that may be in the metal and flooding the same with the above-named lubricant, before attempting to proceed with the tapping. Tool and machine steel, especially of the high carbon grade, require standard machine oil as a lubricant while tapping.

The following materials do not require any lubricant for tapping: fiber, bone, bakelite, formica, hard rubber and cast iron.

Miscellaneous Notes on Tapping.

All threading of machine parts and castings is not done by means of the standard tap wrench by hand, but in some cases the threading is done in a *drill press* or in a *lathe*. In machine shop practise large holes often have to be tapt measuring two inches or more in diameter. It is manifestly impossible, or at least impractical, to attempt to tap such a hole by hand, altho it is sometimes done in an emergency. For such a job, the first point to be watched should be



Three Common Forms of Tap Wrench Used in Machine Shop Practise.

to get the tap firmly over the opening, the edge of the hole being eased off a little with a file if necessary to start the tap. It is a common trick in tapping holes such as this to place the part or casting on the table of a large drill press and center it so that the spindle of the press comes directly over the hole to be threaded. The tap is then placed in a position over the hole and the spindle either fitted with a chuck to hold the tap, or in some cases the spindle simply carries a tapered *center* which presses against the center hole in the end of the tap. By throwing in the back-gear of the drill press, any pressure desired can be obtained on the tap and under these conditions the tap is threaded into the material by turning it slowly with a large wrench; in the case where the person doing the tapping is sufficiently skilled the tap can be held in the drill press chuck, and by throwing in the compound back-gear so as to cause the spindle and tap to just barely turn, the hole is thus tapt out. By throwing the reverse lever on the drill press, the tap can be *backed out* when the tap has been threaded thru the hole a sufficient distance. The "feed" is worked by hand.

Many small parts and castings, etc., are easily and accurately tapt in the lathe.

(*Continued from page* 579)

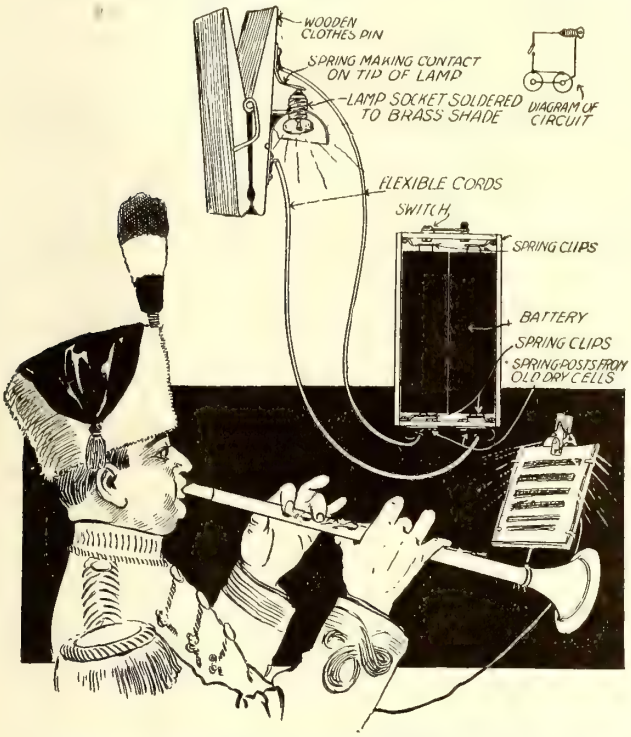
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

MARCHING LIGHT FOR MUSICIANS.

Herewith is a sketch of a Novel Musicians' Light for musicians when marching at night. I have used one for some time and find it very satisfactory. The description follows:



An Electric Light of Many Uses—Here Shown Lighting up the Bandsman's Music.

The box is made of a cigar box or other light wood, of a size to accommodate two flashlight batteries of the type you desire to use, and may be provided with a hinged cover to facilitate replacing the batteries. One end of the box is provided with a small lever switch for opening and closing the circuit. The other end is equipt with two spring clips taken from old batteries.

Secure a piece of brass and bend it in a semi-circle with a projection on one side to be fastened to the wooden clothes pin as shown in the sketch. A lamp socket from an old flashlight is placed thru a hole made in the top of the shade and soldered. Over this is placed a flat bent spring, secured to the clothes pin with small wood screws, and close enough to the socket as to make a firm contact with the lamp when screwed into the socket.

The flexible cords should be of sufficient length to reach from a convenient pocket, in which the batteries will be carried, to the music lyre on the instrument.

The batteries are connected in multiple or parallel to give longer ampere-hour capacity.

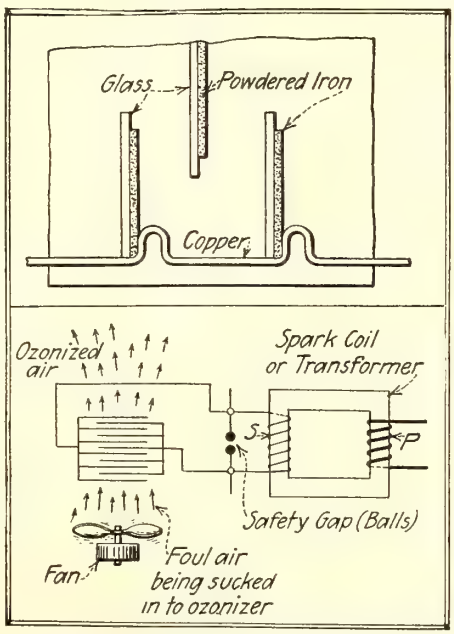
Contributed by A. L. AVERY.

SECOND PRIZE, $2.00

OZONE AND ULTRA-VIOLET RAYS FOR PURIFYING THE AIR.

The many uses for ozonized air makes its production in quantity of growing importance, and apparatus suitable for such work is of increasing interest. A convenient design for apparatus of this nature is shown herewith and consists essentially of glass plates, covered with powdered iron, and fixt alternately to the top and bottom of a suitable receptacle. To make the iron adhere properly it may be mixed with shellac and applied in a thin layer. The glass plates come into contact with copper conductors both at the top and bottom of the receptacle, and a brush discharge of electricity will take place between the two sets when the conductors are connected with the secondary of a spark coil or transformer, giving at least 6,000 to 7,000 volts. Air is forced thru the receptacle by means of a blower, and the air currents will take a zigzag course around the ends of the plates, thus coming into intimate contact with the discharging current.

Contributed by HAROLD C. RIDGELY.



A Home-Made Ozone and Ultra-Violet Ray Generator for Purifying the Air.

THIRD PRIZE, $1.00

AN ODD "SPARK" PHOTO.

The accompanying photograph represents a spark picture which can be easily duplicated with interesting results by any electrical experimenter who possesses a small spark coil, or static machine and Leyden jar. This picture which was contributed by Mr. C. J. Forrest of Blenheim, N. Z., shows a "New Zealand Highlander" in full regalia, and was taken in the following manner:



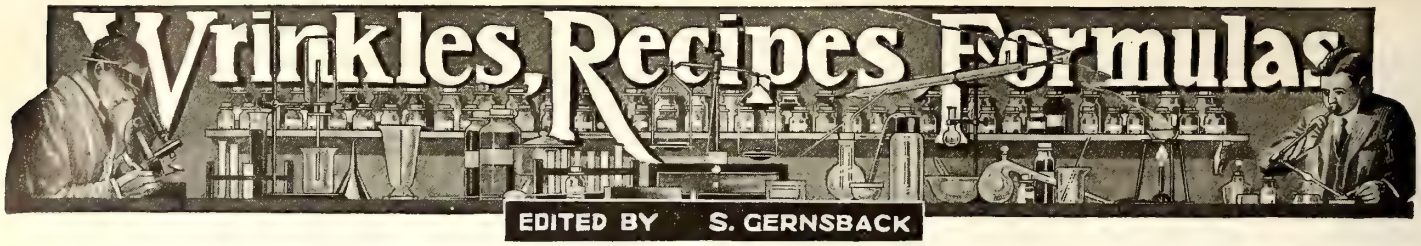
This Odd "Spark" Photo Was Made by One of Our New Zealand Readers. It Represents a New Zealand "Highlander" and Was Obtained by Passing a Spark From an Electro Thru a Photo Plate, to a Tin-Foil Sheet.

The odd results shown were obtained by placing an old postcard block (printing block) on the film side of a photographic plate, and then placing a piece of metal underneath the plate. The metal block bearing the image was connected to the outside coating of one Leyden jar on a small static machine, while the piece of metal below the photograph plate was connected to the outside coat of the other Leyden jar on the machine. The handle of the static machine was then turned and a spark allowed to jump between the discharging knobs. The photo plate was then developed in the usual manner with the results here shown.

HASTENING ACTION OF NITRIC ACID ON COPPER.

To hasten the action of nitric acid on copper, drop a minute amount of sodium carbonate in the acid. This is especially good when the acid is too weak to readily decompose the copper.

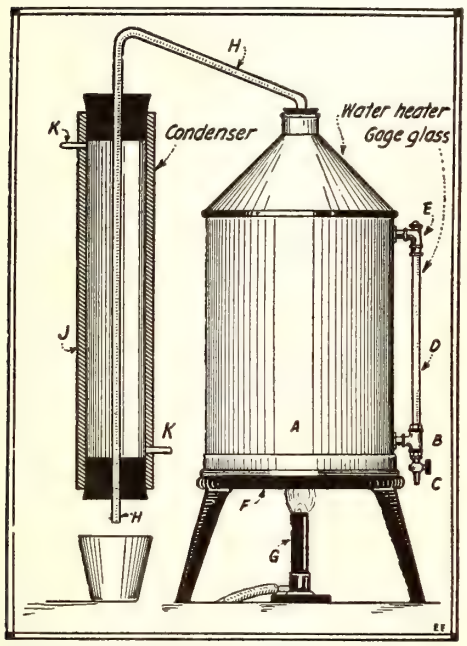
Contributed by BENSON FREEMAN.



LABORATORY HOT WATER SUPPLY.

By H. J. Gray.

A supply of hot water is a great convenience in the laboratory or workshop, and while a tin kettle and a gas ring will serve very well as a makeshift, it is not a difficult matter to fit up a more serviceable installation. The arrangement illustrated was constructed by the writer for



Distilled Hot Water Any Time You Want It. It's Easy With This Laboratory Hot Water Heater, Which Anyone Can Make With a Little Ingenuity.

use in a small private laboratory. The water is heated in a large oil can, A, which should be the largest obtainable. Near the bottom a brass T gas-pipe fitting, B, is soldered into a hole made to receive it. A small brass tap, C, is screwed into the lower arm of the T, while the other supports a length of glass tube, D, the other end of which is fitted into a brass elbow joint, E, near the top of the can. The glass tube forms a gage to indicate the depth of water within the can. It can be fixt like the water gage in a model boiler. In fact, instead of using gas fittings the necessary parts may be obtained from a dealer in model engineers' sundries if preferred. The gas fittings with a glass tube fixt by means of leather packing, with a piece of thick indiarubber tube to cover the joint outside, make a good substitute for a time. The can is supported on a strong iron stand with a piece of asbestos millboard, F, beneath it to protect the bottom from the flare of a Bunsen burner, G, used as a source of heat.

In order to utilize the escaping steam a condenser was fitted to the side, as shown. This consists of a bent glass tube, H, passing thru a hole made in a sound cork closing the mouth of the oil can, so as to just reach inside. The lower part of this tube is cooled by water circulating thru a wider tube, J, which has a waxed cork at both ends and two side tubes, K K. Cold water enters thru the lower side tube and escapes from the upper one, indiarubber tubes being used to make the necessary connection with a full pail placed above the condenser and an empty one on the floor. The boiler may be filled by siphon action so as not to disturb the condenser fittings by removing the cork. Simply connect an indiarubber tube to the tap, drop the other end in a pail of water standing at a higher level, and suck a little air out from the end of the condenser tube to start the siphon. The water which falls from the end of the condenser tube is preserved as distilled water—always a useful thing to have in a laboratory. Of course the longer the water is allowed to boil the greater the quantity of distilled water formed.

WAX THE CORKS—IT PAYS.

Corks can be made quite air- and water-tight by dipping for a second or two in melted paraffin wax heated in a tin over a spirit lamp. The wax should not be made too hot or it swells the corks unpleasantly and also becomes deteriorated.

When chemicals are put away for a considerable time, and in cases in which they are liable to deteriorate by contact with the air a seal of paraffin wax will form a simple and efficient safeguard. Keep the wax in a shallow tin—the lid of a blacking tin will do very nicely when cleaned—and melt by gently heating over a spirit lamp. Cut the cork flush with the top of the bottle and dip momentarily into the molten wax. The writer has stored even very deliquescent substances for many months in this way without a trace of moisture appearing.

PEROXID FOR ACETYLENE LAMPS

A little peroxid of hydrogen—the stuff ladies use for making the hair golden—works wonders in an acetylene lamp. About a teaspoonful added to the water in the generator causes a marked increase in the brilliance of the light, and is in no way detrimental to the metal parts of the apparatus.

SAWING BOLTS AND SCREWS.

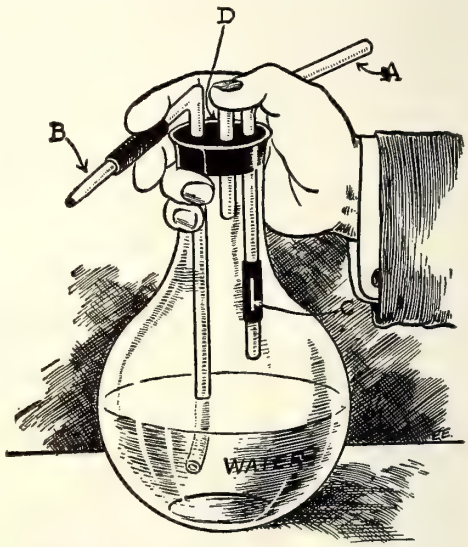
It is sometimes necessary to trim the end of a bolt, or to remove a portion in order to shorten it. In such cases it is a good plan to keep a nut some distance up the bolt, finally running it off to remove any burr left by the saw. Otherwise there is usually some difficulty in starting a new nut, and the threads may sustain permanent injury as a result of the attempt to force a nut over the end.

SHOT FOR CLEANING BOTTLES.

A method of removing obstinate stains from bottles that is often recommended is to pour in some water and small shot and shake until the bottle is clean. This, it is true, removes the dirt, but it generally leaves behind some streaks and particles of lead adhering to the glass which can be distinctly seen in a good light. For chemical and photographic purposes the lead is as bad or worse than the dirt, and must be completely removed before the bottle is used for storing solutions. A little nitric acid should be kept for this purpose, diluted with an equal bulk of water. A good rinse with the acid will dissolve all traces of lead, after which the bottle can be washed in the ordinary way. The acid may be used repeatedly.

A HANDY LABORATORY WASH-BOTTLE

The continuous flow wash-bottle shown in the accompanying sketch will be readily appreciated by those who have used the old type wash-bottle requiring constant blowing. It is simple and effective and should be a valuable asset to every laboratory. It is composed of a flask, stopper and three



We Have Seen Many Types of Laboratory Wash Bottles, But This Is an Ideal One—Simple to Use and Easily Made.

tubes, B, D and A; B being the outlet, D for releasing the pressure and A for blowing. Slipt over the lower end of tube, A, is a short section of the rubber tubing with a small stopper inserted at the free end. A slit is then cut into the rubber tubing, as shown at C. This has the effect of a check valve, allowing air to pass thru the slit C, in only one direction, that being into the bottle.

In operating, the flask is held in the right hand with the outlet tube between the index and second fingers and the thumb over the tube D. It is then ready for blowing, which is done in the regular way thru the tube A. The air passes thru the valve, thereby setting up a pressure in the bottle which causes the emission of water from the outlet. The flow from the bottle will then continue until the pressure is relieved by the displacement of the water. As it is possible to create approximately 2 pounds pressure in one blow, considerable water is ejected before the pressure is exhausted and the flow stops. Should it be necessary to stop the flow instantly, or before it would do so by itself remove the thumb from the tube D.

Contributed by RUDOLPH C. LANG.

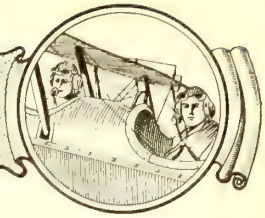
NON-FERROUS MAGNETIC ALLOY.

Though manganese itself is only feebly magnetic, while copper and aluminium are destitute of magnetic properties, an alloy of these three metals is found to possess magnetic properties comparable with those of cast iron. The alloy in question contains 60 per cent copper, 26 per cent manganese, and 14 per cent aluminium.

Contributed by H. J. GRAY.



RADIO DEPARTMENT



The Submarine's Under-water Radio

IN a general way it is known that during the war a method was found to communicate with a submerged submarine from shore or sea. How this is done and how it came to be discovered that it could be done not until now has been made public. Like a good many other revelations it came when the researchers were at work on another problem.

The scientists of the radio section of the Bureau of Standards stumbled on the secret and the lucky ones to suspect it were two young assistants not long out of high school. Their experiments and the development of what is known as the "loop aerial" for submarine radio communication by the bureau, resulted in a device so simple and perfect, and producing such wonderful results, that the navy has adopted it and is equipping all its undersea craft with this style of loop.

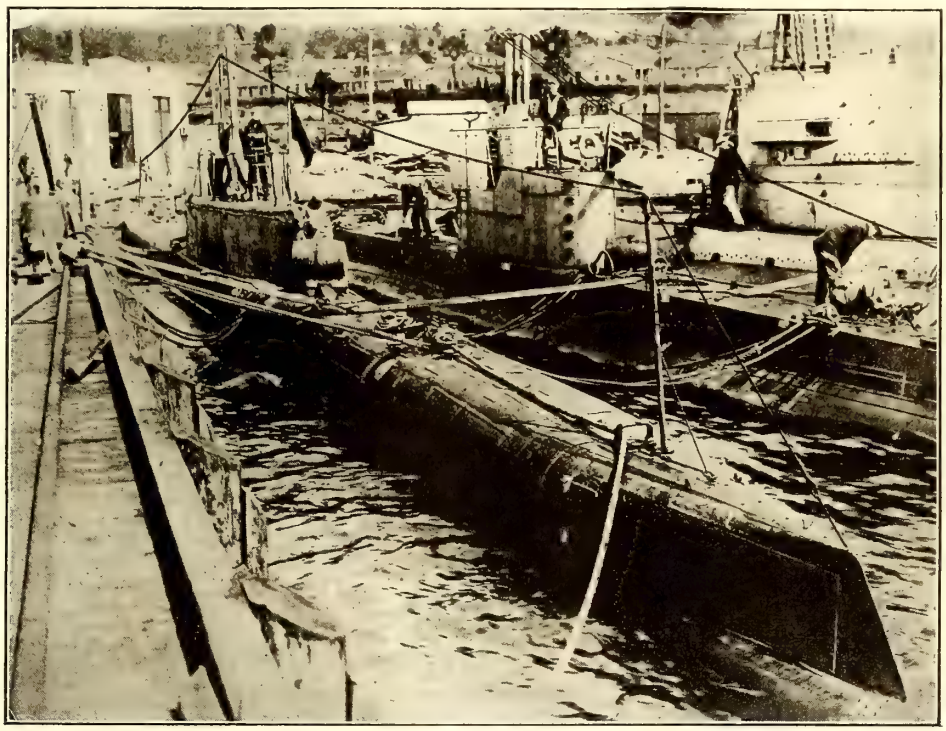
In the fall of 1917 a series of experiments was undertaken by the bureau to develop an apparatus for the detection of enemy submersibles. Mr. J. A. Willoughby and Mr. P. D. Lowell were engaged in the work. They had a notion that a closed "loop" or rubber encased coil of wire offered the best chances for success. They made one and threw it one night into a tank of fresh water on the grounds of the bureau near Chevy Chase, Md., a suburb of Washington. To their delight they received a signal from the big radio station at Arlington. The next night they submerged the coil in the tidal basin of the Potomac near the new Navy Building. Again the signal came with no difference in strength whether the loop or coil was suspended in air or sunk in the river.

DISCOVERY OF THE "LOOP'S" EFFICIENCY.

The significance of this discovery struck both young men. Here was a way possibly to detect the presence of enemy submarines, but surely to talk with our own, which was equally important, had been thought impossible. This was in November.

In December improvements in the submerged coil brought the reception of signals from Lyons, France; Paris and San Diego, Cal. By March last year excellent signals were received on a single turn coil 150 feet long by sixty feet high having a wave length range of 100 meters to 15,000 meters. Experiments continued.

In April Mr. Willoughby discust with Lieutenant Commander H. P. St. Clair, of the Radio Division of the Navy, the use of "loops" on submarines for both transmission and reception under water. Both he and Mr. Lowell were sent to New London to work under Commander McDowell in charge of the base to install the apparatus for a try out on submarine D-1. It is a simple contrivance, the metal frame of the submarine itself being a part of it, this being used as a "ground" just as the earth is used in land telegraphy. The circuit is thus made complete. As finally perfected the loop consists of two insulated wires grounded at the extreme ends of the hull carried over suitable supports to the conning tower and thence thru "radio-lead-ins" down into the boat to the receiving and sending apparatus.



Equipping U. S. Submarines with New Under-water Radio Antenna. The Antenna Comprises the Single, Heavily Insulated Wire Passing from Bow to Stern, Over the Conning Tower. Messages Have Been Received 6,000 Miles When the Loop Was Submerged 8 Feet.

SUBMARINE USED AS "GROUND."

A new type of loop was tried on the U. S. S. G-3, in which the lead-in wires were brought in from the upper side of the "loop" instead of the lower and the entire loop was insulated from the hull. Better, but not satisfactory, results were obtained. Up to this time the frame of the boat had not been used as a "ground."

The lower side of the "loop" was removed and the ends of the wire fastened to the bow and stern. The top of the "loop" was submerged eight feet; *signals from Nauen, Germany, were clearly heard.* Very sharp indications of direction were obtained when under water or on top of it. And soon other stations were heard, including *Carnarvon, England, Rome, Italy, and various merchant vessels.* Later experiments showed that communications can be carried on at sea under all conditions more efficiently with the closed "loop" aerial than with the ordinary elevated antenna.

To receive short wave lengths the loop must be near the surface of the water, whereas a wave length of 10,000 meters can be received at a depth of twenty-one feet. Still longer lengths can be heard at greater depths.

TRANSMISSION UNDER WATER.

Signals can be transmitted from the loop to a distance of *ten or twelve miles* when the submarine is completely submerged, the maximum distance being obtained when the top of the "loop" is practically at the surface. The distance decreases to two or three miles when the loop is eight or nine feet below the surface. Submergence of the boat during the reception of or transmission of a message does not alter the wave length. If the maximum depth for the wave length being used is exceeded, communication is then interrupted.

The report of the Bureau of Steam Engineering of the Navy Department in its summary of underwater radio experiments says:—

(*Continued on page* 560)

In October "Radio Amateur News"

Arc Undamped Transmission.
By Ensign P. H. Boucheron, U.S.N.R.F.

Cascade Amplification at Radio Frequencies.
By Thomas Benson

Selector Switch for "Rogers" Underground Antenna.
By Stanley J. Brown

A New Radio Dynamic Controlling System.
By Lieut. W. R. Coventry

Long Wave Receiving.
By H. L. Biedenbender

A Short Wave Receiving Transformer.
By Raymond Evans

Improved "B" Battery Construction.
By J. G. Reed

An Undamped Transmitter of the De Forest Type.
By E. Dynner

Developing Audions for the Amateurs.
By E. T. Jones, Associate Editor

An Exceptionally Well Designed ½ K.W. Transmitter.
By W. H. Priess

The Wireless Ukulele

The accompanying pen and ink sketch by our friend, Emerson Easterling, sure does bring back the golden memories of the good old "Amateur Radio" days. Just imagine, friends and fellow citizens, what a wonderful mental exhilaration it is to slip on the "cans" and hear the wireless telephone hum the strains of the Hawaiian ukulele, as played by the natives on the moonlit beach of far-away Wakakai. Oh boy! that sure is the life, and it doesn't require any excessive strain of the mental fibres of your cerebrum and cerebellum to picture the fair Hawaiian maidens dancing the Hula Hula to the tantalizing strains of the Hawaiian Elite orchestra. All this and more does the wireless amateur enjoy at some time in his glorious and educational career, but if Secretary of the Navy Daniels has his way there "ain't agoin' to be no sech animal" as a Radio Amateur from Portland, Maine, to the "Barbary Coast." No siree. In onion—we mean "union," there is strength. So get together, fellow Radio-bugs, and think up all the good arguments and good deeds you can about Amateur Radiodom. Talk about it at your radio club meetings.



The "Radio-Bug" Has it on All of Us—He May Put on the "Cans" and Listen to the Ukuleles Strumming Gaily in Far-off Hawaii, and With a Little Imagination—Well Say, Who Couldn't See the "Hula Hula" Maidens Dancing in All Their Native Charm?

Unique Radiophone Helmet



Photo Underwood & Underwood

The Radio Telephone Apparatus Worn by an Airplane Pilot in the Recent Successful Experiments With This Wonderful Voice-Transmitting Wireless.

Recently Secretary of the Navy Daniels spoke by wireless telephone with a naval seaplane in flight, 150 miles away from Washington, where the apparatus was located which Secretary Daniels used in talking to the plane.

The accompanying photograph shows the interesting radio telephone receiving helmet used by aviators, and which effectively cuts out all extraneous sounds and noises, including that from the airplane engine. These helmets are made of rubber and leather, and the telephone receivers are mounted in the best quality sponge rubber in such a way as to effectually prevent the transmission of sound, even thru the bones of the head.

The wireless telephone conversation held with Ensign Harry Sadenwater, while flying at a distance of 150 miles from Washintgon, when Secretary Daniels asked him *via radio* what kind of a flight he was having, constituted a new record in the field of Airplane Radio-telephony.

The microphone is of a new type and is open back and front, so that the air waves in front are balanced by those in the back. The engine noises are thus nullified and only the voice air waves are effective in vibrating the diafram of the microphone.

A FOOL THERE WAS.

(With apologies to Kipling)

A FOOL there was, who a wireless made,
Even as you and I.
Two coils of wire together he laid,
With the bill at the junk shop still unpaid,
Tho he called his father's purse to his aid,
Even as you and I.

Oh, the years he'd waste and the tears he'd waste,
And the work of his head and hand
Belong to the science he did not know,
And now we know that he never will know,
And never will understand.

A Fool there was and his coin he spent,
Even as you and I.
The money that should have gone for rent
He paid for receivers. for he was bent
To pull from the skies a radio sent
Even as you and I.

Oh! the news he'd get, and the use he'd get
From this instrument he had planned;
But his scheme didn't work, he didn't know why,
And now we know he never knew why,
And never did understand.

He sent a wave as broad as a car
Even as you and I,
Which even Fessenden couldn't bar,
His coil was large and the spark went far,
And mixed with a message for N.A.R.,
Even as you and I.

And it wasn't the kale, and it wasn't the jail
That filled his soul with despair,
But 'twas the losing the set
That he'd famished to get,
For he'd violated the "laws of the air."

By—
Osborne Anderson,
Ernest A. Innes.

HOW RADIO IN THE CLOUDS FOILED THE GERMANS.

Sounds real mystical, doesn't it, radio in the clouds? And it proved just as mystical as it sounds for a long, long time to many hapless German aviators, and other wearers of the ex-Kaiser's iron cross. Airplane radio among the clouds was finally worked out into a regular melodrama by the Yankee wireless experts and fliers in France. It usually required two Allied airplanes at least to play this game, and the villain Hun aviator was invariably brought to justice sooner or later, once the stage had been set.

The setting was arranged in the following manner: An Allied aviator would rise from the ground and fly toward the rear of his own lines, so as to secretly gain a high altitude, and he would then return toward the front, flying so high as to be almost invisible. Presently another Allied flier would join him. Then the trap would be set for the German flier, or fliers. One of the planes would rise above the clouds and hover in a certain locality, out of sight, while the other plane would remain fully exposed, and in some cases even drop to a lower altitude so as to be more visible to the enemy. It would not be long before a German flier would be seen sneaking up in an effort to surprise the Yank. But here is where modern science, in the rôle of wireless telephony, which was so wonderfully developed by the American Signal Corps during the war, is to step in. The aviator watching for the German signals his approach and his position to his fellow aviator hiding above or in the clouds, by a wireless telephone message. At the critical moment the final information is given by radiophone to the hidden flier, and he pounces out of the clouds on the German, who often leads him a merry chase, but our second flier who had been on the watch joined in, so that it was a case of two to one. Sometimes there were several German planes, and then it often happened that two or three Allied fliers had to battle with an equal, or even double and triple number.

See Cl. 250 - 14 X for next page.

Radio Problems in Aviation

By EDWARD RICE DOYLE

Former Radio Officer, Air Service, U.S.A.

THE day is not far distant when all airplanes used in long distance flights will be required to carry standard *wireless equipment*, permitting of communication over distances equal, if not greater, than the ranges of sets required on passenger steamship liners. The reason is obvious. An airplane in distress is far more helpless than a ship and in case of forced landing, relief is almost always an immediate necessity.

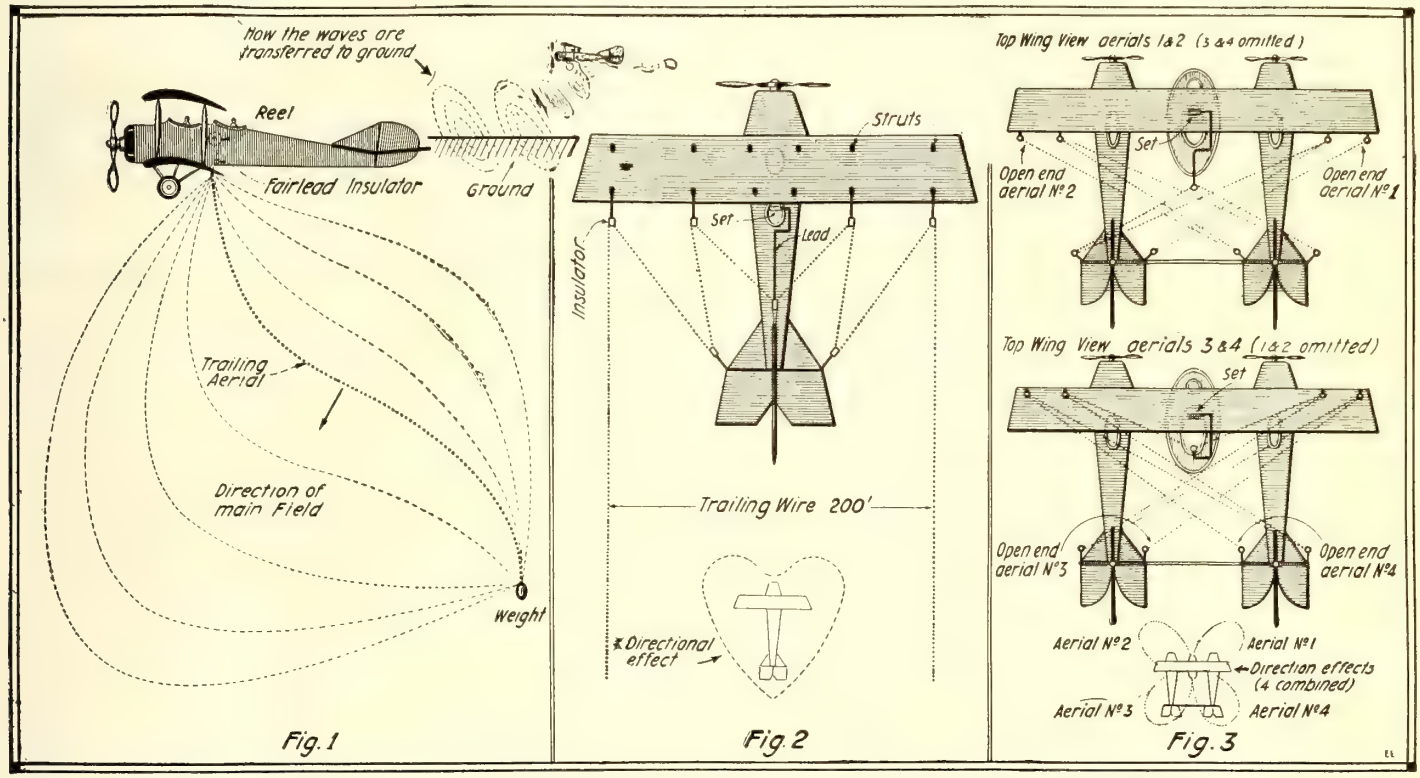


Fig. 1—This Illustrates the Simple Trailing Type of Airplane Radio Antenna, Used to a Great Extent During the War. It Can Be Reeled Up Quickly But Possesses Several Disadvantages. Fig. 2—A "W" Type, Combined Fixt and Trailing Radio Antenna, Successfully Used for Inter-plane Communication. Top View. Fig. 3—Radio Antenna Rig-up Proposed By the Author, for Double Fuselage Biplane. The Quadruple Antenna and Its Directional Effects Are Clearly Illustrated.

Even in cross-country flying a good radio outfit is a necessity in holding a true course and in signaling ahead for special parts or supplies to save time at intermediate landing points *en route*.

The requirements for a reliable radio apparatus on airplanes bring up certain problems which are still unsolved and subject to considerable experiment at this date, when American ingenuity has been able to advertise its achievements in airplane radio. These intensive problems will attract the highest radio engineering skill in their solution.

The problems may be considered as:

1. Directional control of transmitted signals.

2. Wave length adjustment of incoming and outgoing signals.

3. Transmitting ranges and sensitivity of receiving apparatus.

Under the first item, that of directional control, the engineer faces a very difficult task. The design of the aërial has always been the critical factor in directional control, and it is greatly limited by the facilities which an airplane offers for setting up the antenna.

The most effective control has been secured by the single trailing wire antenna. (See Fig. 1.)

A length of about 300 feet of wire is allowed to swing in the air held down partly by a weighted "fish." Thus the metallic parts of the airplane form the counterpoise and as the trailing wire swings backward in a characteristic curve the major electrostatic field is projected downward ahead of the airplane at about 45 degrees.

This gives a directional effect directly ahead of the airplane. Signals behind the plane or to the side of the lateral axis are greatly weakened. Even when the plane banks on a turn, the signals ahead die down rapidly. Hence to transmit in any given direction the plane must be pointed in the direction of the receiving station and to find that direction by compass is not as easy as it seems.

Furthermore, an airplane might have to reverse its direction every time it desired to communicate with a given station, and on long flights this lack of control would be extremely inefficient, in view of the fuel thus lost and the time consumed.

In land radio for long distance transmission the towers supporting the aërial are built for a given directional effect. Where non-directional effect is desired an umbrella type of antenna is used. However, since the airplane must get the maximum efficiency in range from the least amount of aërial weight, an umbrella type antenna, even if practicable, would not be suited to the airplane.

When it is attempted to arrange a fixt antenna (as opposed to the trailing type, which is free to sway) on an airplane the limiting conditions of aërial capacity and structural areas impose very harsh conditions on the designer. Consider the capacity of a wire equal to the wing span of an airplane, seldom more than 30 feet, and with no means of suspending the aërial over a foot above the wing surface, and with comparatively little metal in the wing itself to give the desired field its maximum capacity. Wing spread is the longest overall dimension of the airplane in any case.

Fixt wire antennæ on airplanes have never attained results commensurate to their cost in installation and in reduced flying efficiency; for every wire that is thus exposed to the air means increased *head resistance* and a few wires can multiply head resistance to a very serious extent.

One design of fixt wire antenna which was used in the army combined the fixt type with the trailing type. (See Fig. 2.) Here the ends of the wire were not weighted and as they were constantly liable to become tangled in the controls such fine wire had to be used that their effective capacity, low enough with any practicable airplane antenna, was further reduced. Furthermore, the trailing wires were awkward in landing and in taking off, since they could not be reeled and the fixt wire system was an added menace, due to the fire hazard which they involved.

This "rig-up," however, was effective for *interplane communication* over short distances, not exceeding a mile, using a 200 watt fan-driven generator. Communication to the ground was easily establisht, but receiving from the ground was difficult. The directional effect was low ahead and strong to the rear of the airplane.

The results obtained in army aviation radio were generally satisfactory for their purpose, but in the broad field of commercial aviation, the *directional control* must be far more highly developed before the radio apparatus can be relied upon.

The same structural conditions which impose so many difficulties on directional control also affect selectivity of wave lengths. As is well known, a long wave length is more efficient for long distance transmission. To get long wave lengths a great deal of inductance and capacity are needed. The land radio operator little considers the

(*Continued on page* 588)

An Efficient Radio Crystal Detector

By ROBERT F. GOWEN, Radio Engineer

THE Multi-crystal Detector Mounting here illustrated is the result of an extended study by the author of many different forms of crystal detectors both commercial and home-made. It was built to provide a detector having the following characteristics: (1) Maximum sensitiveness; (2) Maximum robustness or power to hold its adjustment; (3) Maximum flexibility in its use.



Left:—The Detector Arranged to Use Two Crystals. Center:—The Detector Top Bar Swung Back and Cups Removed.

View Above Shows the Detector Being Used with Metal Point on Single Crystal, Held in Lower Cup.

Fig. 1 (at left) shows the mounting used to hold a pair of crystals or a crystal couple such as Zincite-Chalcopyrite or Zincite-Bornite. The electrodes are made eccentric to each other so that any point in the lower cup may be made to intersect with any point in the upper cup. The crystals are mounted in small brass thimbles by means of Wood's metal, Hugonium, or a similar soft solder and are held fast in the cups by means of the set screws.

By removing the upper cup a phosphor-bronze point is exposed which is used in connection with *Silicon*. When using *Carborundum*, the pin cup is unscrewed and the pin reversed to obtain a contact having a comparatively large area. When *Galena* is used, a pin shown in front of the instrument and having a very fine contact wire, takes the place of the pin shown in use. The lower cup is made large enough to hold several crystals at once so that in the case of one burning out, another may be immediately substituted by simply rotating the cup on its pedestal.

Rotating the cups also provides an easy method of determining the most sensitive crystal surfaces. It is only necessary to connect the detector in circuit with a test-buzzer and rotate the cups and thimbles until the head receivers show that the most sensitive crystal faces are in contact.

A good method of comparing the sensitiveness of different crystals is also a feature. This is accomplisht by inserting the several types of crystals in the large cup and bringing one after the other in contact with the pin while an observation for each is made with some type of receiver shunt. In this manner, the crystals may be separated into groups of varying sensitiveness for future use.

In order to change the cups it is simply necessary to throw the lever back against the spring as shown in Fig. 2 (at center). This cut shows the detector unassembled.

The large hole shown in the pedestal provides a bearing for the small shoulder shown in front of the large cup, into which it is screwed when in use; or if preferred, the large cup may be screwed on to the pin in the lever arm.

The small hole shown directly in front of the larger one is threaded to take an 8-32 machine screw which may be used to hold in place a small acid container for an electrolytic detector. In this case a third pin is used, to the end of which is soldered the fine Wollaston wire.

The adjustment screw on the front of the detector is provided with a very fine thread, thus assuring a very sensitive adjustment. The spiral spring shown in the unassembled view is slipt over the contact pin to allow of an easy adjustment while pushing the pin down in place, after which the pin is clamped in place by means of the set screw with its hard-rubber handle

The lever arm holding the pin moves in adjustable conical bearings in the fork mounted on the back piece and is held under tension by means of a flat, steel spring, the end of which may be seen directly over the bearings.

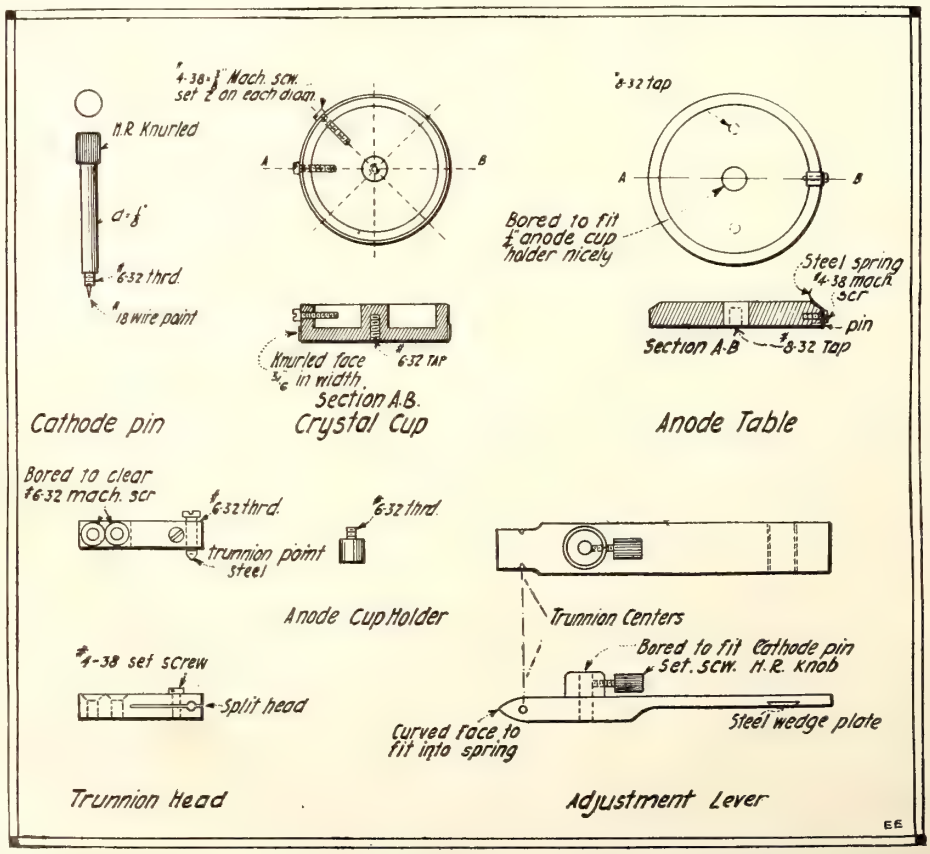
Experience has shown that for the experimenter the detector fulfills a long felt want in that the parts are entirely interchangeable and accessible. It may be used as a detector of any of the well known crystal types or as an electrolytic detector of the "whisker-point" type. By replacing the contact point with a small glass tube containing a fine platinum wire, a "Dip-point" electrolytic detector is provided.

To change from one detector to another it is simply necessary to throw back the lever arm and take out the cups. This action requires a very small time period to perform.

In order to adjust the detector the large cup is turned so that the crystal to be used is underneath the pin or upper crystal holder, whereupon the pin is pushed down against the spiral spring until contact is made, after which it is clamped in place by means of the set screw. The lower cup is then turned slightly until a good point of contact is obtained, whereupon the detector is brought into final adjustment by means of the sensitive adjusting screw at its front.

The author has found this type of detector to retain its adjustment for several weeks at a time and believes this is due to the use of a rigid marble base and the stiff, non-vibrating spring. For the base a special marble is used having a very high insulation value.

(*Cont. on page* 584)



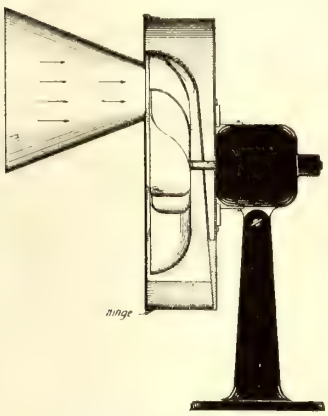
Detail Drawings of Parts Used in Making Universal, Single or Multiple Crystal Detector.

LATEST PATENTS

Electric Fly-Catcher.

(No. 1,311,281, issued to Maik Kurka.)

Of all the thousands of inven-

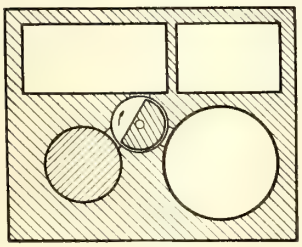


tions made monthly and yearly in this country, perhaps there is nothing at this time of the year which interests us more than a fly-catcher—and especially an electric fly-catcher, for by its very cognomen it must be good. This electric fan device for catching flies provides a specially designed blade which acts when rotating at a high speed to produce a suction thru the horn or tunnel, and the flies are whirled around inside the fan casing into the blind vault, where they conveniently die a most horrible death.

Electric Heat Storer.

(No. 1,311,464 issued to Oskar Sælid.)

An electric heat storing device, in which the heat may be accumulated

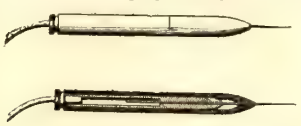


from an electric heating member or grid in a storing body placed in a chamber formed in a secure body of sealed "heat insulating" material. This is designed particularly to apply to electric heat-storing kitchen ranges. The heat generated electrically may be transferred thru special channels and a multiple heat valve to various heat-storing chambers. The heat may be conducted by metal members or by air-filled channels, as provided by the movement of the valve.

Electro-Surgical Needle.

(No. 1,311,494, issued to Ervin M. Camp.)

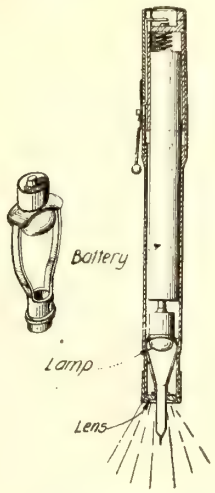
This electro-surgical needle is intended to provide a device of this kind, in which the electrically operated needle is provided with a grip chuck arranged to hold it positively in any desired position or adjustment. Further, the surgical needle is longitudinally adjustable in the gripping chuck, in such a manner as to project any distance.



Illuminated Pen or Pencil.

(No. 1,310,476, issued to Louis F. Hart.)

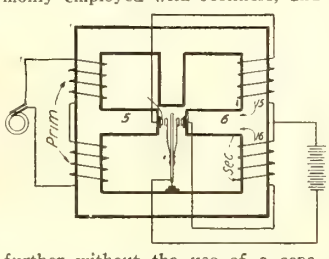
A novel writing instrument is here illustrated which may be in the form of a fountain pen or pencil. It is very cleverly designed, and incorporates a small incandescent electric lamp similar to a flash-light bulb, together with a small reflector lens and a tubular dry battery. There is also a clever cap switch for opening or closing the lamp circuit. The lamp bulb proper is mounted a short distance above the writing point in a special form of tripod as shown in the illustration; the light from the bulb flashing downward thru the lens having a hole thru its center to accommodate the pen or pencil point.



Vibrating Rectifier.

(No. 1,311,490, issued to Quincy A. Brackett.)

In the ordinary A.C. to D.C. vibrating rectifier, several of which have been on the market for an appreciable period of time, it is usual to provide two co-acting magnetic fluxes; one of these is uni-directional and the other alternating, the uni-directional flux being invariably supplied by a permanent magnet or from coils excited by auxiliary direct current. In the present design the inventor very cleverly arranges a special circuit for the rectifier, whereby he obtains both of these magnetic fluxes in a simple and yet effective manner, without the use of any windings except those of the ordinary transformer commonly employed with rectifiers, and

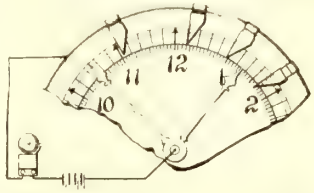


further without the use of a separate direct current exciting source. The alternate pulses of current in the two halves of the secondary winding will set up waves of magnetic flux, as indicated by the arrows 15 and 16, and these waves will consolidate to form a uni-directional magnetic flux thru the pole pieces 5 and 6, as becomes apparent. The vibrating reed will thus oscillate at synchronous speed and co-act with the uni-directional poles 5 and 6.

Electric Clock Alarm

(No. 1,311,424, issued to Benjamin H. M. Spargo.)

This electric clock alarm is devised with a number of adjustable contact

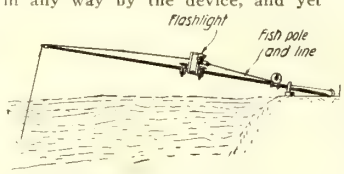


members, which may be arranged around the dial at any hour or fraction of an hour desired. One side of a bell and battery circuit is connected to the hands, while the other side connects to a metal member on which the contacts may be snapt into place. It is at once seen that the alarm may be arranged to ring as many times in the course of a day, as desired. This is often required in schools, offices, factories, etc.

Electric Fishing Signal.

(No. 1,309,365, issued to John E. Monighan.)

This invention comprises something which is of interest particularly to sportsmen and Nature-lovers during the warm months of the year. It comprises nothing else than the fisherman's rod, which supports a flashlight electric alarm for night fishing, so that the instant the fish bites on the hook and starts to unreel the line, the movement of the line thru a special trigger switch device on the flashlight holder, closes the circuit and the lamp flashes. Full details of the device are given in the patent and the action of the switch is simple and ingenious, permitting a line to be run out or wound up on the reel, without being interfered with in any way by the device, and yet

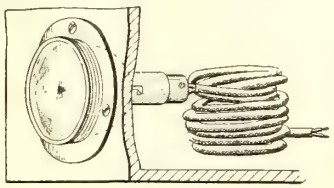


providing means for illuminating the flashlight whenever a fish bites.

Tonneau and Trouble Lamp.

(No. 1,311,295, issued to Jason C. Stearns.)

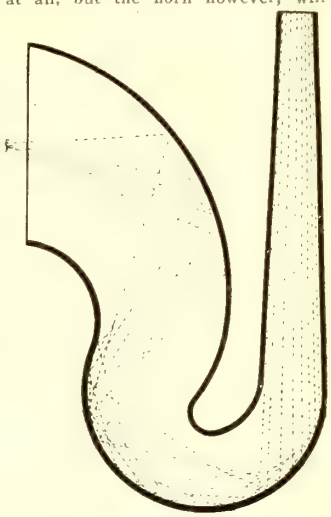
A useful and practical development in auto accessories, comprising an electric tonneau and trouble lamp, so constructed as to be capable of use in an efficient and convenient manner. The design of this lamp is carried out in such a manner that the lamp proper and its holder can be readily removed or replaced in its stationary receptacle on the auto dash or on the wall of a tonneau, etc. In order to do this, the inventor has provided a clever bayonet joint, by which the lamp is held rigidly in position when desired, or also easily and quickly removed, and when used as a portable trouble light, current is supplied to lamp thru a flexible duplex wire, which is normally coiled up in back of the lamp as the drawing shows.



Amplifying Horn.

(No. 1,311,478, issued to Russell A. Willson.)

A specially designed amplifying horn for use on phonographs and other similar instruments. The inventor claims that to give a clear-cut sound reproduction of a record, the horn must be so designed that each tone will be conveyed thru the horn so as to reach a certain focal point, after having travelled over approximately the "same distance" thru the horn, as have been travelled by other accompanying tones. In other words, the inventor states that the length of the sound waves or vibrations in the horn is the same. We do not agree with his theory at all, but the horn however, will

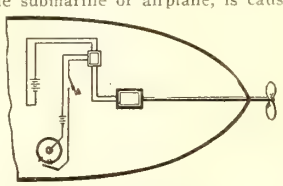


work in the usual manner in spite of it, if so we may express our idea of the matter. The inventor also mentions that the horn is designed rectangular in cross-section with diverging walls, while the outlet end of the amplifying portion is provided with parallel walls. Sound waves when conveyed thru a horn like this have a tendency to swirl or travel in a spiral direction giving inferior tone reproduction; the rectangular construction overcomes this by providing dead air spaces along the corners of the horn.

Submarine Signaling.

(No. 1,311,157, issued to Reginald A. Fessenden.)

This invention by Prof. Fessenden, relates to signaling by sound in a fluid media, such as water or air. It is also applicable to airplane signaling, and should prove particularly efficacious in sending out signals at night. The secret of this invention lies in the fact that either by means of automatic or key-operated electric switches, the electric circuit for driving the propeller on the submarine or airplane, is caused



to fluctuate a slight amount in its rotation. This need not be sufficient to cause the propeller to stop, but simply to cause a slight change in the humming note projected from the spinning propeller. The inventor states that he has tested this idea out under practical working conditions, and that slight variations in the notes are readily detected.



WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER— EDWARD H. COX

I PRESENT herewith four flashlight photos of my "Experimental Laboratory." In the first photo may be seen my electrical test-board, all controlled from the small switch-board observed in the upper left-hand corner of photo. This switch-board is so wired that I can obtain 1½ volts; 24 volts A. C. or 120 volts A. C. thru a rheostat of my own design. Also 1½; 24 or 120 volts D. C. thru a rheostat, all from the plug shown on bottom of the fiber switch-board panel. There is also shown my submarine chaser model which is undergoing repairs at present. In front of this is a small brass steam engine constructed entirely without any lathe work. On the right-hand side of photo may be seen my electric furnace and high frequency set. In the upper centre is shown a safe operated entirely by electricity.

One photo shows my "Chemical Laboratory," while a third photo shows my wireless set and "Yours Truly." I have a wood-turning lathe and jig-saw which are not shown.—Edward H. Cox, 9 Pierce Avenue, Hamburg, N. Y.

HONORABLE MENTION— ARMAND DE PICHON $2.00 PRIZE PAID EACH "HONORABLE MENTION"

AFTER seeing numerous photos of Amateur "Labs" publisht, I at last decided to send some photos of my own. In my chemical "Lab." I have Florence and Erlemeyer flasks, a retort, pestle and mortar, test tubes, microscope and other apparata. My radio receiving set consists of a loose coupler, two detectors, two sets of receivers, a 43-plate variable condenser, switch, fixt condenser and a test buzzer. I also have quite a number of transmitting instruments, including a helix, transformer, key, spark coil, spark gap, D.P.D.T. switch for sending and receiving, and a fuse block switch. Some of my apparata is home-made, and I intend to put up my sending set sometime in the future, or as soon as the ban on transmitting sets is lifted by Uncle Sam.

I am now fixing up a switch-board in my electrical "Lab.", and I will send you some more photos of it when completed.

I find much useful and interesting information in your magazine, which I read constantly. Armand de Pichon, 1100 Morton Street, Alameda, Calif.



Science in Slang

By EMERSON EASTERLING



"POWER'S off," remarked a passenger as our trolley car came to a dead stop in absolute darkness.

"While we are so conditioned," I remarked, "would you mind spilling us a little anointment in the line of electro-propelled vehicles and the like, and so forth?"

"Yes," he replied. "I was just dying to slip you the oil, anyhow."

"Yes," spoke up a stranger from Missouri, "let us all in on it. I have a brother that knows a street car conductor in Vancouver, Washington. He works for the North Coast Power Company on the car that walks out to the Standifer Steel Ship Yards."

"Well," commenced Jazz, lighting up a cigar—and also the entire car. Over in one corner a man and a woman—but that is another story. "It all started way back in 1835——"

"Say, partner," reproved the rather aged man with the ditto woman in the corner, "you don't need to insinuate."

"As I was saying," continued Stokes, "a bird by the name of Tom Davenport invented——"

"A couch!" broke in a furniture dealer absent-mindedly.

"A Yankee by the name of Davenport invented an apparatus, contraption, or contrivance that was able to live up to the name of primeval surface jolter.

"About the same time a Scotch Highlander (or Lowlander), Bobbie Davidson —no relation to Harley as far as known— tried out a trolley in the 'auld' country.

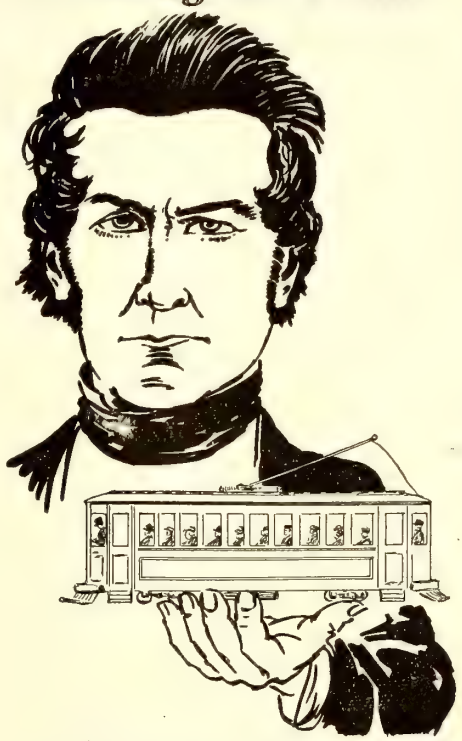
"In Washington, D. C., Prof. C. I. Page gave the public the sensation of seeing a real (almost) street car. That was way back in 1850.

"Moses G. Farmer stuck onto the public the first electro-bus with reduction gears from the motor—in spite of his name.

"But it was in Berlin that a couple of guys combined efforts and gave the grasping—or should I say yawning or reaching —world the pleasure of witnessing the first practical working model of life size—of the 'juice jerked' juggernaut. These ducks were Siemens and Halske. The same Siemens that is guilty for the early dynamos and motors that bear his John Hancock. No, not the one that met the pieman!

"From 1880 to 1883 Steve Fields and Tom Edison had a spat over patent rights, but finally they came to a settlement by forming a League of Notions; that is, they consolidated in the traffic jamming project. At the 'Chi' Railway Exhibition they showed off their first performance of their product and in a few years the people over the country were cautiously entering the moving houses and gripping to their seats and praying while the motorman did his best to 'keep things going' up in front.

Trucking the Traffic



A Yank by the Name of Tommie Davenport Invented an Apparatus, Contraption, or Contrivance, that was Able to Live Up to the Name of Primeval Surface Jolter.

"Kansas City was the first 'burg' to install an electric railway of any note. That was in '84. I don't know why that 'burg' should be first in the line any more than I know why it is one of the toughest towns in the States.

"The first line had the juice entering one rail and leaving the other. Then along come another model having the juice from double overhead trolleys, as in Kansas City. Another bird figgers out the third rail, and another the stunt of using the trolley and track, while still others carried the batteries aboard the municipal boxcar. Edison had a pretty fair example of the battery car.

"The original—and a lot of the subsequent—cars were put out with about the same horsepower as the present-day motorcycles. Think of it! They grew up to twenty horsepower, and then they *doubled* the power by furnishing both trucks with motors. The larger electrical interurban railways have ten times—and in some cases more than that—the power of the street cars."

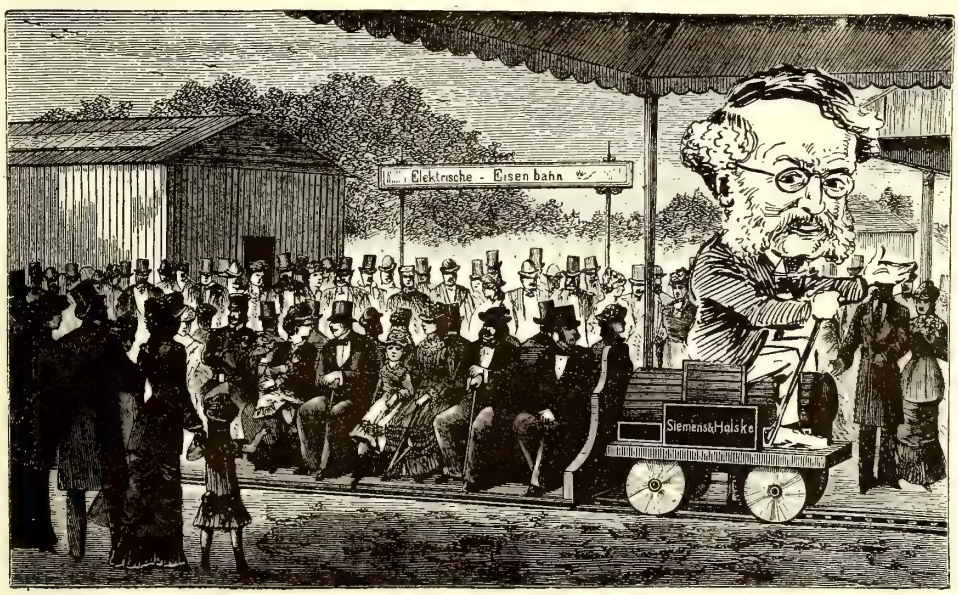
"How do these strings of cars that snake thru the ways work?" asked a voice next to me. "They have only one engineer on the front car."

"They employ what we call the multiple unit system of control. The cars are connected together by connections at the ends of each car. The motorman at the head car in controlling his own car operates the other ones automatically. The—but if I would explain the workings of a single unit you would probably get me better.

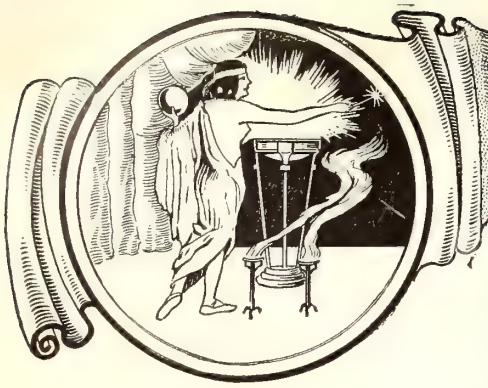
"On the simple or single unit the juice is handled by resistance and varied connections at the control panel that the motorman operates. On starting the resistance and all the separate (the field coils are arranged so as to be connected series or multiple, or both—that is, some series and others multiple) field coils are in series with each other, the resistance and the armature. To increase the speed the resistance is first thrown out, then the field is changed from series to series and multiple and then to multiple; then the armature is connected multiple, making the motor shunt wound instead of series. If you should look out the window at this point you find yourself jazzing right along under ideal conditions.

"To get back home without turning the car around the motorman straddles thru the car to the other end and jams his crank down on the controller and when the conductor gets one trolley arm down and the other up—or the same one yanked around —the connections are now so arranged that the armature is in a different relation with the field; that is, the different judicial flow renders the magnetic jerk on the armature around to another field pole instead of the one that it did before—the result: 'reversed motion.' Also there is a separate control in each end that makes it possible for the street car to be backed up without going thru the above actions. This makes it nice in the 'traffic jams,' as it avoids the necessity of the passengers getting out and pushing said car back to let the auto truck, go-cart, bicycle, ice wagon, widow with pack-

(*Continued on page* 558)



Herr Werner von Siemens of Berlin Gave the World the Pleasure of Witnessing the First Practical Working Model of a Life-Size "Juice Jerked" Juggernaut. Von Siemens, as Will Be Seen, Is at the Helm. The Dope, Elektrische-Eisenbahn, Means Electrical Railway. And Pipe the 1880 Style of Clothes and Lids.



THE ORACLE

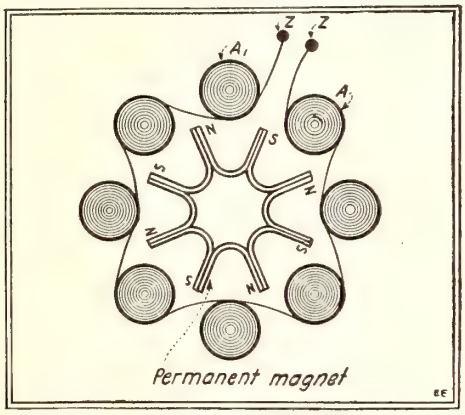
The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered. Your correct name and address must be signed.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

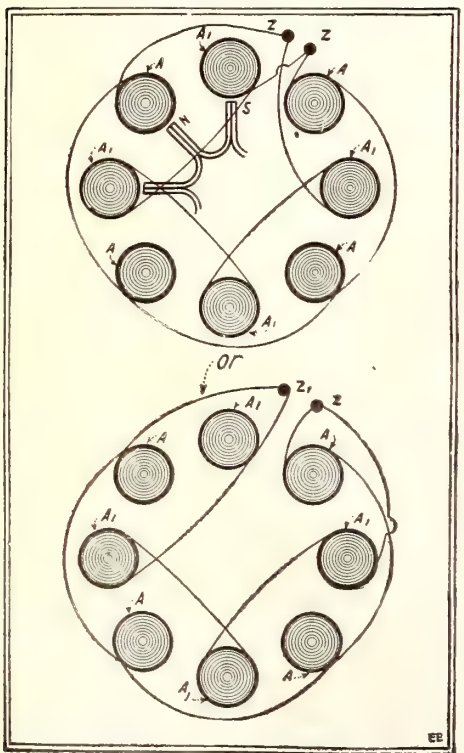
CHANGING THE FORD MAGNETO FROM A. C. TO D. C.

(1023) Rev. V. F. M., North Dakota, asks the "Oracle" several questions relative to converting the Ford auto magneto from A. C. to D. C.

A. 1. We have examined your diagram



Original Connections of Ford Magneto and Arrangement of Rotating Steel Magnets to Produce "Alternating" Current.



Two Proposed Re-connection Schemes for Ford Magnetos, in Order to Derive "Direct" Current. The Reason it Will Not Work as Anticipated Is Explained in the Accompanying Text.

and proposal for converting a Ford A. C. fly-wheel type magneto to a D. C. generator. We have looked over your diagrams carefully, but do not see that you will gain any such result by simply changing the connections and the coils, for the following reason. If you will take, for example, one of your diagrams where you have changed the windings so as to have two series of four poles each, and select a given pole, let us say, A, and note that the revolving steel magnets having alternate north and south poles, of course you will see that this coil will, for example, first be acted upon by a moving *north* pole—and then successively by a moving *south* pole, then by a *north* pole, etc., etc. This will mean, of course, that an *alternating current* will be set up in that particular coil, and in all the other coils so situated and acted upon in that circuit.

Your suggestion prompts the following discussion: Your idea would seem to be the same as trying to get direct current from a revolving field type of alternating current generator, without using a commutator. And here the same reasoning as just set forth comes into force, i. e., you must not forget that in any such case as this the *north* and *south* field magnet poles act alternately on each winding coil, pole or unit, many times per minute. Therefore you will get, as we always do get from a revolving field type of alternator, an *alternating current.* The simplest solution of the whole problem would appear to be to either rig up a commutator on the machine or else to use a D. C. dynamo, and this can be purchased for about $10.00. The Ford magneto, which is an A. C. type of course, owing to its fundamental design, is very rugged, simple and efficient, all things considered, as it only operates the lamps, and in some cases an electric siren, the A. C. current does the work in a thoroly efficient manner. Where a self-starter is fitted to a Ford, which is very exceptional in the Editor's observations, a storage battery is used for operating the starting motor, and this *same* motor is utilized as a charging dynamo by a simple relay arrangement, which changes the circuits for either requirements. The Ford A. C. magneto operates all right as a generator, but it would certainly work very poorly as a motor under any consideration.

TRAIN-DISPATCHING SELECTOR.

(1024) H. H. Gowan, Peterboro, Ont., Canada, writes:—

Q. 1. What book or manual is there available on the subject of train-dispatching selectors?

A. 1. Regarding the details of the "Selector" used on the Western Electric Railroad telephone dispatching system, would say that, so far as the Editor knows, there is no special book on the subject, but the best thing to do, as he has found, is to obtain copies of some of their patents which explain the matter fully. One of these patents which proves very interesting is U. S. Patent No. 1,244,544, which we can supply for 10c.

SPINTHARISCOPE.

(1025) Paul S. Howard, Okmulgee, Okla., asks:—

Q. 1. About construction of a home-made spinthariscope?

A. 1. The microscope by itself cannot be used as a radium spinthariscope. It is necessary to have radium or some radio-active material at one end of your magnifying tube in order to have a spinthariscope. The radio-active substance must be mixed with zinc sulfid or arranged just above a disc covered with the zinc sulfid. The alpha particles shooting off from the radium and colliding with the zinc sulfid is what gives the effect of the "shooting stars." This radio-active material may be secured from radium supply companies.

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OPTICAL PHOTOS—
Peculiar stunts obtained with various lens arrangements; odd film effects caused by unusual conditions; novel micro-photographic subjects.

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New eclipse photos; star and moon effects caught by the camera; comets; shooting stars; progressive moon studies; moon and star photos.

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Odd double and triple exposure effects; novel and striking effects due to unusual exposures.

MECHANICAL PHOTOS—
Electrical and Mechanical apparatus of unusual news interest.

RADIO PHOTOS—
New stations, both commercial, government, and private. Owners of private or amateur stations will find a special contest for these photos on another page of this issue.

And don't send us plate or film "negatives"; send unmounted or mounted "prints", preferably a light and dark one. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation.

Address photos to—Editor "Odd Photos", Electrical Experimenter, 233 Fulton Street, New York City.

Why Electrical Workers Are Needed.



Consider for a moment what part electricity plays in every-day life, in the comfort, convenience, pleasure and even health of the whole civilized world.

Think of having to ride in horse cars again—

of writing a letter every time you now phone—

of waiting days for what the telegraph does in a few minutes—

of no automobiles or moving picture shows—

Electricity takes millions to and from work. Without it the automobile and airplane would be impossible—the telephone and telegraph would be useless. All the civilized world relies on it for light, heat, transportation and communication. In a thousand ways electricity is used in factories, offices and in the homes.

Electricity is almost as essential as the air we breathe. Business would be almost at a standstill if deprived of its energy.

To say that electricity is still in its infancy is no exaggeration. Every day brings into practical use some new method of controlling it, some new device or appliance for using it. In industrial work there are still scores of operations where electricity will be utilized sooner or later. The day is coming when the railroads will entirely replace steam with electricity. Doctors, dentists and scientists are only beginning to realize the possibilities af electrical energy.

These facts merely touch the high spots, yet they prove beyond a doubt that electricity plays a vital part in business, in our individual lives, and that there is unlimited scope for those who make electricity their life work.

The electrical worker provides other men light to work by, the telephone and telegraph to convey their orders, the power to run their machines and transport their goods. He supplies power in the homes to operate washing machines, vacuum cleaners; for ironing, heating and ventilating. In short, it is the electrical worker who makes it possible for the world to live more comfortably, to enjoy more pleasures and to do a bigger, more profitable business.

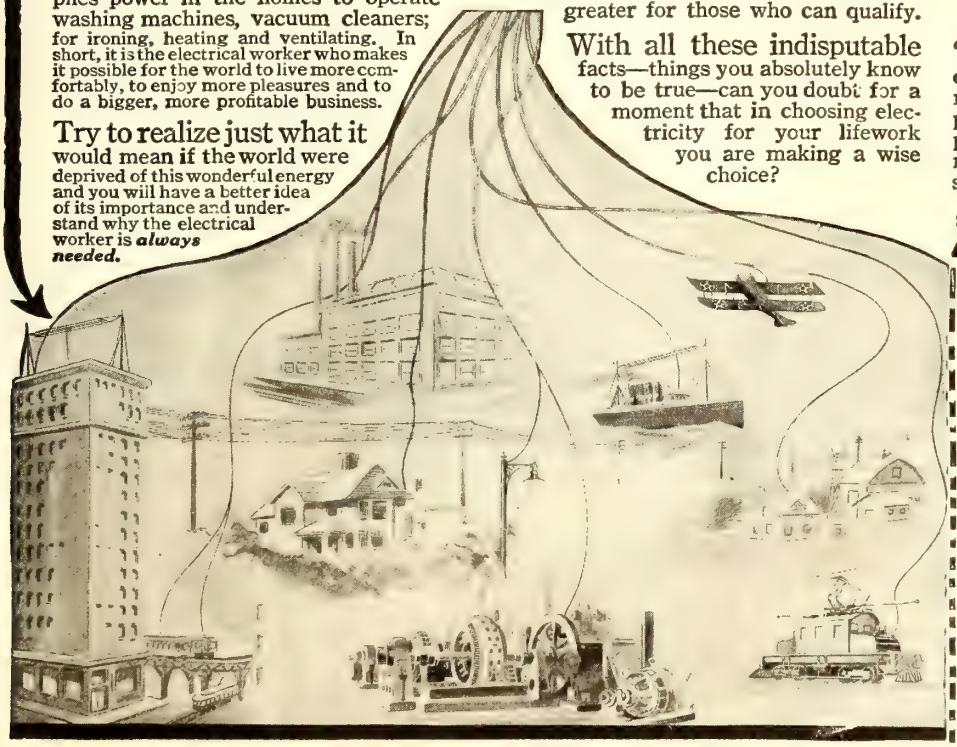
Try to realize just what it would mean if the world were deprived of this wonderful energy and you will have a better idea of its importance and understand why the electrical worker is ***always needed.***

What Electricity Offers You

Once you have mastered the A-B-C of electricity you are confronted with unlimited opportunities for advancement. You can specialize in extending and perfecting the wonders already accomplished in the field. You may take up those branches of electrical and mechanical work which cover the design and manufacture of electrical apparatus or start in to qualify for a well-paid position in the designing, construction, operating or consulting branches of the electrical engineering profession, and to fit yourself eventually for a position as Distribution, Operating, Testing, Erecting or Designing Engineer.

In the automobile, airplane, telephone and telegraph lines there is also great scope for the trained electrician. Many wonders of electricity have yet to be unfolded—its uses multiplied—and opportunities still greater for those who can qualify.

With all these indisputable facts—things you absolutely know to be true—can you doubt for a moment that in choosing electricity for your lifework you are making a wise choice?



How You Can Qualify

You don't have to interfere with your present work while qualifying for a good electrical position. The American School can give you just the training you need in your SPARE TIME. Our electrical courses have been specially prepared for home study—are written so you can understand everything quickly—and from your first lesson until you get your Diploma expert instructors coach you. Our training will enable you to get into the game RIGHT.

Read This Guarantee —Then Act

"We guarantee at any time during the first year of your enrollment to refund the entire amount paid if, immediately upon the completion of ten examinations, you notify the School that you are not satisfied with your course."

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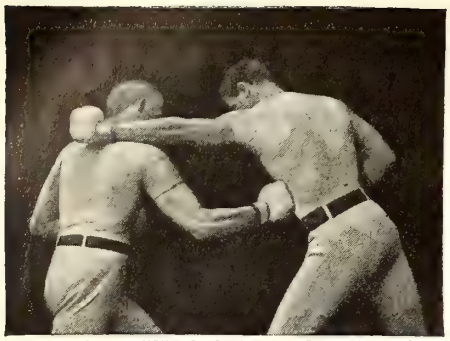
Please send me booklet and tell me how I can fit myself for the position marked X

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..Electric Light and Power Superintendent	..Airplane Mechanic
..Hydroelectric Engineer	..High School Course
..Wireless Operator	..Architect
..Mechanical Engineer	..Building Contractor
..Heating and Ventilating Engineer	..Lawyer
..Sanitary Engineer	..Business Manager
..Master Plumber	..Certified Pub. Acc'nt.
..Civil Engineer	..Accountant and Auditor
..Structural Engineer	..Bookkeeper
..Western Union Course	..Gen'l Education Course
..Telephone Engineer	..Com. School Branches
..Draftsman and Designer	..Fire Insurance Adjuster
..Automobile Engineer	..Shop Superintendent
	..Steam Engineer
	..Stenographer

Name.....

Address.....

.....



One pupil says, "It's the best money I ever invested. The lessons would be cheap at double the price."

Who wants to learn boxing?

Would you like to know how to protect yourself against a bully? To be able to outbox someone bigger than you? To know the eight most effective blows to use, and the best guards against violent attack, not only against blows, but kicks and wrestling holds? Do you know that you can learn these things easily and quickly by the new "shorthand" system of boxing instruction, the Marshall Stillman Method, making your daily exercise interesting as well as beneficial?

Marshall Stillman teaches boxing by science. By this new method he has taught a novice in 15 minutes the difficult scientific left hand lead. It often takes 20 lessons to learn it by the old method. In 40 minutes Marshall Stillman taught 46 new members of the New York State Guard the principles of the hit, guard, and duck. Boxing professors in the Army say that it took them weeks to teach a group those fundamentals by the old method.

This system is so simple that it is taught by mail. You learn the fundamentals right in front of your own mirror. When you face your first opponent, you know how to hit him, what to expect in return, and how to guard against it. Two weeks after receiving it pupils have been able to outbox bigger and stronger opponents. Even boys of 15 have learned to hit and to protect themselves. Men of 50 and 60 have taken it, not only to learn boxing, but for the interesting and beneficial daily exercise.

The new complete Home Study Edition is only $5—less than you would pay for a few lessons by the old method. Besides the 5 "shorthand" lessons on the hit, guard, duck, feinting and clinching and footwork with 25 illustrations, it includes one lesson on daily exercise, 8 illustrations; 3 rounds of shadow boxing, 8 bone-breaking holds and releases (Jiu Jitsu) and 8 holds in standing wrestling, with 69 illustrations; and a complimentary copy, specially bound for home study, of Mike Donovan's famous book "The Science of Boxing," including 70 illustrations.

Send no money

Frankly, you don't believe boxing can be taught by mail, do you? All right, we'll take you on your own ground—we will mail the complete course to you on 5-day approval. Use the coupon below.

Marshall Stillman Association, Suite E-10, No. 461 Fourth Ave., New York.

You may send me on free 5-day approval your new complete Home Study Course in Boxing, including 5 "Shorthand" or Sub-conscious Boxing Lessons, one lesson for daily exercise, 3 rounds of shadow boxing, 8 bone-breaking holds and releases, 8 holds in standing wrestling, and a complimentary copy of Mike Donovan's Book, "The Science of Boxing." I will either return the course or remit $5 in full payment within 5 days after its arrival.

Name.....

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"Piped Cold" — Prof. Bell Has It

(*Continued from page* 517)

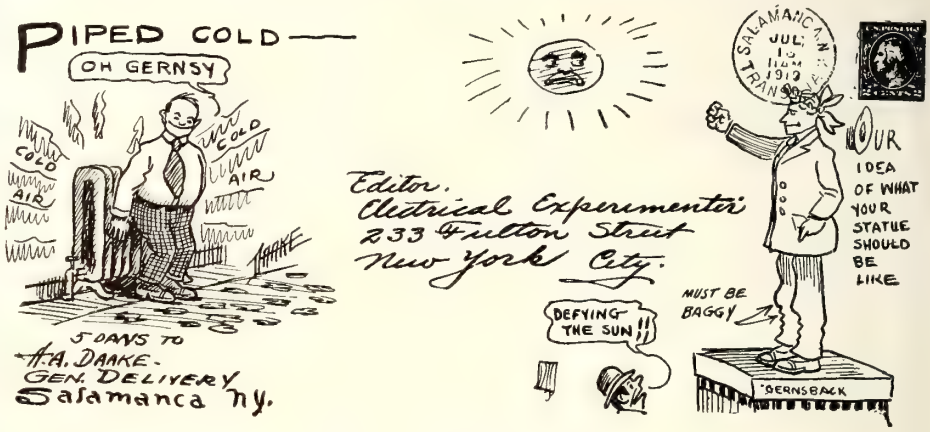
our radiators and pipes. But we prefer not only to let our babies and our feeble old folk die unnecessarily every summer, but we actually lose untold millions of dollars thru non-production when the "dog-days" are upon us. No one can work at his best when the mercury climbs to dizzy heights. Production, whether mental or physical, slows down anywhere between forty and eighty per cent. Statistics prove it. Factories as well as offices slow down and just barely creep along. Think of this enormous, incalculable loss alone, not to mention all the physical suffering due to the heat.

Ah, yes, we *do* have our brave fans—which, however, do not cool at all, but only remind us how hot our bodies are the minute we are not in the immediate vicinity of one of these spinning monuments to our stupidity.

For our dear fans only stir up the hot air *and* the dust. Our skin, wet or moist from perspiration, meets this stirred up air and due to a well-known physical phenomenon, *surface evaporation,* we experience a *sense of coolness,* but the air itself is *not* cooled. It is true that surface evaporation produces cold, but in order to have it, it is necessary to let the fans blow upon us, or nearly so, and everyone knows this is far from healthy, frequently producing severe colds. Besides, as soon as we leave the fan our suffering from the heat is all the more acute.

Where is the practical genius who will "study up" on refrigeration and sell us a cheap refrigerating machine which we can connect to our already existing steam or hot water radiators? For the same money which we now spend on fans we ought to be able to buy the machine. And for the money it costs to run the fans we can run the refrigerator, too.

Hundreds of refrigerators have been invented, but the simplest and best no doubt for our purpose is the *cold-air process.* It is based on the principle that the compression of air generates heat and in its subsequent expansion absorbs heat. The air is first comprest, is then past thru a cooler under pressure, after which it is expanded in a cylinder. No chemicals are used with this system and it possesses the very distinct advantage that extremely low temperatures are readily obtainable.



What H. A. Daake, of Salamanca, N. Y., Thought of Mr. Gernsback's Editorial "Piped Cold."

My Inventions

By Nikola Tesla

(*Continued from page* 508)

receiver. The higher the terminal and the greater the space encompast by the wires, the more pronounced is the effect, but it must be understood that it is purely local and has little to do with the real trouble. In 1900, while perfecting my wireless system, one form of apparatus comprised four antennae. These were carefully calibrated to the same frequency and connected in multiple with the object of magnifying the action, in receiving from any direction. When I desired to ascertain the origin of the transmitted impulses, each diagonally situated pair was put in series with a primary coil energizing the detector circuit. In the former case the sound was loud in the telephone; in the latter it ceased, as expected, the two antennae neutralizing each other, but the true statics manifested themselves in both instances and I had to devise special preventives embodying different principles.

The Remedy for Static.

By employing receivers connected to two points of the ground, as suggested by me long ago, this trouble caused by the charged air, which is very serious in the structures as now built, is nullified and besides, the liability of all kinds of interference is reduced to about one-half, because of the directional character of the circuit. This was perfectly self-evident, but came as a revelation to some simple-minded wireless folks whose experience was confined to forms of apparatus that could have been improved with an axe, and they have been disposing of the bear's skin before killing him. If it were true that strays performed such antics, it would be easy to get rid of them by receiving without aerials. But, as a matter of fact, a wire buried in the ground which, conforming to this view, should be absolutely immune, is more susceptible to certain extraneous impulses than one placed vertically in the air. To state it fairly, a slight progress has been made, but not by virtue of any particular

(*Continued on page* 552)



Be a Draftsman
Raise Your Income

Get into this paying profession and have positions opened to you by manufacturers, architects, railroads, contractors—by every kind of a corporation where mechanical design and construction are carried out. Draftsmanship puts you in the class of specialists, raises you above the crowd of job hunters, makes you a man whose services are needed.

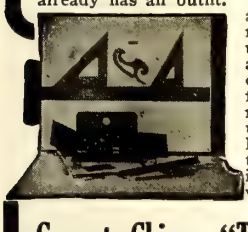
You have the same opportunity to get the training that other men had who took the Chicago "Tech" Course in Draftsmanship and are now drawing large salaries and holding important, responsible positions. You also can learn how to earn

$25 to $100 a Week

Not enough really skilled draftsmen are available to fill the places open now. All you need is training to be prepared to answer the call that will mean more money for you. Begin your training without delay. Don't waste time waiting. The Chicago "Tech" experts are ready today to give you the thorough, practical instruction which will enable you to step into the drafting room of some big organization prepared to do the kind of work that earns high salaries and leads to advancement. At least write. Mail the coupon below or a letter stating which branch specially interests you.

Drawing Outfit
(No Extra Charge)

Every student of the Chicago "Tech" Home Study Course in Draftsmanship receives this drawing outfit—set of instruments in case, drawing board, T square, triangles, scale, curve, drawing paper, pencils, etc. or a cash credit in case he already has an outfit. These instruments are of the same make and sizes as used by high salaried experts in drafting rooms of factories, shops, railroads, etc. You use them while learning — then take them right into your practical work.



Come to Chicago "Tech" OR TRAIN AT HOME

Chicago "Tech" has its students everywhere. If you can't come to Chicago, take the Home Study course. The same professors who direct the resident courses will teach you by mail. You will have their personal direction, you will learn the most modern methods—all this while holding your present job. We train hundreds of ambitious men—and see them quickly rise to success. You therefore need not be denied this technical education. Sign and mail the coupon.

Get Practical Training from Practical Men

NO TIME PUT IN ON NEEDLESS STUDIES

Enrollment with Chicago "Tech" means getting direct personal instruction from men who for years have planned and directed big architectural and engineering work in leading cities. They have weeded out useless theories and needless studies and will give you the kind of instruction which will enable you to work beside the most experienced men.

That is one reason why you can get a complete, thorough technical training here in such a short time. Also the reason why Chicago "Tech" men are in such great demand. They go into work prepared to give the kind of service wanted.

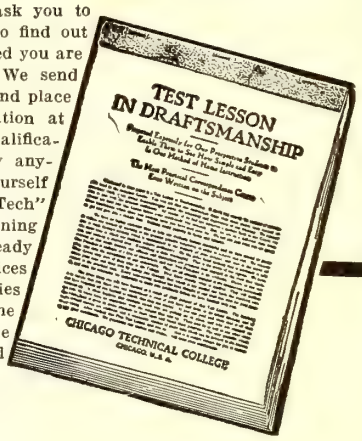
This is the training you are offered either at the college or by mail. And this is the time to enroll when there is such a pressing need for highly trained draftsmen. Use your spare hours to fit yourself for a bigger salary—a more important position. Chicago "Tech" offers you the opportunity. **WRITE.**

EASY PAYMENTS

Low tuition fees and easy terms of payment. Pay as you go along. Get training which will soon repay in extra earnings all the cost of the course. You know the salaries received by skilled technical men today. Get information on the opportunities which are opened wide to you by Chicago "Tech". We will give you all this information about fees, terms, etc., and send testimonials from Chicago "Tech" graduates on how they have profited from our instruction, if you will send the coupon.

FREE TEST LESSON

Other institutions ask you to pay first—and then to find out later how well qualified you are for this profession. We send the free lesson first and place you under no obligation at all. Discover your qualifications before you pay anything. And see for yourself just what Chicago "Tech" offers you in training which will bring a ready market for your services and open opportunities which are closed to the untrained man. The coupon will bring all the facts about the course, the small fee, and the easy terms.



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All about automobile mechanism—its construction, operation and REPAIR—taught by mail. You train directly under the Chicago "Tech" automobile experts. Learn all about Principles of the Automobile, all about Gas Engines, Power Plants, Transmissions, Lubrication, Cooling, Batteries, Starting and Lighting Systems, etc.

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Most complete instruction in auto repair work. Equips you for high pay or to start a business. Big demand for trained repair men.

Aeronautics

Complete, practical instruction in Aeronautic Engineering. Every principle made clear. Construction of every type of machine fully explained. This course equips you for expert work. Get the catalog and information. Send coupon.

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Below we list our principal courses in Drafting and several others. Just mark X in the [ ] to show which course interests you and we will send catalog and information about that particular subject. If in doubt about yourself, tell us your ambitions and we will advise you. Sending this coupon may mark a turning point in your career. May lead to a larger measure of success than you have expected. We can train you as we have trained others. Send the coupon today.

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Boys! Win an Auto-Wheel

In This Interesting Contest

TO THE BOY who can think of the most interesting uses for the popular AUTO-WHEEL COASTER, for earning money and for play, we shall award one of our large models absolutely FREE. It's a mighty generous prize for a few minutes' work. And the following eleven valuable prizes will be given to those sending in the next best uses: **Camera, Camping Tent, Mess Kit, Scout Knife, Fleetwing Steering Sled, Compass, Ingersoll Watch, Axe, Bank, Electric Flashlight, Poncho.**

INFORMATION ABOUT CONTEST

1. Any boy or girl not over 15 years may compete.
2. Contest will be judged by three men well-known in the Boy Scout organization.
3. Write to Business Idea Dept., Buffalo Sled Co., for pamphlet explaining the Contest, and colored catalog telling all about Auto-Wheel.
4. At end of letter write names of three Coaster Wagon Dealers in your town. If any carry the Auto-Wheel put an "x" after name.

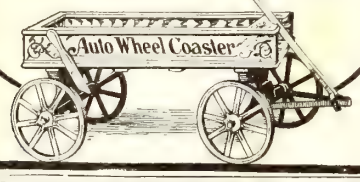
YOU CAN DO IT. Any live boy who knows how to get fun and earn money out of a good, strong coaster wagon, has a fine chance to get the Auto-Wheel as a prize. **Here are a few pointers:** The Auto-Wheel is a wagon for work or play. It's built for strength and speed. Has roller bearings, steel axles and tires, body white ash, maple gear.

If there's an Auto-Wheel dealer near you, he'll gladly let you see the Auto-Wheel Coaster in his store, and he'll give you some good ideas for your letter. CONTEST CLOSES NOVEMBER 30, 1919.

HERE'S YOUR CHANCE. GET BUSY.

Buffalo Sled Co.,
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ONLY $5.00
A MONTH PAYS FOR THIS SPLENDID DIAMOND RING

SPECIAL VALUE

SWEET'S Cluster; 7 fine Diamonds set in Platinum. Looks like $225 Solitaire.

Seven perfectly matched, blue-white Diamonds, skilfully mounted in Platinum to resemble one magnificent Solitaire. The Diamonds were selected for their perfect cut, their blue-white color, their superior quality and wonderful brilliancy, by one of our most skilful Diamond experts; together they look like one large, single stone. A most handsome and showy ring for the least amount of money.

SEND NO MONEY—we will send the ring, all charges prepaid—you are sure to be pleased. Pay only $12.50 on delivery—the balance in ten months; $5.00 EACH MONTH, until entire price, $62.50 has been paid.

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My Inventions

By Nikola Tesla

(*Continued from page* 550)

method or device. It was achieved simply by discarding the enormous structures, which are bad enough for transmission but wholly unsuitable for reception, and adopting a more appropriate type of receiver. As I pointed out in a previous article, to dispose of this difficulty for good, a radical change must be made in the system, and the sooner this is done the better.

Radio Government Control Not Wanted.

It would be calamitous, indeed, if at this time when the art is in its infancy and the vast majority, not excepting even experts, have no conception of its ultimate possibilities, a measure would be rushed through the legislature making it a government monopoly. This was proposed a few weeks ago by Secretary Daniels, and no doubt that distinguished official has made his appeal to the Senate and House of Representatives with sincere conviction. But universal evidence unmistakably shows that the best results are always obtained in healthful commercial competition. There are, however, exceptional reasons why wireless should be given the fullest freedom of development. In the first place it offers prospects immeasurably greater and more vital to betterment of human life than any other invention or discovery in the history of man. Then again, it must be understood that this wonderful art has been, in its entirety, evolved here and can be called "American" with more right and propriety than the telephone, the incandescent lamp or the aeroplane. Enterprising press agents and stock jobbers have been so successful in spreading misinformation that even so excellent a periodical as the *Scientific American* accords the chief credit to a foreign country. The Germans, of course, gave us the Hertz-waves and the Russian, English, French and Italian experts were quick in using them for signaling purposes. It was an obvious application of the new agent and accomplished with the old classical and unimproved induction coil—scarcely anything more than another kind of heliography. The radius of transmission was very limited, the results attained of little value, and the Hertz oscillations, as a means for conveying intelligence, could have been advantageously replaced by sound-waves, which I advocated in 1891. Moreover, all of these attempts were made three years after the basic principles of the wireless system, which is universally employed to-day, and its potent instrumentalities had been clearly described and developed in America. No trace of those Hertzian appliances and methods remains today. We have proceeded in the very opposite direction and what has been done is the product of the brains and efforts of citizens of this country. The fundamental patents have expired and the opportunities are open to all. The chief argument of the Secretary is based on interference. According to his statement, reported in the New York *Herald* of July 29th, signals from a powerful station can be intercepted in every village of the world. In view of this fact, which was demonstrated in my experiments of 1900, it would be of little use to impose restrictions in the United States.

America First.

As throwing light on this point, I may mention that only recently an odd looking gentleman called on me with the object of enlisting my services in the construction of world transmitters in some distant land. "We have no money," he said, "but carloads of solid gold and we will give you a liberal amount." I told him that I wanted to see first what will be done with my inventions in America, and this ended the interview. But I am satisfied that some dark forces are at work, and as time goes on the maintenance of continuous communication will be rendered more difficult. The only remedy is a system immune against interruption. It has been perfected, it exists, and all that is necessary is to put it in operation.

The terrible conflict is still uppermost in the minds and perhaps the greatest importance will be attached to the Magnifying Transmitter as a machine for attack and defense, more particularly in connection with *Telautomatics*. This invention is a logical outcome of observations begun in my boyhood and continued thruout my life. When the first results were publisht the *Electrical Review* stated editorially that it would become one of the "most potent factors in the advance and civilization of mankind." The time is not distant when this prediction will be fulfilled. In 1898 and 1900 it was offered to the Government and might have been adopted were I one of those who would go to Alexander's shepherd when they want a favor from Alexander. At that time I really thought that it would abolish war, because of its unlimited destructiveness and exclusion of the personal element of combat. But while I have not lost faith in its potentialities, my views have changed since.

The Road to Permanent Peace.

War can not be avoided until the physical cause for its recurrence is removed and this, in the last analysis, is the vast extent of the planet on which we live. Only thru annihilation of distance in every respect as, the conveyance of intelligence, transport of passengers and supplies and transmission of energy will conditions be brought about some day, insuring permanency of friendly relations. What we now want most is closer contact and better understanding between individuals and communities all over the earth, and the elimination of that fanatic devotion to exalted ideals of national egoism and pride which is always prone to plunge the world into primeval barbarism and strife. No league or parliamentary act of any kind will ever prevent such a calamity. These are only new devices for putting the weak at the mercy of the strong. I have exprest myself in this regard fourteen years ago, when a combination of a few leading governments—a sort of Holy Alliance—was advocated by the late Andrew Carnegie, who may be fairly considered as the father of this idea, having given to it more publicity and impetus than anybody else prior to the efforts of the President. While it can not be denied that such a pact might be of material advantage to some less fortunate peoples, it can not attain the chief object sought. Peace can only come as a natural consequence of universal enlightenment and merging of races, and we are still far from this blissful realization. As I view the world of today, in the light of the gigantic struggle we have witnest, I am filled with conviction that the interests of humanity would be best served if the United States remained true to its traditions and kept out of "entangling alliances." Situated as it is, geographically, remote from the theaters of impending conflicts, without incentive to territorial aggrandizement, with inexhaustible resources and immense population thoroly imbued with the spirit of liberty and right, this country is placed in a unique and privileged position. It is thus able to exert, independently, its colossal strength and moral force to the benefit of all, more judiciously and effectively, than as member of a league.

(*Continued on page* 554)



"The Job is Yours— on One Condition!"

"For a long time I watched the new men who came into this business. Some stood still—stayed right where they started. Others climbed—made each job a stepping stone to something better.

"Now, what was the difference? Well, I investigated and found out. The men who were getting ahead had been devoting part of their spare time to study along the line of their work. Our treasurer used to be a bookkeeper. The factory superintendent was working at a bench in the shop a few years ago. The sales manager started in a branch office up state. The chief designer rose from the bottom in the drafting room.

"All of these men won their advancements through spare time study with the International Correspondence Schools. Today they are earning four or five times—yes, some of them *ten* times as much money as when they came with us.

"So out of this experience we have formed a policy. We are looking for men who care enough about their future not only to do their present work well, but to devote part of their spare time to preparation for advancement.

"And I'll give you this job on one condition—that you take up a course of special training along the line of your work. Let the I. C. S. help you for one hour after supper each night and your future in this business will take care of itself."

Employers are begging for men with ambition, men who really want to get ahead in the world and are willing to prove it by training themselves in spare time to do some one thing well.

Prove that you are that kind of a man! The International Correspondence Schools are ready and anxious to help you prepare for advancement in the work of your choice, whatever it may be. More than two million men and women in the last 28 years have taken the I. C. S. route to more money. Over 100,000 others are getting ready in the same way right now. Surely the least you can do is to find out what there is in this proposition for *you*. Here is all we ask: Without cost, without obligating yourself in any way, simply mark and mail this coupon.

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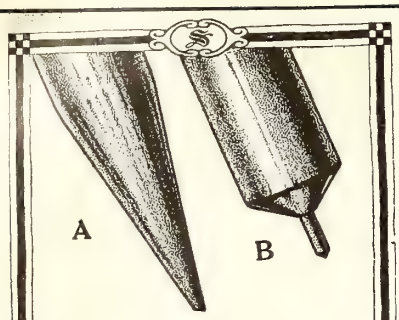
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- ☐ Electric Wiring
- ☐ Electric Lighting
- ☐ Electric Car Running
- ☐ Heavy Electric Traction
- ☐ Electrical Draftsman
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My Inventions

By Nikola Tesla

(*Continued from page* 552)

The Mechanistic Theory of Life.

In one of these biographical sketches, published in the ELECTRICAL EXPERIMENTER, I have dwelt on the circumstances of my early life and told of an affliction which compelled me to unremitting exercise of imagination and self-observation. This mental activity, at first involuntary under the pressure of illness and suffering, gradually became second nature and led me finally to recognize that I was but an automaton devoid of free will in thought and action and merely responsive to the forces of the environment. Our bodies are of such complexity of structure, the motions we perform are so numerous and involved, and the external impressions on our sense organs to such a degree delicate and elusive that it is hard for the average person to grasp this fact. And yet nothing is more convincing to the trained investigator than the mechanistic theory of life which had been, in a measure, understood and propounded by Descartes three hundred years ago. But in his time many important functions of our organism were unknown and, especially with respect to the nature of light and the construction and operation of the eye, philosophers were in the dark. In recent years the progress of scientific research in these fields has been such as to leave no room for a doubt in regard to this view on which many works have been published. One of its ablest and most eloquent exponents is, perhaps, Felix Le Dantec, formerly assistant of Pasteur. Prof. Jacques Loeb has performed remarkable experiments in heliotropism, clearly establishing the controlling power of light in lower forms of organisms, and his latest book, "Forced Movements," is revelatory. But while men of science accept this theory simply as any other that is recognized, to me it is a truth which I hourly demonstrate by every act and thought of mine. The consciousness of the external impression prompting me to any kind of exertion, physical or mental, is ever present in my mind. Only on very rare occasions, when I was in a state of exceptional concentration, have I found difficulty in locating the original impulses.

Lack of Observation a Form of Ignorance.

The by far greater number of human beings are never aware of what is passing around and within them, and millions fall victims of disease and die prematurely just on this account. The commonest, every-day occurrences appear to them mysterious and inexplicable. One may feel a sudden wave of sadness and rake his brain for an explanation when he might have noticed that it was caused by a cloud cutting off the rays of the sun. He may see the image of a friend dear to him under conditions which he construes as very peculiar, when only shortly before he has passed him in the street or seen his photograph somewhere. When he loses a collar button he fusses and swears for an hour, being unable to visualize his previous actions and locate the object directly. Deficient observation is merely a form of ignorance and responsible for the many morbid notions and foolish ideas prevailing. There is not more than one out of every ten persons who does not believe in telepathy and other psychic manifestations, spiritualism and communion with the dead, and who would refuse to listen to willing or unwilling deceivers. Just to illustrate how deeply rooted this tendency has become even among the clear-headed American population, I may mention a comical incident.

Psychic Phenomena in the Manufacture of Flivvers.

Shortly before the war, when the exhibition of my turbines in this city elicited widespread comment in the technical papers, I anticipated that there would be a scramble among manufacturers to get hold of the invention, and I had particular designs on that man from Detroit who has an uncanny faculty for accumulating millions. So confident was I that he would turn up some day, that I declared this as certain to my secretary and assistants. Sure enough, one fine morning a body of engineers from the Ford Motor Company presented themselves with the request of discussing with me an important project. "Didn't I tell you?" I remarked triumphantly to my employees, and one of them said, "You are amazing, Mr. Tesla; everything comes out exactly as you predict." As soon as these hard-headed men were seated I, of course, immediately began to extol the wonderful features of my turbine, when the spokesmen interrupted me and said, "We know all about this, but we are on a special errand. We have formed a psychological society for the investigation of psychic phenomena and we want you to join us in this undertaking." I suppose those engineers never knew how near they came to being fired out of my office.

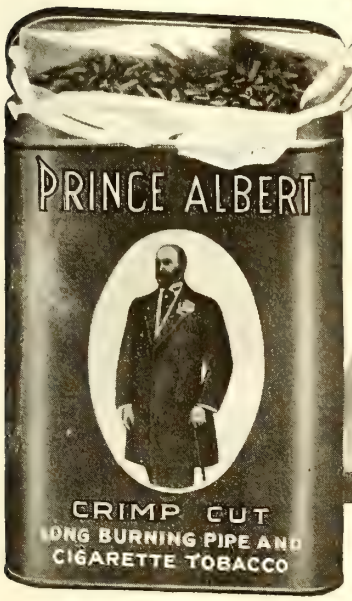
Confuting Spiritism.

Ever since I was told by some of the greatest men of the time, leaders in science whose names are immortal, that I am possesst of an unusual mind, I bent all my thinking faculties on the solution of great problems regardless of sacrifice. For many years I endeavored to solve the enigma of death, and watched eagerly for every kind of spiritual indication. But only once in the course of my existence have I had an experience which momentarily impressed me as supernatural. It was at the time of my mother's death. I had become completely exhausted by pain and long vigilance, and one night was carried to a building about two blocks from our home. As I lay helpless there, I thought that if my mother died while I was away from her bedside she would surely give me a sign. Two or three months before I was in London in company with my late friend, Sir William Crookes, when spiritualism was discussed, and I was under the full sway of these thoughts. I might not have paid attention to other men, but was susceptible to his arguments as it was his epochal work on radiant matter, which I had read as a student, that made me embrace the electrical career. I reflected that the conditions for a look into the beyond were most favorable, for my mother was a woman of genius and particularly excelling in the powers of intuition. During the whole night every fiber in my brain was strained in expectancy, but nothing happened until early in the morning, when I fell in a sleep, or perhaps a swoon, and saw a cloud carrying angelic figures of marvelous beauty, one of whom gazed upon me lovingly and gradually assumed the features of my mother. The appearance slowly floated across the room and vanished, and I was awakened by an indescribably sweet song of many voices. In that instant a certitude, which no words can express, came upon me that my mother had just died. And that was true. I was unable to understand the tremendous weight of the painful knowledge I received in advance, and wrote a letter to Sir William Crookes while still under the domination of these impressions and in poor bodily health. When I recovered I sought for a long time the ex-

(*Continued on page* 556)

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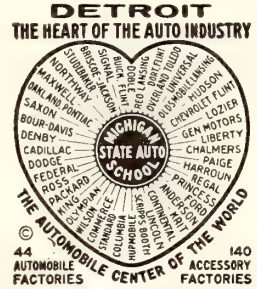
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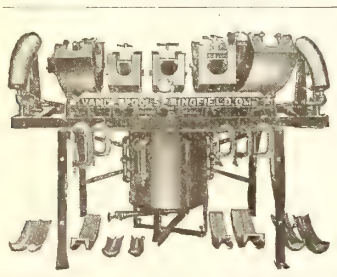
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My Inventions

By Nikola Tesla

(*Continued from page* 554)

ternal cause of this strange manifestation and, to my great relief, I succeeded after many months of fruitless effort. I had seen the painting of a celebrated artist, representing allegorically one of the seasons in the form of a cloud with a group of angels which seemed to actually float in the air, and this had struck me forcefully. It was exactly the same that appeared in my dream, with the exception of my mother's likeness. The music came from the choir in the church nearby at the early mass of Easter morning, explaining everything satisfactorily in conformity with scientific facts.

This occurred long ago, and I have never had the faintest reason since to change my views on psychical and spiritual phenomena, for which there is absolutely no foundation. The belief in these is the natural outgrowth of intellectual development. Religious dogmas are no longer accepted in their orthodox meaning, but every individual clings to faith in a supreme power of some kind. We all must have an ideal to govern our conduct and insure contentment, but it is immaterial whether it be one of creed, art, science or anything else, so long as it fulfills the function of a dematerializing force. It is essential to the peaceful existence of humanity as a whole that one common conception should prevail.

Tesla's Astounding Discovery.

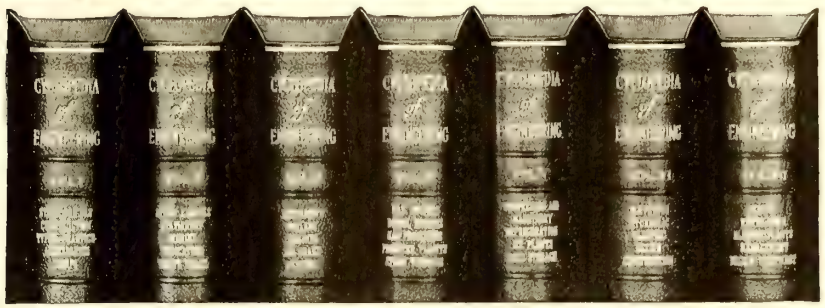
While I have failed to obtain any evidence in support of the contentions of psychologists and spiritualists, I have proved to my complete satisfaction the automatism of life, not only through continuous observations of individual actions, but even more conclusively through certain generalizations. These amount to a discovery which I consider of the greatest moment to human society, and on which I shall briefly dwell. I got the first inkling of this astounding truth when I was still a very young man, but for many years I interpreted what I noted simply as coincidences. Namely, whenever either myself or a person to whom I was attached, or a cause to which I was devoted, was hurt by others in a particular way, which might be best popularly characterized as the most unfair imaginable, I experienced a singular and undefinable pain which, for want of a better term, I have qualified as "cosmic," and shortly thereafter, and invariably, those who had inflicted it came to grief. After many such cases I confided this to a number of friends, who had the opportunity to convince themselves of the truth of the theory which I have gradually formulated and which may be stated in the following few words:

Our bodies are of similar construction and exposed to the same external influences. This results in likeness of response and concordance of the general activities on which all our social and other rules and laws are based. We are automata entirely controlled by the forces of the medium, being tossed about like corks on the surface of the water, but mistaking the resultant of the impulses from the outside for free will. The movements and other actions we perform are always life preservative and tho seemingly quite independent from one another, we are connected by invisible links. So long as the organism is in perfect order it responds accurately to the agents that prompt it, but the moment that there is some derangement in any individual, his self-preservative power is impaired. Everybody understands, of course, that if one becomes deaf, has his eyesight weakened, or his limbs injured, the chances for his continued existence are lessened. But

(*Continued on page* 600)







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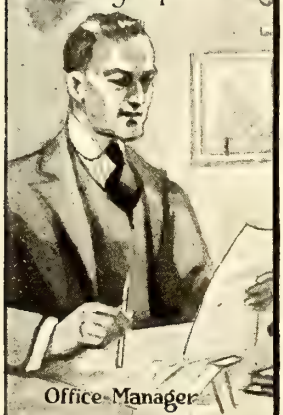
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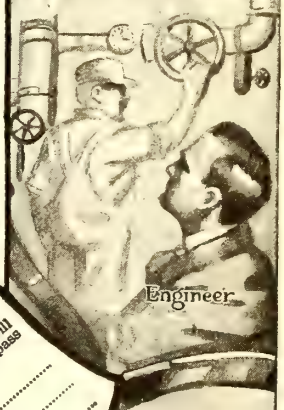
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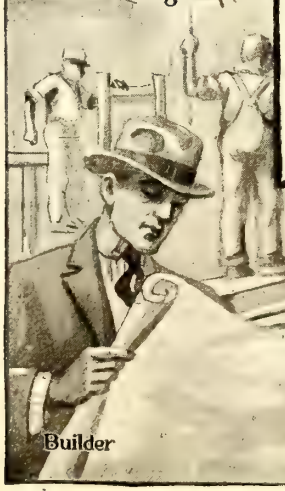
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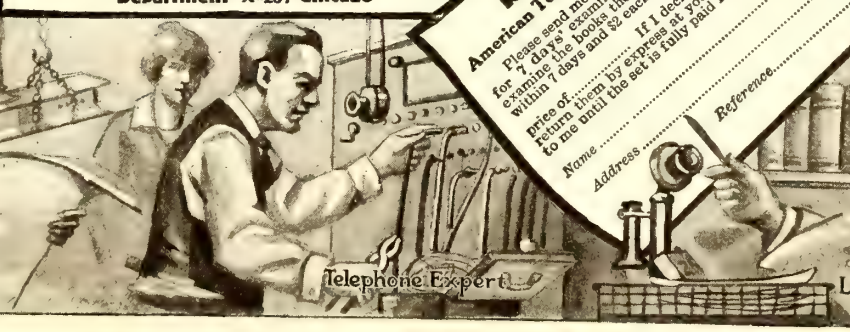
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Science in Slang

By Emerson Easterling

(*Continued from page* 547)

ages, baby buggy, and other objects ahead untangle and get on their way. And it always looks more graceful to see the cars running under their own power, too."

"How about the lights and heat in the cars?" spoke up a stranger. Then, after apparent thought, "Oh, of course it comes in like the power."

"Of course," replied Jazz.

Just then the power came on. The lights flashed up again. We were lighted as well



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as enlightened. (How do you get that way.)

Somehow I couldn't help looking around at the couple in the corner. They were gone. But some rice was left in the seat. I don't know whether they will have rice or eggs for breakfast, tho.

"Does it make much difference whether they use direct or alternating current for the cars?" I asked of Stokes.

"Not much," he answered back as he spit out of the window of the car, now in motion.

EDISON VS. SPRAGUE ON ELECTRIC RAILWAYS

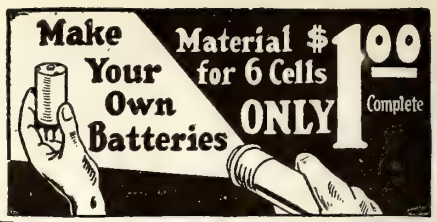
To the Editor of the New York Sun.

SIR: I have noticed in your paper of August 27, 1919, a communication from Frank J. Sprague in which he takes me to task for claiming in a recently published article the invention of the trolley car.

Mr. Sprague's principal contribution to the trolley car was the mechanical suspension of the electric motor to the truck. The motor itself was the modern reversible, low resistance, high efficiency, dynamo-motor devised and developed by me in working out the incandescent electric light system. This was already invented and at hand for Mr. Sprague to adopt to the conditions of a railway car truck. Neither he nor Siemens nor any one else could have succeeded in making a trolley system commercially practicable without this development.

A trolley car does not constitute a trolley system. A central current generation and distributing station and a complete system of conductors are absolute necessities. I had already spent years in their development for the incandescent electric light system and they were available to Mr. Sprague.

Mr. Sprague states also that he had great financial difficulties in introducing the trolley system into Richmond and carried it out largely by his personal credit. Perhaps he has forgotten that when his com-



Fresh Batteries—Easy to Make

In about 2 minutes you can make a better, fresher flashlight battery than you can buy—and you get full life of chemicals. Stronger light, 25% cheaper—400% more service in Make-UR-Own batteries. Fit 1½ x 6½ in. tubular flashlight case. Enough in outfit to last a year of ordinary use. Don't buy "dead" batteries—make your own. Satisfaction, or money-back guarantee.

Renewal Outfit—Parts and chemicals to make 6 cells complete.... **$1.00**

Marvel Flashlight Outfit—Flashlight case of fibre heavily nickel trimmed, Mazda lamp, complete with 6-cell Make-UR-Own battery outfit **$2.35**



In ordering give name and full address plainly written; mention amount enclosed and which outfit is desired.

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A pleasing, effective warning signal—clear, loud tone. Gets the right-of-way in dense traffic—prevents accidents. Replaces priming cup, or furnished with attachment for spark plug. Cannot get out of order—no wiring. Attach it yourself in a few minutes. Specify make of car. Order today. $2.50 complete.

$2.50 Complete AGENTS WANTED

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Build a high-grade talking machine with Acmephone motor, turn table, tone arm, reproducer, hinges, knobs—everything complete at only $11.85. Plays all records. Blueprints free with instructions. A $100 machine can be produced using these parts.

Blueprints only, 25c each.

Full set of working parts with instructions complete at only.. **$11.85**

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LUCKY 13 PHONOGRAPH COMPANY
Export Dept. 46B E. 12th St., N. Y., U.S.A.

pany was without funds and the Richmond project was in a serious situation, due to too much mathematics on the part of Mr. Sprague, I came forward and trusted his company for over $100,000 worth of apparatus and the aid of my men to pull the scheme thru.

What Mr. Sprague can really claim is that by his persistence and electrical knowledge he was the first one to start the trolley car system commercially. This is what I have always thought and publicly stated.

THOMAS A. EDISON.

Orange, N. J., September 3.

Treasure Ships Located Electrically

(*Continued from page* 512)

simple matter to locate the wreck. All the commander of his submarine will have to do is to cruise back and forth near the spot where the sunken vessel is supposed to lie. Sooner or later the faithful induction balance will find the wreck.

In our illustration it will be seen that the balances can be raised or lowered by means of winches on board the submarine. This is necessary because the submarine floats at a certain level. The depth of the ocean naturally varies more or less; if a deeper strata is encountered, the induction balances must be lowered further than in cruising in shallow water. Not only will the induction balance give us the exact spot where the ship is located, but it will also give us the exact location if the ship should be entirely covered with sand or silt.

The cost of an outfit of this kind is negligible, as such an under-water Hughes balance can be constructed for less than $100.

MEASUREMENTS OF WAVE-LENGTHS IN THE SPECTRUM OF NEON.

The lines in the neon spectrum are very sharp, a quality which recommends this gas as a standard source wherever the lines have sufficient strength. The ultra-violet group between 3369A and 3520A may be used for standards, and there are a few good infra-red lines, but the strength and distribution of the lines in the region 5852A to 7438A make the neon spectrum particularly useful as a comparison in this region, says the *Bureau of Standards* Bulletin.

The wave-lengths of fifty-five lines in the neon spectrum have been measured by means of the interferometer. These lines lie in the region of 3369A to 8495A. The strong lines in the visible region of the spectrum have been observed with great accuracy, the probable error being one part in several millions, or less than one-tenth the width of the line. These strong lines were observed by means of three different pairs of interferometer plates, which were each used on several interferometers. The ultra-violet lines and all the strong lines in the visible were compared directly with the fundamental standards 6438A. Some of the deep red and infra-red lines were compared with well-determined lines in the visible neon spectrum.

One hundred and eighty-nine faint lines in the visible and infra-red neon spectrum have been measured by means of a concave grating. The probable error of these grating measurements is one or two hundredths angstrom. The region covered by the grating observations extends from 5343A to 8783A.

The constant differences discovered by Watson are found to hold with remarkable exactness in the case of lines which are strong enough to be measured with the highest accuracy. In fact, the differences are exactly constant within the limits set by the accuracy of the wave-lengths.

Do Germs and Climate Cause CATARRH, Coughs and Colds?

By R. L. ALSAKER, M.D.



R. L. ALSAKER, M.D.

NOTE.—Dr. Alsaker is a successful practicing physician in one of the largest cities of the U. S.

Doctor Alsaker: I have had catarrh since boyhood, and now my two children have it. During the winter months my wife suffers with bad colds.

We have taken treatment from local physicians, using the medicines prescribed; we have used sprays and salves, but have derived no lasting benefit.

We live well, eating and drinking whatever we want, but we do not dissipate in any way. Our family physician tells us that catarrh is caused by germs. Another doctor told us to blame it on the climate. If germs and the climate are the cause of catarrh, I don't see how it can be prevented or even cured. What have you to say on the subject?

J. B. W.

THIS family is no exception. The majority have catarrh, either chronic or acute. Catarrh of the head is annoying—and filthy. In the throat it causes irritating coughs. When it is seated in the chest it is called bronchitis. If allowed to continue, the bronchitis becomes chronic and robs the individual of refreshing sleep, comfort and health. It weakens the lungs and paves the way for pneumonia and consumption.

Catarrh of the stomach and intestines points toward indigestion. So does catarrh of the liver, which produces various ills, such as jaundice and gall-stones, often ending in disagreeable and painful liver colic.

Catarrh sometimes causes earache, headache and other forms of pain, and it lays the foundation for many diseases.

This gentleman says that he lives well, but no one lives well who is ill. That is poor living. He can continue to eat what he likes, and grow healthy, if he will only learn how.

He thinks that germs and the climate are to blame, and as germs and climate are everywhere, we are helpless. It is a tragic fate, or would be, if it were true, for we can't escape the omnipresent germs and climate.

But neither germs nor the climate causes catarrh. Catarrh is due to improper eating—so are coughs and colds—and these conditions can be prevented and cured through right eating. And here is how it happens:

When people eat as they should *not,* they get indigestion, which fills the stomach and bowels with acids, gases and poisons; a part of these abnormal products are absorbed into the blood, which becomes very impure and the whole body gets acid. The blood tries to purify itself, and a lot of the waste attempts to escape by way of the mucous membrane. This causes irritation, and the result is colds and catarrhs.

The right kind of food, properly eaten, makes pure blood and produces health, vigor and strength. The right kind of food builds a sound body, puts catarrh, pimples and blotches to flight, and paints roses on the cheeks and makes life worth living.

Catarrh can be conquered quickly, surely and permanently. It has been done in thousands of cases. *If you have catarrh you have eaten your way to it.* You can cure yourself—you can eat your way out of catarrh into health, and while you are losing your catarrh you will rid yourself of other physical ills: The dirty tongue, that tired feeling, the bad taste in the mouth in the morning, the gas in the stomach and bowels, the headache and other aches, pains and disabilities will clear up and vanish. It is marvelous what proper eating will do, when other means fail. Don't take my word for it, but prove it in your own case and on your own person.

Catarrh is a luxury, not a necessity. Those who get it, can keep it indefinitely. They can also get rid of it and stay rid of it. Those who have catarrh should not complain about it, for they can easily get the knowledge that will show them how to get rid of catarrh and back to health.

Realizing the universal need of clearly defined instruction on the cause and cure of catarrh, coughs and colds, I have outlined in a small volume an attractive plan of living that has proved successful in curing and preventing these troublesome conditions. My instructions are easy to understand and pleasant to follow.

The plan shows how to live so as to have health at all times. It tells you in plain English the true cause of catarrh, and it gives you the true cure—a cure that works. There is nothing mysterious about it. You need not go to health resorts. You need not take drugs. It is simple, good, workable common sense that you can apply without expense *right in your own home.* The title of this book is, "CURING CATARRH, COUGHS AND COLDS." Its price is considerably less than the usual charge for prescribing treatment—less than the usual charge for a patent "cure all" *that doesn't cure*—less than it would cost you to lose a day's pay on account of sickness—less than the cost of an evening at the theatre. In fact, its real value to you cannot be measured in dollars and cents.

Send only two dollars and ten cents to my publisher, Frank E. Morrison, Dept. 312, 1133 Broadway, New York, and get your copy of this book of instructions. Follow my complete plan of treatment for the cure of Catarrh and the prevention of colds, for one month; then if you are not entirely satisfied with the improvement in your health, return the book and your money will be refunded to you.

Remember this: If you want to free yourself of Catarrh you can do so. You have your choice of living right or living wrong. This book teaches you the truth and nothing but the truth. Get it.—

(*Continued on page* 560)

PUBLISHER'S ANNOUNCEMENT: R. L. Alsaker, M.D., is an eminent authority on the subject discussed in the above article. He has a large and constantly growing practice; his patients come from all corners of the globe and they learn from him how to get well and stay well. He has put the net results of his many years of professional experience with sick people into his writings and it is a real pleasure for me to recommend them, because I know from personal experience and observation that good results *always* follow an observance of his simple instructions. Don't risk another day's sickness. Send $2.10 for "Curing Catarrh, Coughs and Colds" and learn quickly how you can get back to health and happiness. Money returned if you follow instructions for one month and are not entirely satisfied with your improvement in health. FRANK E. MORRISON (Estab. 1889), PUBLISHER, Dept. 312, 1133 Broadway, New York.

•(*Continued from page* 559)

The Alsaker Way

The most remarkable cures known to man have been produced without the use of drugs in any form. Don't continue wasting money for pills, powders and potions. Stop trying to live, or make a living in violation of natural laws. Send $2.10 for any one of the following guides to health and learn how to feel well and vigorous all the time.

Book 1. "Curing Catarrh, Coughs, and Colds."

Dr. Alsaker tells you in simple English the true cause of Catarrh, and he gives you a true cure—a cure that works. He does not prescribe salves, sprays, drugs, nor medicines of any kind. This book costs no more than a single visit to your doctor, and less than you have paid for medicine that has not cured your trouble.

Book 2. "Getting Rid of Rheumatism."

You need not take drugs nor waters, nor have your teeth extracted to cure Rheumatism. Learn from this book the true cause of Rheumatism, and then follow instructions for the correct use of the foods you like, and you will get rid of your rheumatic pains and aches.

Book 3. "Dieting Diabetes and Bright's Disease."

Dr. Alsaker explains in this book the many causes of Diabetes and Bright's Disease, and tells how, when, and what to eat to regain health. He shows how a cure may be effected if a cure is possible, and how to prolong the life of those who cannot regain full health. This book would be cheap at $50.00.

Book 4. "Curing Constipation and Appendicitis."

Medicines will not cure Constipation. Constipation and Appendicitis are due to the wrong use of foods. Indigestion is generally the first stage, then Constipation, then Appendicitis. The cause and cure are fully explained in this book. Learn from it what to eat to overcome Constipation, and to prevent Indigestion and Appendicitis.

Book 5. "Conquering Consumption."

In this book Dr. Alsaker has explained the true cause of the disease, and how to overcome it in its early stages—without drugs, serums, or sanitariums. A complete, satisfactory, and successful treatment is given in this book. Sufferers have paid thousands of dollars for less valuable advice.

Book 6. "Curing Disease of Heart and Arteries."

It is generally believed that arteriosclerosis, high blood-pressure, apoplexy, and chronic heart disease cannot be cured. This is far from the truth. This book explains how those who suffer from these diseases can be made safe, and how many of them can make complete recovery even after they have been given up as incurable.

Book 7. "How to Cure Headaches."

A headache is an indication that something is wrong somewhere. There must be a cause, and that cause must be found and removed before permanent relief can be got. This book explains how to find the true cause, and how to prevent and cure headaches of all kinds.

Book 8. "How to Live on 3 Meals a Day."

This is a book of food facts, showing in a common sense way how to reduce the cost of good foods and increase the pleasure and profit of eating. It contains scores of balanced menus for the whole family.

Publisher's Personal Guarantee of Satisfaction or Money Refunded.

An investment in any of these books will pay **daily** dividends in health and happiness as long as you live. It will enable you to save many dollars that might otherwise be wasted on worthless and harmful "cure alls"—and that's the truth!

As soon as you receive your book, read every page thoughtfully. Then put its teachings into daily practice. Give **The Alsaker Way** an honest trial for 30 days. The plan is pleasant and practical to follow and you are sure to be satisfied with results. You take no chances in sending your money **today**, because if you are not satisfied after a 30 day trial you may return the book and I will refund your money. So send me $2.10 today for the book you need, and I will mail it, postpaid, the day your order is received.

Frank E. Morrison (Estab. 1889), Publisher,
Dept. 313, 1133 Broadway, New York.

The Submarine's Underwater Radio

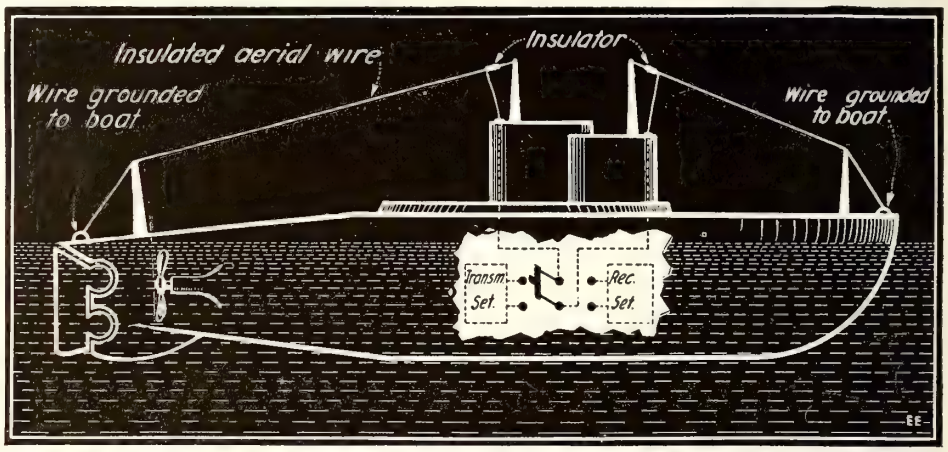
(*Continued from page* 539)

"Messrs. Willoughby and Lowell, of the Bureau of Standards, working for the Navy Department, have completed a series of experiments in transmitting and receiving radio signals on board submarines. Their results from using a single turn "loop" are very promising and incorporate the most complete data ever obtained in receiving and sending radio signals on board submarines."

Signals Received 6,000 Miles.

We are glad to have the opportunity of presenting herewith official report on the work in "Submarine Radio" conducted by Messrs. Willoughby and Lowell, of the Bureau of Standards, in coöperation with the Navy Department, at the submarine base at New London, Conn. In the tabulated results below we find one of the most remarkable wireless tests ever conducted—a submarine under water receiving signals from Nauen, Germany, *a distance of* 6,000 *miles*. The submarine was submerged eight feet during this particular test. We are indebted for this information to Dr.

(*Continued on page* 584)



The New Submarine Loop Antenna as Installed by the Radio Engineers Who Made the Tests Here Cited. The Receiving Record—6000 Miles.

"RECEPTION" RESULTS, ON BOARD SUBMARINE

Date 1918	Wave length in meters	Distance in miles	Power	Depths at which readable signals could be heard, measured from top of loop to surface of water
June 10	6000	200	100 k. w. undamped (Arlington)	16 ft.
June 11	9600	100	150 k. w. undamped (N. Brunswick)	21 ft.
June 11	9600	100	150 k. w. undamped (Tuckerton)	21 ft.
June 21	10000	3000	250 k. w. undamped (San Diego)	8 ft.
June 21	13000	6000	? undamped (Nauen, Germany)	8 ft.
June 21	2500	200	Arlington's Spark	8 ft.

"TRANSMISSION" RESULTS, ON BOARD SUBMARINE

Date	Wave Length in Meters	Actual Distance in Miles	Estimated Maximum Distance in Miles	Current in Amperes	Remarks
1918 Sept. 12	540	50	150	12	Submarines running full speed on surface in heavy sea.
Sept. 12	600	50	150	11	Submarines running full speed on surface in heavy sea.
Sept. 12	756	50	100	10	Submarines running full speed on surface in heavy sea.
Sept. 12	952	50	80	8	Submarines running full speed on surface in heavy sea.
Sept. 16	540	97	150	12	Submarine tied up at dock.

			Current in Amperes		
			Surface	Submerged	
Sept. 9	952	12	12	6	Submarine submerged running full speed with top of loop near surface.
Sept. 16	952	9	12	6	Submarine submerged and balanced so that top of loop was submerged a few inches.
Sept. 16	952	3	12	6	Submarine submerged and balanced with top of loop submerged 9 feet.



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Your enjoyment increases as you get to know Camels better. They return such generous cigarette satisfaction. Camels *certainly fit your taste* exactly as if they had *been made for it.*

Camels are unlike any cigarette you ever smoked. For instance, they leave no unpleasant cigaretty aftertaste or cigaretty odor. In fact Camels are in a class by themselves! That's why we ask you to *compare Camels with any cigarette in the world at any price!* You will not look for or expect premiums, coupons or gifts. *You'll prefer Camel quality!*

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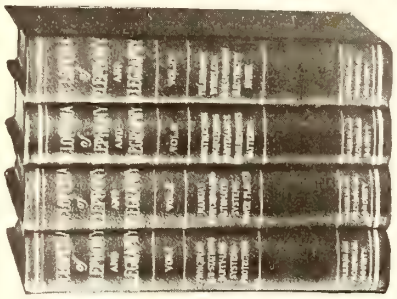
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American Technical Society
Dept. T 257 **Chicago, U. S. A**



American Technical Society, Dept T 257, Chicago

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Name.....

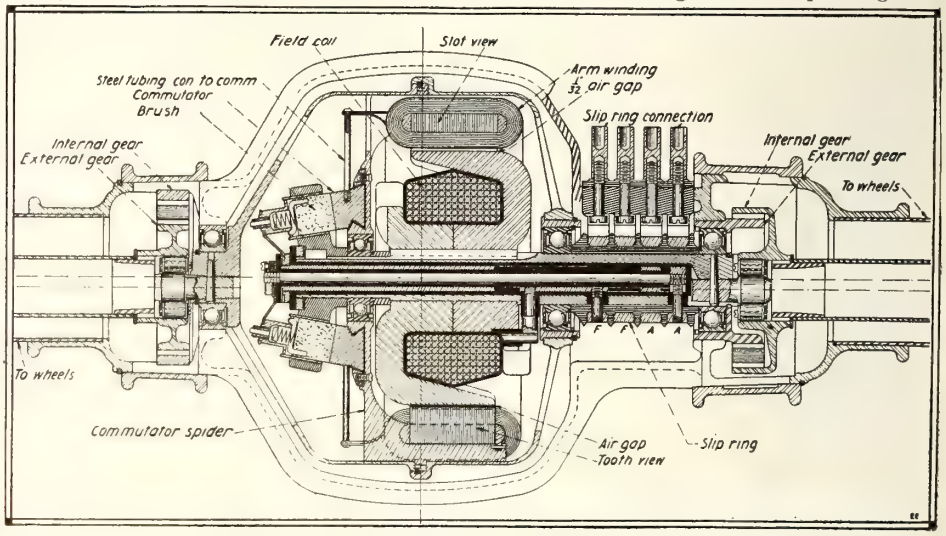
Address.....

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A New Era Electric Auto

(*Continued from page* 523)

charge. On this basis, for every pound weight saved in mechanical construction an additional pound can be saved in the battery weight; thus it can be truly said that "one pound saved is two pounds earned." The total weight of the rear axle, which includes the entire power plant, is approximately 100 pounds; which is several hundred pounds lighter than any other known to the writer; air springs will save 50 pounds; the wood frame with truss rods accounts for another 75 pounds. These savings are all duplicated in the battery weight, and are only a few of the many savings thruout the car that enables it to be produced at such record light weight, considering its size; but lightness begets lightness, and that is the whole secret.



Sectional View of the New "Dey" Electric Automobile Motor Which Has a Revolving Field as Well as Revolving Armature. This Motor Fits on the Rear Axle, Each Revolving Unit Driving One Wheel. No Differential Gear Is Necessary.

The inventor has largely increased the future field for his car by designing a *portable charging plant*, weighing only about 100 pounds, to be carried under the bonnet of the car. It comprises an exceptionally neat four-cylinder, four-cycle air-cooled engine, minus its flywheel; it is direct connected to the ring armature of a dynamo very similar in design to the motor; its field, however, is stationary. The cylinders of the engine are made of steel tubing, the cooling flanges of which are machined on by rotating the cylinders before a gang of milling cutters that cuts all in one operation. The flanges being formed in this manner permits doubling or tripling the radiating surface, as compared with cast cylinders. There are a number of other special features about the cooling arrangements that should produce an exceptionally well cooled engine, even if we did not consider the small size; for it requires less than two horsepower to meet the power consumption requirements on the road. With this combination the mileage per gallon will be at least *twice that of a gas car;* due to the engine always running at its maximum efficiency load, while a gas car does not average one-tenth of its rating; making its efficiency very low, probably not one-tenth of its best. The experimental car, which weighed 400 pounds more than the commercial vehicle, will *consume less than two electrical horsepower when running at 23 miles per hour* on level dirt roads. Hills will not appreciably change the figures for an average, for there are as many downs as ups in a round trip, and unless a grade is steep enough to make a demand upon the brakes the excess force of gravity will be stored in the form of momentum; and in the Dey Electric the motor converts its braking power into electricity that is stored in the battery; so there is very little loss due to hills, regardless of how steep their grades.

This plant will charge the battery at any time, while the car is running or standing. An automatic device stops the engine and opens the charging connection whenever the battery becomes fully charged. The dynamo acts as a starter when charging is desired. If short runs are the rule, *the plant can be removed from the car and used as a stationary charging plant for both the car and a stationary battery for house lighting.* It is a simple matter to replace at any time for long-distance touring. With the generating outfit aboard one-half of the battery equipment can be dispensed with, thus making a net saving in the weight of the car exceeding 100 pounds. The cost of the plant will also be largely cancelled for the same reason. When ladies drive it will probably be mainly as a plain electric; there is nothing, however, to prevent them using the engine, for the turn of a switch will set it going with a pep not equaled by any self-starter. The operation will be as quiet as any automobile engine.

$1000.00 Reward! For a Single Word

Can you create the one word which will best denote the United States and all parts of Britannia? If so, you will be paid at the rate of $1,000 a word. The World Trade Club of San Francisco has offered $1,000.00 to the person who suggests the word which, in the judgment of the club's Metric Campaign Committee, is best adapted to world-wide use.

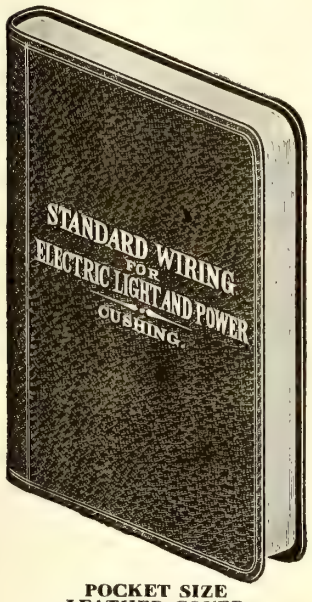
The competition is open to all humankind. The money will be paid to the winner at noon on the 15th of May, 1920, by a committee appointed by President W. H. Hammer of the World Trade Club.

"Brit-Am," "Ambria," Ambrittica," "Br-Am," "Sam-Bull" are some words thus far suggested. New names are constantly coming. The World Trade Club is offering this award because in carrying on its present compaign for the adoption of metric units by all English-speaking people—the United States, the British Isles, Canada, Australia, New Zealand, Tasmania, United South Africa, and so on—it was hampered by the lack of a single short word which would express all these.

The metric units of weight and measure are now used by all the world except "Brit-Am" or "Ambrittica," or "Sam-Bull."

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OUTSIDE WIRING—Pole line construction, line wires, service wires, roof structures, poles and their dimensions and weights, and how to erect and protect them and wires they carry. Insulators, guard arms, guy anchors. Tree wiring, splicing, service and entrance wiring. How to install Lightning arresters. Transformers with diagrams and instructions.

INSIDE WIRING—when and where to use rubber covered, slow burning and weatherproof wire. How to find the proper size of wire to use for lamps, motors or heating devices for any current, voltage and drop, either by formula or by the many tables that are given in this section of the book. How to wire for two-wire or three-wire systems. Direct current, two-phase and three-phase with formulae and tables, with examples worked out for each system and in a simple manner that anyone can understand and use. How to run wires on walls, ceilings, floors, through partitions and walls and in concealed places, damp places and where dangerous surroundings exist. When and where to install Switches, Cut-outs and Circuit Breakers and just how to do it. How to wire for high and low voltage systems and the precautions to be taken. The proper way to install Knife and Snap Switches, Cabinets and Cut-out Boxes, Outlet, Junction and Switch Boxes, Panel Boards, Wooden and Metal Raceways. How to install complete interior conduit jobs either for rigid metal, flexible metal or flexible non-metallic conduit. Concealed knob and tube work or armored cable. How and where to install and wire electric and combination lighting fixtures. How and where to use flexible cord and where not to use it. How to install arc lamps and gas filled lamps and the fixtures and rules required.

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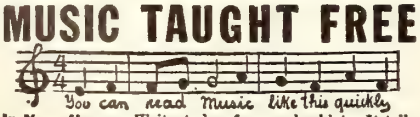
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(*Continued from page* 530)

both sides of the car are electric chime bells, which may be rung from conveniently placed push buttons, and the car is thoroly equipt with electric lights, both inside and out. Moreover, not only is this car used for pleasure purposes, but it is also used to economize on the High Cost of Living. The car is equipt with two small stoves on which the cooking is done, the fuel for the same amounting to about 10 cents per week. All cooking utensils are placed in a very tidy position, as neat as any housewife would care to have them. There is a collapsible bed, which can be stretched out and slept in with ease and comfort. This, too, is so arranged that a small tent, which is always carried, may be pitched in some open field on the road from here to "somewhere West," and the bed removed from the car and made use of in the tent. And talk about other comforts, you'll find the machine fitted with an electric fan and dozens of smaller items too numerous to mention, such as a clothes rack, medicine chest—in fact, anything which a small modern home can make use of. According to Mr. Hammel, the only thing that is lacking is a "wife."

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WAR IDEAS SENT U. S. FROM ALL OVER WORLD.

The latest war secret to leak out is how friendly inventors from all over the world gave to the United States their ideas for death-dealing machines for the destruction of Germany.

A companion secret is how all these ideas were kept from the enemy by the "seven serious sphinxes" of the Patent Office. This was a board of seven men, of unquestioned loyalty and sworn to secrecy, empowered to examine and withhold patents on war machines until the war was over and meanwhile turn ideas of promise over to the Government.

Among the spectacular inventions were the depth bomb, submarine signals, and devices for air photography. The committee approved a patent for the special leather for trench shoes, designed to resist the mud and water. It also approved a patent for special alloys for use in steel tools to turn out shells. Patents for wireless and aiming machine guns from airplanes were past upon.

More than 2,000 devices which it was thought might be of value to the United States or the Allies were past upon and 200 were important enough to get before military authorities. Some of them, it is said, helped win the war.

The ideas came from England, France, Switzerland, Hawaii, New Zealand, Australia, Mexico, Spain, Italy, Russia, Poland —*and one from Germany!* Of course, a larger number came from within the United States. Now that the war is over, the patents are being allowed.

Patent Commissioner Newton's committee included five who were West Point or Annapolis graduates, being Sidney Smith, A. E. Glascock, J. H. Colwell, F. W. Holt and F. C. Skinner. They were assisted by A. C. Lewers, chemist, and William J. Rich, metallurgist.

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31x4	8.00	2.25	35x5	12.50	3.50
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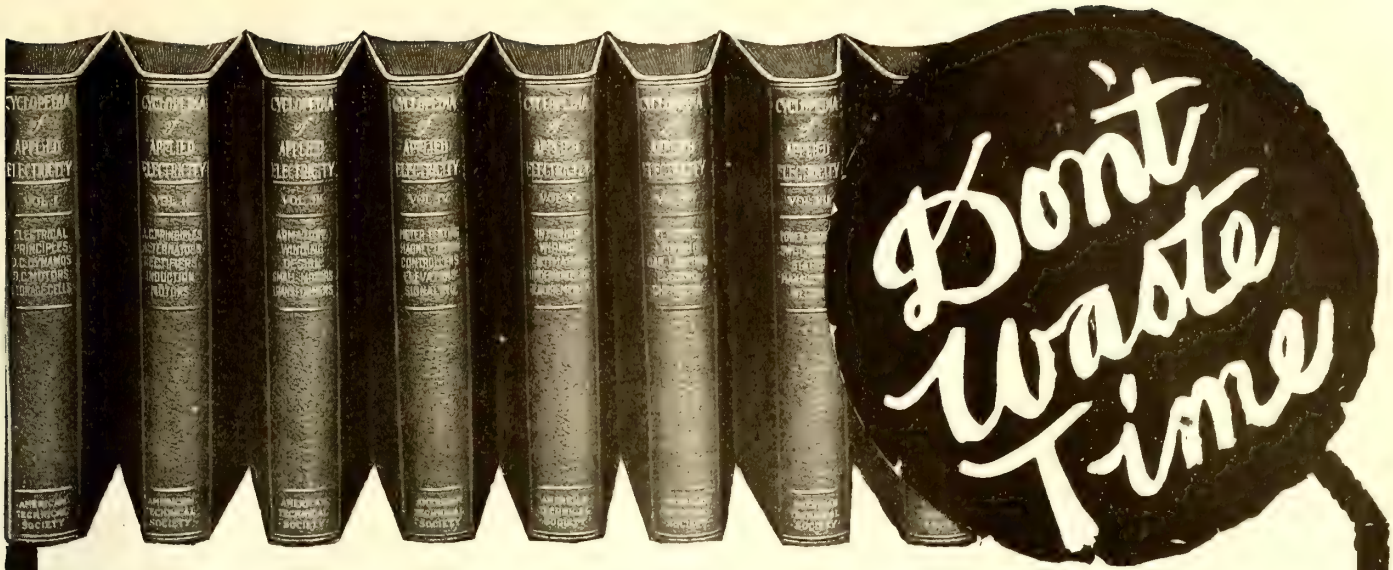
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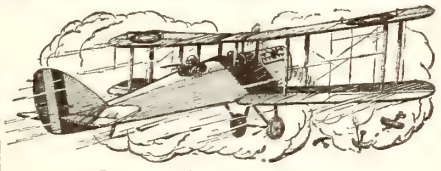
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PHOTO COURTESY CORRECTION.

We wish to make a correction in giving courtesy for the article entitled "NC Planes Had Electric Self Starters," which appeared on page 411 of the September issue, and which was credited to The Westinghouse Electric and Mfg. Co., in error. This credit should have been given to the General Electric Co., and the makers of the Liberty motor electric starter used on the NC planes in the trans-Atlantic flight to Europe, was the Bijur Motor Appliance Co.

Investigating "Psychical Phenomena With Scientific Instruments"

(*Continued from page* 521)

convinced of the reality of these phenomena,—was busy devising an instrument which would register and direct *psychic power* liberated from the body of a physical medium when in trance.

Dr. Imoda, the assistant of Professor Mosso, has also conducted a number of experiments in the discharge of an electroscope, by means of "rays" issuing from the medium's body. It was found that, if the medium held her fingers at a distance of an inch or so from the knob of the electroscope, some form of energy, apparently *radio-active* in character, issued from her fingers, and *gradually discharged the electroscope*. This is the "radiation" or "emanation" issuing from the body, which has been studied extensively by students of the occult. Dr. Imoda concluded—as the results of his experiments—that *"the radiations of radium, the cathode radiations of the Crookes' tube, and mediumistic radiations are fundamentally the same."*

Some other very interesting facts have been observed, by means of the electroscope. For example, Dr. W. J. Crawford (D.Sc.), in his experiments, noted that:—

". . . In séance rooms where tables are moved without physical contact, I found that after a sitting was well started, I was always *unable* to charge an electroscope, even tho I tried to do so in the corner of the chamber farthest from the medium. In order to charge it I had to take it outside the room. I asked the 'operators' (intelligences 'running things,' apparently, in the séance-room) if there was any 'power' in the séance-room so far away from the medium, and they answered in raps that there *was*. By 'power' I understand them to mean particles of matter taken from the medium . . ."

Again, in his "Reality of Psychic Phenomena," he says:—

"I took the electroscope to the table in the corner; then placed it in the circle near the medium. I asked the operators to touch the disc of the instrument very gently. They did this almost at once, the 'touching' consisting of a metallic scraping upon the brass disc, quite audible, similar in type to the imitation of the floor being rubbed with sand paper, a phenomenon I quite often observed. (*Continued on page* 571)

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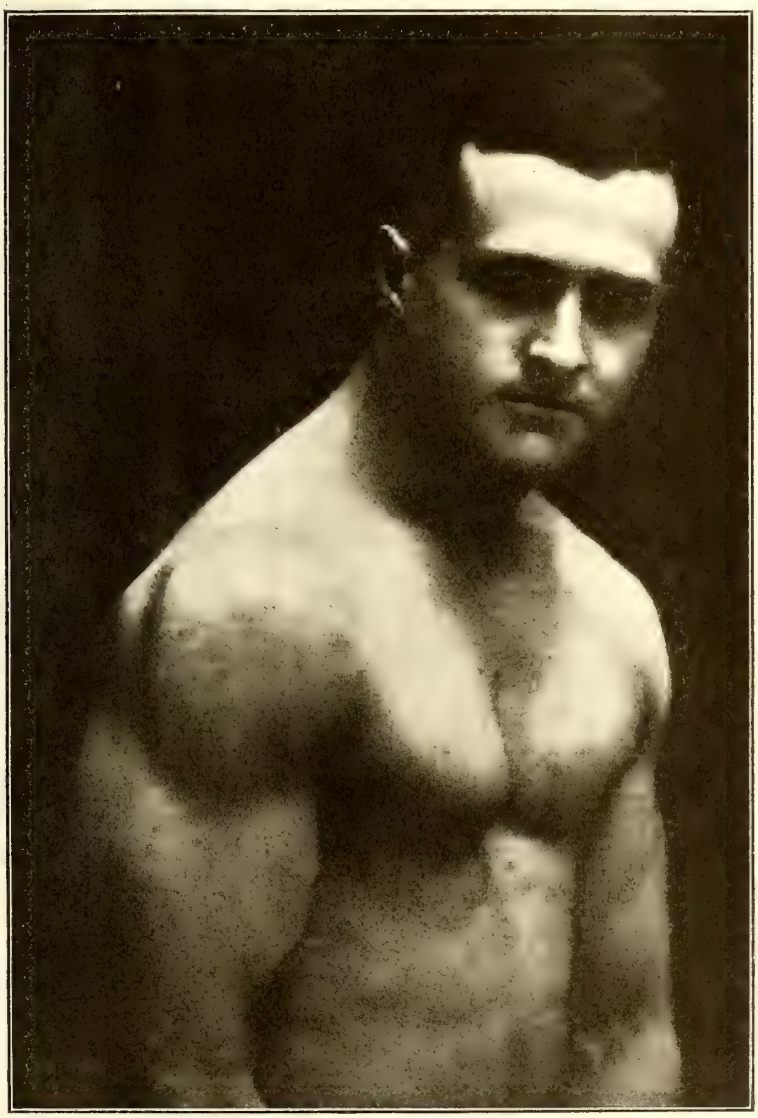
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Making a Machine for Telegraphing Pictures

By Leroy J. Leishman

(Continued from page 533)

or wires which are in turn connected with the shaft. E is a narrow piece of metal also connected with the shaft. F is a metal band much wider than E which extends around the cylinder from one side of E to the other, but does not touch E, as E and F must be insulated from each other. G, H, I, J and K are brushes. J touches both E and F as the cylinder revolves, but K touches F only. L and M are binding posts to which the wires are attached that come from the distant machine. N and O are the binding posts of the particular picture *transmitting* machine to which the synchronizer is attached. H and I are connected to two solenoids into which the horns of an iron rocker arm protrude. There is sufficient friction in the pivot of this rocker arm to keep it from turning excepting when the solenoids are energized. U is a rheostat with which a brush on the rocker arm makes contact. V is also a rheostat, and W is resistance in series with the motor. T represents the electro-magnets of a gravity relay, the arm of which rests against the stationary contact Z until T is energized, after which it rests against the contact Q. R, S, P is a two-way battery switch. X is a motor that is geared down to operate the picture transmission machine proper. The electrical connections are all shown in the diagram.

If this type of synchronizer is to be used, one must be made for both machines. The particular advantage of this type over all others which require no additional line wires lies in the fact that the cylinders are permitted to revolve continuously and are not stopt momentarily each time a revolution is made.

Now let us see how this synchronizer operates. With the arm of relay T against Q, we adjust the rheostat V so that the motors X of the sending and receiving machines run as nearly as possible in synchronism when the contact of the rocker arm is in the center of U. The synchronizer is now ready to operate.

Of course, we have not yet explained how a picture is prepared or transmitted, but you know that the needles on the carriage arms must be in contact with the cylinders. Until the machines are running in synchronism, we therefore do not let the needles rest on the pictures, as everything transmitted before synchronism is establisht would be distorted beyond recognition.

On the sending outfit put the arm of the gravity relay against Q, and put the two-way battery switch on S. The motor of the sending machine is now started, and by studying the diagram you will see that a circuit is completed every time B and E come in contact with G and J, respectively, causing an impulse to be sent over the wire once every revolution. Start the motor of the receiving machine with the relay arm against Z, and throw the battery switch to R. This motor is now going slightly slower than that of the other machine, because it is in series with the resistance W. The motor of the sender is not in series with its resistance, as its relay is against Q instead of Z. On account of the slower motion of the receiving cylinder, the brushes are on a different part of the circumference of the drum A each time the once-every-revolution impulse comes from the sending machine. The brushes H and I are therefore finally on C and D when this synchronizing impulse comes. This causes the current to go thru the solenoids and the relay T, the arm of which

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is pulled from Z to Q, thereby cutting out the motor resistance so that the motor will of its own accord run at the approximate speed of the motor on the sending apparatus.

The accurate synchronizing now goes on automatically. You will remember that the current to the resistance pieces C and D comes from metal strips on opposite sides. When the synchronizing impulse comes in, when H and I are in the exact centers of C and D, the currents in H and I are therefore equal. The solenoids also receive equal current and keep the rocker arm in the center of U, supplying the motor with a uniform amperage. If the receiving machine gets slightly behind or ahead of the sending machine, the brushes H and I will be slightly above or below center, and one brush will be nearer the metal strip which supplies the current to the resistance, and the other brush will be further away. One brush, therefore, carries more current than the other, and one solenoid will pull harder than its companion, causing the rocker arm to change its position on the rheostat U, thereby correcting the speed of the motor. The function of E, F and K is to distribute the current alternately to the synchronizer and the picture machine proper.

If this synchronizer seems too difficult or costly to make, the other synchronizer may be used or else the rod connection employed. In the latter case, your picture transmitting set will have been very easily and inexpensively constructed, and the degree of excellence of the received pictures will not be lessened in the least.

The machines are now ready to be adjusted. When sending, the needle in the carriage arm may have a play of as much as a quarter inch. It must at all times touch the cylinder, and should there be any sort of bulge in the rolled transmitting plate, this much play is necessary so that the bulge will not raise the needle beyond its play and throw the half nut on the bottom of the carriage out of mesh with the threads on the shaft. For receiving, the needle must be very delicately adjusted. It must rest on the cylinder when the magnets are not energized, and when raised up, it should be just high enough to clear the cylinder at all points on its circumference. The less upward and downward motion the needle has the faster it will operate and the better the pictures will be.

Extend a wire from one of the binding posts of one instrument to one of the binding posts of the other. The remaining posts must be connected to the batteries—preferably two dry cells. If the last explained synchronizer is used, these wiring directions may be considered to apply to the synchronizer binding posts instead.

TRANSMITTING PICTURES

Before transmitting *half-tones,* you can write or draw with shellac upon a thin metal plate and transmit this. After the shellac is dry, roll the plate into a cylinder and slip it over the cylinder of the machine you are going to use for transmitting. Place the edges at the top of the cylinder with the overlapping part of the cylinder toward the carriage, and if the plate is put on as explained the overlapping edge will not strike the needle and cause trouble. Put heavy rubber bands around the ends of the plate to hold it firmly against the cylinder.

RECEIVING THE PICTURES

To receive the picture, you will need a sheet of ordinary white paper and a piece of pen carbon paper. The carbon sheet goes on the cylinder face down around the white paper. If the rod connection or the first explained electric synchronizer is being used, be sure that the edges of the paper are placed at the top. If you are using the synchronizer which requires the extra cylinder or drum, the edges of the paper when placed on the picture cylinder should be in a straight line with the resistance pieces and the copper strip. This also



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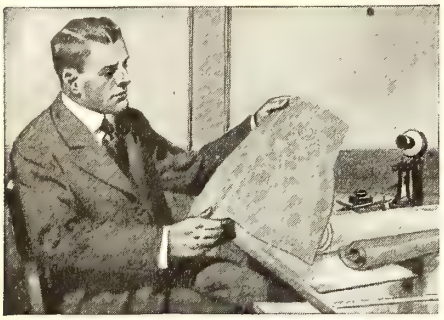
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applies to the copper sending cylinder. Overlap the ends of the paper toward the carriage, the same as you did with the plate. If you should carelessly overlap it the other way, the needle will catch the edge of the paper and tear it off. Be sure that the carbon sheet fits *tightly* against the white paper. Secure these to the cylinder with rubber bands.

Put the carriage at one end of the cylinders with the needle in contact with the same. Now place the switch on your sending instrument at the right and on your receiver at the left. Start your motors, or else turn the cylinders with a crank. As before mentioned, the speed should be about one revolution in three seconds.

By the time your carriages have advanced to the other side of the cylinders the picture is finished. As long as the needle of the transmitting instrument is on bare copper, the current flows, energizing the electric magnets of the receiving carriage and causing the needle to be raised out of contact with the carbon paper. Whenever the shellac comes under the needle the current is broken and the spring holds the receiving needle against the carbon paper, thereby making a mark. In this way the transmitting of the entire picture is accomplisht.

In the inexpensive sets that I mentioned having designed for the market, half-tone pictures are supplied already prepared on copper for transmission; but there is some satisfaction in having them prepared yourself. Any photo-engraver can do it. You should have a photograph without too much detail and with considerable contrast—that is, black and white. Better results are possible if the photograph has a glazed finish. Obtain a sheet of thin polished copper of a size that will roll to fit the cylinders. Tell the engraver that you want him to proceed as if he were going to make a half-tone on this copper plate, but that he must stop after he has cooked his gelatine to a dark chocolate color. *It must not be etched.* Tell him you want the screen to be no finer than 25 or 30. He undoubtedly will have no screen this coarse, so instruct him to make a small zinc half-tone cut of 40 or 65 screen, and to make a print from this. Then have him make an enlargement of this print, *without his screen,* until he has the 25 or 30 mesh which you desire.

This plate is rolled and the picture transmitted just the same as the shellac drawing.

Pictures do not have necessarily to be received with carbon paper. Your apparatus will permit the use of a few other methods. Smoked paper or wax-coated paper will do. If the former is used, however, the received picture will be a negative unless a negative is used for transmitting. Various other plans of receiving may be experimented with and will be found very interesting to the experimenter.

Pictures may be received without any carbon paper by turning the switch of the receiving machine to the right or sending position and utilizing a sheet of paper soaked in a solution of the following proportions:

Nitrate of ammonia, 4 pounds; ferricyanid of potassium, 1 ounce; gum tragacanth, 4 ounces; glycerine, 4 ounces; water, 1 gallon.

The paper should be kept moist while the picture is being received. Like the smoked paper, this produces a negative when a positive is being used for transmission, and a positive when a negative is being sent. These visible ways of recording make a much more interesting demonstration, altho the picture is not as good.

Of course, there are ways to telegraph pictures which are radically different from those explained here, but only the simpler ways are given so that the apparatus can be constructed easily and cheaply.

The experimenter will find telephotography a very interesting, instructive and fascinating field.

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Investigating "Psychical Phenomena"

By Hereward Carrington, Ph. D.

(*Continued from page* 566)

"*Result:*—On examination, the electroscope was found to be completely *discharged!*

"I took the electroscope to the table in the corner of the room and tried to recharge it, but found I was unable to do so even after repeated trials. Accordingly I asked the 'operators' to put back into the body of the medium the matter they had taken out (for the production of the sledge-hammer blows) and to give a few raps when they had done so. In a minute or two some *very light raps* were given, and when I asked if the process was complete I received *no raps in reply at all,* which seemed to indicate to me that all the matter used for rapping had been returned to the medium. At any rate, I found that I could now charge the electroscope; which done, I placed it on the floor as before within the circle, and asked that the disc should be touched lightly. After a little time, there was the metallic scraping as before, and on examination the electroscope was found to be completely *discharged.*"

It will be at once apparent to the reader that two problems confront the investigator, when once he is called upon to solve such problems as the above: (1) the *physical miracle* itself; and (2) the nature of the *intelligence,* lying behind and directing or controlling the manifestations. This latter is called a *psychological* question, which, immensely important as it is intrinsically, does not enter into the *physical* problem. It need only be said that this is *the* baffling question in psychical investigation, and the most puzzling. Whether it be an independent "spirit," as it claims to be; or the subconsciousness of the medium; or whether it is a sort of compound consciousness, made up of the collected minds of those forming the circle at the time; or whether still other interpretation is open to us—this is all a moot question, which is referred to here, merely to draw the reader's attention to the fact of its existence.

It will be at once apparent to the reader, also, that physical and electrical apparatus has played an important part in such investigations, in the past, and is certainly destined to occupy a far more important place in the future. These curious phenomena—like all others in our world—depend upon invisible forces or energies for their production. Those interested in electricity should realize, more than all others, the power of the invisible; and the fact that *the invisible is the real.* Anything that we see consists merely in a bundle of "phenomena"—of *effects.* The real cause is always behind, and is always invisible. Thus, there is an old saying that "No man hath seen God." But it is equally true that "No man hath seen man." We see his clothes; these can be changed. We see his face and features; even these can at times be camouflaged! But the real man, the Self, the Ego, is something within,—invisible, intangible,—the directing and guiding power, which in life we know as the "Person."

There is nothing inherently absurd or impossible, therefore, in these odd manifestations,—however bizarre and unusual they appear to us at first sight. An unusual combination of circumstances might bring them about. Stones do not ordinarily fall out of the air; yet at times they *do* (meteors). Water does not usually rise above its own level, yet it can be made to do so. The curious freaks of lightning are well known. There is nothing inherently impossible, therefore, in supposing that a

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table can be "levitated" into the air, under unusual conditions; it is simply the manifestation of an unknown energy—of which, doubtless, there are many. We can manipulate and control the electric current; but we do not know yet precisely what it *is*. Similarly, we can study the effects of many of these curious biological forces, without understanding their true nature. Above all, it behooves us to keep an open mind, and not to cry "impossible," just because we have never seen such facts, or because they appear to us innately improbable.

Here, as elsewhere, we depend upon hidden and unknown energies. Could we but find *an energy common to the two worlds*—the spiritual world and the material world—we should have here a means of direct communication, possibly by instrumental means. *Delicate physical and electrical apparatus may be the means, after all, by which such communication will ultimately be established!* At all events, when subtle causes and forces are in operation (as they doubtless are during a séance) it is only natural to suppose that instruments, *far more delicate than our senses*, should be the logical method of detecting them, and, as yet, such experiments have rarely been attempted.

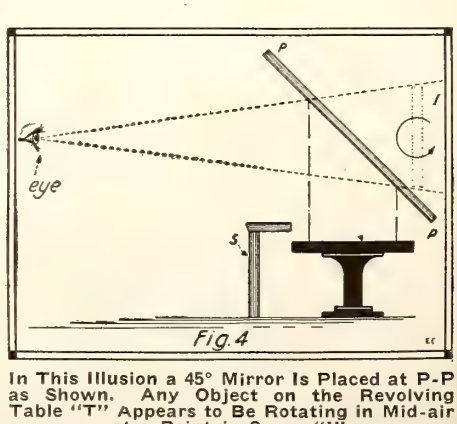
When we take into consideration finally the electrical theory of the nature of matter; when we remember the many striking analogies between electricity and the life-force; when we remember that the science of electricity is yet in its infancy, it should hold out to us the hope that, *here*, we may find a solution of many of these obscure problems, and that further investigations in the field of electricity may serve to explain to us many of these unknown and mysterious secrets of our inner nature, and the still more mysterious secrets of the séance-room. No more interesting and profitable researches could be attempted than those which endeavor to establish a connection between known and unknown phenomena; between physical and electrical manifestations, on the one hand, and these curious "psychical" phenomena, on the other. I hope that a number of readers of this article may see their way clear to try experiments in this direction, and to publish their results.

Experiments in Physics

By John J. Furia, A.M.

(*Continued from page* 531)

After the performer has stept into the cage and the door is closed, he pulls in the mirrors as in B. When the door is opened again he is hidden behind the mirrors, while the *mirrors reflect the sides of the cage* out to the audience, giving the illusion that *the back of the cage* is seen. On pushing the mirrors back into place again while the door is shut the performer again comes into the view of the audience when the door is opened.



In This Illusion a 45° Mirror Is Placed at P-P as Shown. Any Object on the Revolving Table "T" Appears to Be Rotating in Mid-air at a Point in Space "I".



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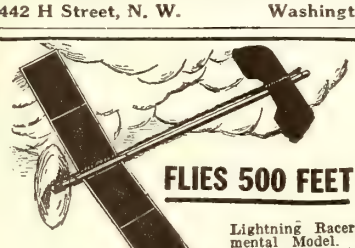
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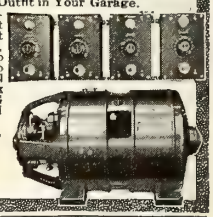
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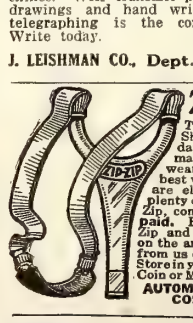
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So far the illusions described have been of the *virtual image* class. The audience has seen an *unreal* image. The real image class is not used as extensively. The following is an illustration of this type. A fragrant odor meets the nose, a beautiful bouquet is seen in a handsome vase. One gets nearer and nearer to the vase and the bouquet has—disappeared! Figure 6-C

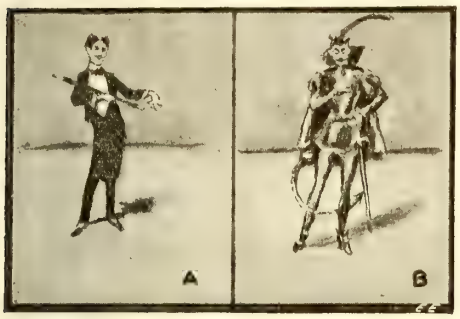


Fig. 3. The Performer Mystically Changes from His Evening Clothes to a Devil's Costume Before Your Very Eyes—Thanks to the Lighting Stunt and Glass Screen Shown in Figures 1 and 2.

tells the story. An empty vase A is placed on a hollow box. Inside the hollow box hangs a bouquet unside down. A concave mirror M, directly in front of the eye, is concealed by its dark surroundings. The mirror forms a *real image* of the bouquet, and by moving the mirror to the proper distance and tilting it to the proper angle this image can be formed just at the right point on the vase as to give the appearance of the bouquet being actually in the vase. As one moves out of the line of the vase and mirror, the image is no longer seen and the flowers have disappeared.

The subject of illusions is a vast one, and in a short article of this kind one can only "hit the high spots." In detecting illusions always look for mirrors and polished surfaces.

(To be continued)

To Europe In Three Hours

By H. Winfield Secor

(*Continued from page* 514)

what a difference the body and its organs have to accustom themselves to in this short time, and it is small wonder that the pilot can hardly stand the rapid atmospheric changes occurring. Ascending to an altitude of 40,809 feet in another official test which the weather bureau has conducted, and utilizing a pilot balloon with scientific instruments attached for recording the atmospheric constants, we find the air pressure here dropt to the low figure of 2.69 pounds per square inch. At 60,000 feet elevation above sea level, the official figures show but 1.17 pounds per square inch. At 88,000 feet, 16.7 miles above sea level, the recorded air pressure is .3146 pounds per square inch, or approximately 5 ounces. Let us now jump to a real high altitude—100,000 feet, or 18.9 miles above good old terra firma at sea level, where we find but a fraction of a pound, or 3.05 ounces (.91 lb.) per square inch, atmospheric pressure. Even a flea could not live up there, we will wager, except that it is in a vacuum bottle, and a strong one at that. The highest figure to which a test balloon carrying recording instruments has flown is 126,800 feet, or 24 miles above sea level. The pressure at this dizzy altitude is but a fraction of an ounce.

The various degrees of cold found in recent tests, most of which were carried on during the summer months, are tabulated

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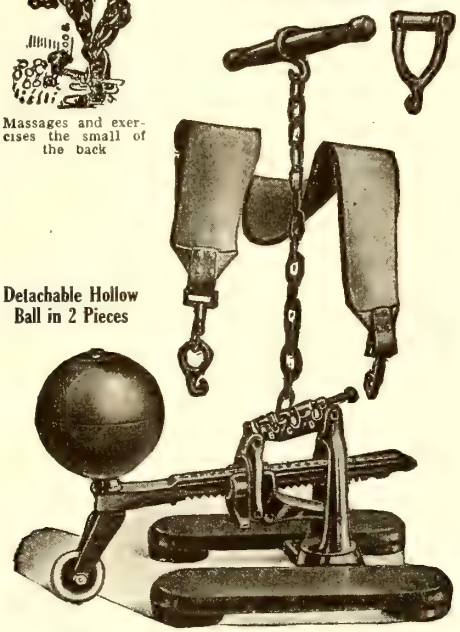
Like the heart, which has a rest between each beat, so in my system there is a resting pause between each contraction of the muscle brought into action with the "Automatic Exerciser." This enables you to develop a superior physique without undergoing the strenuous and exhaustive training which the ordinary gymnasium methods require.

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Calves and Ankles	410 lbs.	892 lbs.	482 lbs.
Back	508 lbs.	1,382 lbs.	874 lbs.
Shoulders and Arms	356 lbs.	641 lbs.	285 lbs.
Neck	185 lbs.	375 lbs.	190 lbs.
Biceps	87 lbs.	280 lbs.	193 lbs.

His fingers show an average gain in strength of 100%.

Records of one month's results by Mr. Thomas Waring, Hamilton, Ont., Can.

First Record	Second Record
159 lbs.	411 lbs.
134 lbs.	461 lbs.
.....	.....
54 lbs.	88 lbs.
41 lbs.	86 lbs.
20 lbs.	54 lbs.
.....	.....
Abdomen	
46 lbs.	102 lbs.

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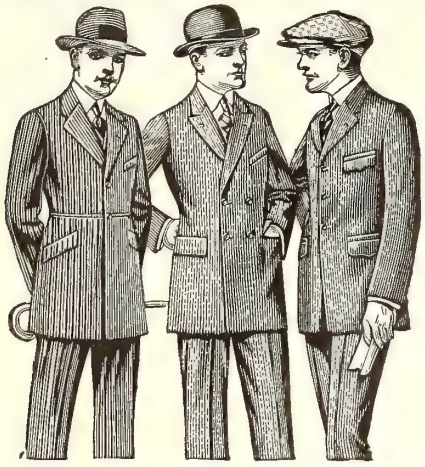
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in the accompanying illustration, and these exert a very severe effect on the pilot indeed, covering his glasses with frost, so that it is impossible to see the instruments and steer the plane, even at altitudes of 25,000 feet and less; causing the engine to misfire, and in fact to stop in many instances. Electric self-starters which are now being fitted to most of the sea and land planes help the pilot out of many difficulties such as this, which may otherwise end disastrously for him.

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If we have an airplane which can go over 200 miles an hour, such as the "Christmas" Bullet plane, and ascending to an elevation let us say of between 30,000 and 40,000 feet, where we had an air current traveling Europeward at 200 miles an hour, then our net speed upon reaching this strata would total 400 miles an hour. With a "vacuum bottle" cab fitted to the airplane, together with oxygen tanks and atmospheric compressors for the carburetor system of the engine as well as for the cabin, it would then become possible to fly the 3,000 miles separating New York and London in approximately *one-half day or seven and one-half hours.* Possibly in flights of the future, when aircraft will abound in large numbers, there will be a strict classification of the air strata, such as shown in the accompanying drawing; the lower strata being assigned to the slow-going and shorter trip airships—the middle strata to the speedier open-cabin planes or dirigibles; and finally, the upper highly rarefied, rapidly moving air strata to the specially protected aircraft engaged in negotiating long distances, such as trans-oceanic and trans-continental trips, where speeds of 400 to 600 miles will be not only frequent, but common. The passengers will hardly realize that they are traveling at such prodigious speeds, owing to the fact that one of the principal components of their relative velocity to the earth will be the air current in which they are moving. If the plane had to tear its way thru the air, so that air currents had to rush by the edges and surfaces of the machine at a velocity of 400 to 500 miles an hour, the terrific air friction would probably injure the craft speedily; however, when the plane is actually cutting thru the air at 200 miles an hour, and the air current with which it travels is going at an equal speed, then no abnormal air friction will be encountered.

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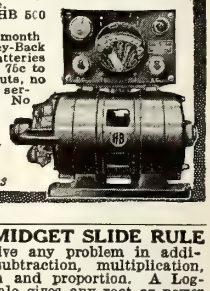
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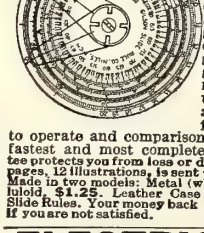
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Flying Corps, who found himself carried 200 miles *east* of the location from which he had ascended; and not only this, but with his plane traveling *west* at 100 miles an hour, the great eastward moving air current must have had a velocity of more than 300 miles an hour, or it would not have carried him 200 miles *eastward* from where he ascended. Thus do we learn more and more daily of the uncharted wonders of the great translucent envelope surrounding our earthly habitation, which we call the "atmosphere."

High Altitude Flying Machines.

What type and form of aircraft will the high altitude machine be? This question was answered in part by the above discussion, where it was mentioned that the machine intended to fly at altitudes of 40,000 feet or over would be necessarily equipt with wings of much greater sustaining surface or else a triplane or quadplane could be employed. Also in order to "get hold" on the thin rarefied air of the higher strata, longer propellers would be necessary, and preferably also an increase in the propeller speed. It should be remembered that while the air has become lighter and less dense at these high altitudes that the weight of the plane and aviator has remained practically the same, the slight loss in weight due to the change in gravity pull, occasioned by going away from the earth's surface, being very small and having no practical bearing on the matter. Balloons have ascended with passengers as high as 38,000 feet. The heat of the sun rapidly expands the gas in balloons, and they also expand markedly at such altitudes, due to the reduced air pressure. At a height of 70,000 to 80,000 feet a pilot test balloon (no passengers) *will expand to about four times its normal size.* The air pressure acting on the balloon bag has fallen decidedly; so the hydrogen gas with which it is filled pushes outward on the envelope to a proportionate extent. Many times these weather bureau pilot balloons burst before they have reached the altitude intended for these reasons—heat and rarefication of the atmosphere. The large passenger-carrying dirigibles, containing gas to make them buoyant, such as the R-34, which recently crost the Atlantic ocean and return, have special compensating valves which release some of the gas at intervals as the airship ascends—losing about 1/30 of its volume of gas for every thousand feet of "climb."

What does this demonstrate? Simply this: that what gas is lost by heat and rarefication expansion by ascending cannot be recovered. Therefore the balloon must carry sufficient gas to permit its remaining buoyant when it descends again to a denser or lower atmospheric strata. A certain amount of expansion in a non-rigid or even in a rigid balloon or dirigible is permissible and desirable, as this increases the surface area exposed to the atmosphere; therefore the lifting power is maintained, within certain limits, in the less buoyant and highly rarefied air. It is conceivable, therefore, that as the rarefaction of the air increases very rapidly as we rise to greater altitudes than 40,000 feet above sea level we shall probably find our dirigible altitude airmen confined to air strata below 40,000 feet. This seems logical, for the reason that to ascend much above this air level a very considerable amount of gas would have to be liberated to prevent the balloon expanding to the bursting point, and therefore the gas so lost would apparently soon reach the limiting point where no more gas could be liberated, or else the dirigible would not retain a sufficient volume of gas to give it the necessary buoyancy to hold the weight of the crew, cabins, engines and fuel. A pilot balloon as used by the Weather Bureau for testing purposes is a simple spherical and easily expansible af-

(*Continued on page* 596)

The apprentice says:

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"When I got into the shop myself, I noticed the toolmakers and everybody who had 'fussy' jobs preferred Starrett Tools.

"There's something about 'em that the fellows like. Yeh! They're accurate and they're convenient, but I guess the fact that the men who make 'em are pretty good mechanics themselves, has something to do with it.

"What? Sure I'm getting me a set of Starrett Tools—I need 'em every day. Yes, I got me one of those seventy-five cent Starrett Apprentice Books, too. It saves me asking the foreman a question every five minutes. Now, when I want to know how to do something, I can look in the book and study it out myself."



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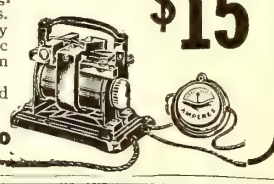
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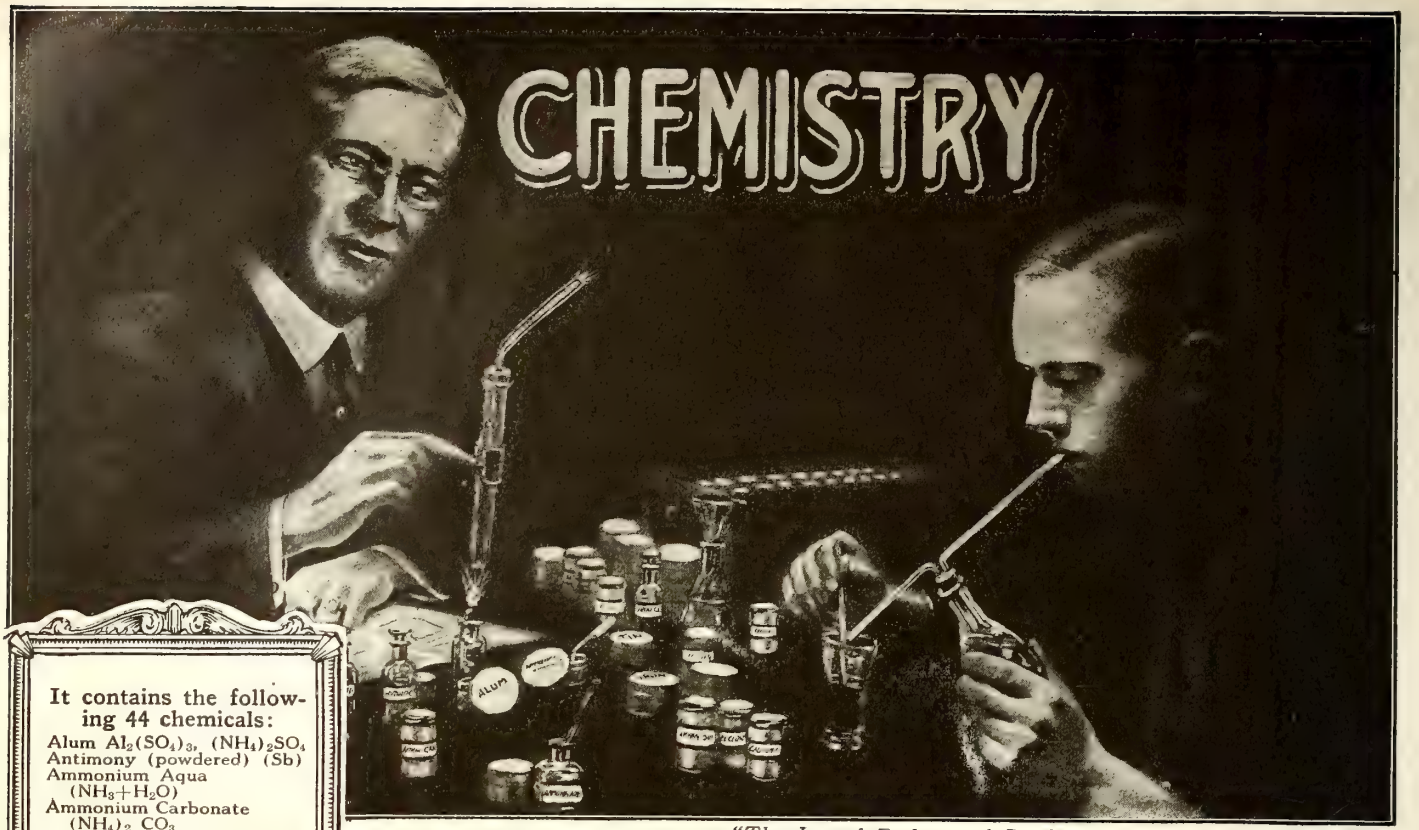
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Ammonium Carbonate $(NH_4)_2\ CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride $(BaCl_2)$
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride $(CaCl_2)$
Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_4 2H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate $(MgCO_3)$
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
Sulphate of Nickel $(NiSO_4)$
Sulphate of Zinc $(ZnSO_4)$
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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

Combination Salt and Pepper Shaker.

(340) Messrs. Frank B. Martin and G. L. Pastor, Braddock, Pa., submit what they call a combination salt and pepper shaker. The idea is to use the two vessels side by side, and then by having a sliding member with holes, either salt or pepper may be shaken out from either vessel as desired. Our advice is asked on the invention.

A. This is a capital idea and should prove a success. We are certain that a patent can be obtained upon it, and that the article when made properly will prove a good seller.

Multiple Phonograph Record.

(341) Jackson Lloyd, Long Beach, Calif., would like to know whether a patent can be obtained on a phonograph record which has four pieces on it, two on each side. The idea is to use a double track, similar to a double thread on a bolt. This would require the record to be twelve inches in diameter to hold the same amount, or the same length, of music as on a ten-inch record. The starting operation would be accomplisht by placing the needle in a groove, which would have to extend out into the smooth rim while the machine was not in operation. It is then started going.

A. There is nothing new about this device, and no advantage is gained because each piece would take up a certain amount of the record, and you might just as well have the second piece after the first was played. This is the present mode of doing it, and is perhaps more satisfactory than the suggested manner, which has been tried out in the past and found unsatisfactory.

Electric Shutter Trip.

(342) Lewis H. McCarrow, San Diego, Calif., would like to have our advice on an electric shutter trip for cameras to be used as a cable release operated shutter. Drawings accompany the request.

A. Nothing fundamentally new is shown in this device, and while no doubt it will work, there is nothing new contained in it that would warrant our correspondent to obtain a patent.

Pliers.

(343) B. F. Freese, Williamsburg, Pa., submits description and illustration of a combination electrician's pliers. Several new improvements are shown, where the jaws of the pliers have several different sizes of openings, which are used to remove insulation from different gage wires. Our opinion is asked as to patentability, etc.

A. We can offer no encouragement to our correspondent on this idea. Nothing fundamentally new is shown, and we doubt very much whether a patent could be obtained.

Shuttle Alarm.

(344) G. L. Busse, Cedar, Minn., has conceived an idea to use an electric contact arrangement which gives an alarm when the thread on the sewing-machine bobbin becomes depleted. It is well known that many pieces of material are spoiled or have to be run over because the thread has run out from the shuttle bobbin when the person operating the machine was not aware that the thread supply had run low. Our advice is asked as to patentability and usefulness of this improvement.

A. This is a very good idea, and we think a patent can be obtained on the device. How practical it will be and how the women folks will take to it, is impossible to say. One advantage of the device is that it can be manufactured for a few cents and is readily attached to any machine. All that is required is a battery and a buzzer, and the whole outfit can be put on the market for $2.00. What success there would be in marketing the device, however, is problematical.

Cold from Electricity.

(345) Mr. Ernest F. Prucha, Howells, Nebr., submits an idea showing a net-work of bismuth and antimony bars, which are crost and soldered together in the form of a Peltier's cross. This is to be used to cool a room, etc.

A. There is nothing fundamentally new shown, and the principle is well known and quite old. No patent could be obtained, in our opinion.

Spark Plug.

(346) Frederick L. Umbach, Troy, N. Y., writes: "I have a small invention and would like to know if it is on the market. It is a low-tension make-and-break spark plug. No coil or magneto is used. All that is needed is a dry-cell battery to make the plug throw a large spark. I have tried this plug on gasoline engines, motorcycle and automobile engines, and it has worked with success. I have made a few and sold them to different men who have cars, and they have had good results with this plug, so that the carbon from the engine could not stop the sparking. I would like to know whether this could be patented, and wish to hear from you as soon as possible."

A. Not having more details on the invention, it is quite impossible for us to give any information on the subject.

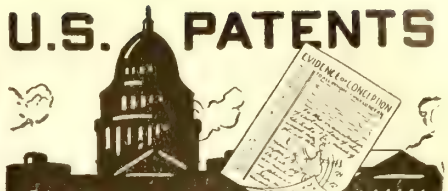
Hat Covering.

(347) Alex. Yenyo, Johnstown, Pa., writes: "I would like to submit a plan for a rubber covering for a hat, which is to be made of thin soft rubber overlapping a quarter of an inch at the brim. It is shaped exactly like the hat so that it fits snugly over it, to protect it from the rain. When not in use, it can be slipt into the pocket or a case made to hold it. I would like to know if this idea can be patented, or if there is any such idea out."

A. It is quite an old idea and any United States army or navy officer will be glad to show you one of the coverings which he uses to cover his cap. Such rubber coverings are for sale in stores selling headwear to officers.

Talking Film.

(348) Donald Hucke, Sheldon, Iowa, writes as follows: "I have read so much of the impossibility up to the present time to obtain perfect synchronism between the motion picture machine and the phonograph. In the February, 1918, issue of the ELECTRICAL EXPERIMENTER, on the first page, the vibrations of the voice was recorded on a celluloid film. Couldn't this be applied to the edge of a regular picture film. If heat was needed for the talking record, it could easily be localized so as not to affect the film. Altho this would have to be recorded on each individual film sent out, this also could be easily done from the original. The difficulties of talking would be few. A phonograph recording attachment and a few sensitive microphones would be all. I have thought this over from every point and I can't see any objection to it that could not easily be remedied. Will you please put this on your "Patent Advice" columns of the E. E. and tell me whether it works or not.



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A. This magazine has publisht quite a good deal about talking films in the past, and while the fundamental idea seems to be right so far, we have never seen the device work out in practise, presumably for the reason that the investigators have struck a snag. As to our correspondent's idea to put the phonograph record alongside of the perforation of the film, this would not constitute a patentable idea, nor would there be enough room for the voice, as far as we are able to ascertain.

Automatic Talker.

(349) A. B. W., Chicago, Ill., says as follows: Could you please advise me through the ELECTRICAL EXPERIMENTER whether or not I would be able to secure a patent on the following apparatus. The apparatus is an instrument which will automatically answer a telephone; that is, when the party being called is not at home; tell the party calling that there is no one at home and asking if there is any message which they would desire to leave, which, if there is, it will take it and reserve for the party being called. Upon the return of the party being called the same machine which talked to the incoming calling party will play off the message which has been received. The instrument is only set at times desired.

Here is an example of the machine having been connected. Machine answering phone: "Hello—Drexel 4368." "There is no one at home just at present. Is there any message which you wish to leave?" The party calling: "Yes. Please tell Mr. Jones that I would like very much for him to call Mr. Smith at Eng. 5346." When the calling party hangs up the machine automatically comes to a stop. Upon the return of the party being called they play off the record which has been made by the call.

The machine is connected in the home and is started by the incoming call.

A. There is nothing new to this device, it having been described a number of times in the ELECTRICAL EXPERIMENTER, as well as other magazines. The device is not impossible, altho we believe it is impractical, as, first of all, few people would go to the trouble of installing it, and the device would be unduly complicated in case two or three more people would call up in succession.

Electrical apparatus for tapping trees, which can be left without attention for months, has been invented.

For mines using electric haulage, a door opening motor and safety signal, operated by the drivers of mine locomotives, has been invented.

Practical Chemical Experiments

By Albert W. Wilsdon

(*Continued from page* 532)

Experiment No. 5. Since the acid potassium malate exists in the stalks of the common rhubarb, the juice that is exprest from this may be filtered and tested for malic acid by the method in Experiment No. 4.

Citric acid occurs in the juice of lemons, currants, unripe tomatoes, gooseberries, etc. It is made on a large scale from lime or lemon juice, by saturating the juice with chalk; the precipitat of calcium citrat is decomposed by an equivalent quantity of sulfuric acid and filtered from the calcium sulfate. Evaporate the filtrat and crystallize out most of the calcium sulfate, and from the mother liquor allow the citric acid to crystallize.

Experiment No. 6. Make citric acid from the juice of at least two lemons, as above described.

Experiment No. 7. Add a moderate quantity of calcium chlorid to a concentrated solution of citric acid, and then add sodium hydroxid till the solution is nearly neutral. Calcium citrat will be formed.

Experiment No. 8. Try the above test with a concentrated and filtered sample of lemon juice, and note the formation of the precipitat of calcium citrat.

Tartaric acid is found in many fruits, particularly ripe grapes, as acid potassium tartrate. When the "must" ferments the "cream of tartar" precipitates as the alcohol increases, and this precipitat is known as crude tartar. It is frequently much contaminated with calcium sulfate, which is used in "plastering" the wine. To make

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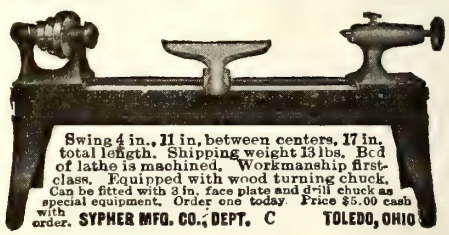
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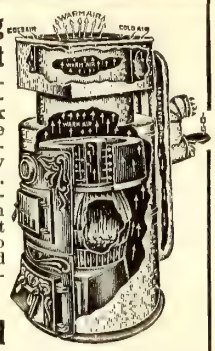
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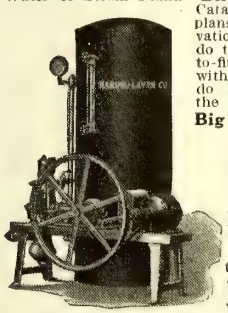
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tartaric acid from this, the solution of the argols (crude tartar) is treated with milk of lime to form the calcium tartrat, and the latter salt is suspended in water and treated with an equivalent of sulfuric acid, and the calcium sulfate so formed is filtered off, and the tartaric acid is obtained in crystals by concentration of the filtrate.

Experiment No. 9. Add to a concentrated solution of tartaric acid a concentrated solution of potassium chlorid, when a precipitat of potassium tartrat will be formed on shaking and allowing to stand at ordinary temperature. The test is more delicate if the solution is nearly neutralized with sodium carbonat before the potassium chlorid is added.

Experiment No. 10. Make a similar experiment with filtered grape juice, which may conveniently be obtained from canned grapes. A more delicate test is made by adding to 100 cc. of the fruit juice a few drops of concentrated potassium acetate solution, and 15 g. of pure, finely ground potassium chlorid; dissolve the latter salt by shaking and add 20 per cent of 95 per cent alcohol. Stir and shake vigorously to assist in the crystallization of the acid potassium tartrat.

Cultivation has changed the character of many fruits, and has much improved their flavor, so that many luscious fruits have been developed from disagreeable, or, to say the least, very medium stock. Cooking improves many fruits by softening the cellulose and converting the gums and allied bodies into a gelatinous form. Sucrose is inverted and pectin bodies converted into soluble forms. If there is starch remaining, this is made more digestible by cooking. There are many fruits that in the raw state are not suitable to use as food for persons with dyspeptic tendencies. They are, however, very satisfactory and useful when suitably cooked. Apples, pears, quinces, and cranberries belong to this class. It should also be noted that a jelly made from the fruit juice is usually more acceptable to an invalid and less irritating in its action than the raw fruit or the jam. This is especially true of raspberries, blackberries, and currants, on account of the numerous fine seeds that are present in the jam.

(*To be continued*)

Experimental Mechanics

By Samuel D. Cohen

(*Continued from page* 536)

Practically all brass fixture parts are threaded in the lathe.

One of the commonest methods of tapping the part, where it is not too large, is to grip it in the large chuck on the *live* spindle of the lathe. The tap may then be held by its square head in a monkey wrench or tap wrench, in such a way that the center hole in the top of the tap rests on the tail center of the lathe. The wrench holding the tap from turning rests against the lathe bed. The belt on the lathe or the gearing is shifted so as to give a slow rotative speed to the lathe chuck supporting the part to be threaded. When the material is thus rotating slowly, the tailstock center is slowly advanced, thus causing the tap to start cutting. A taper or plug tap is invariably used in this case, and where the hole does not pass entirely thru the material a bottoming tap may be employed to cut the threads of full pitch and diameter clear to the bottom of the drill hole. Where much tapping is done in the lathe, it becomes a very simple matter to lubricate the tap by placing a can contain-

(*Continued on page* 595)

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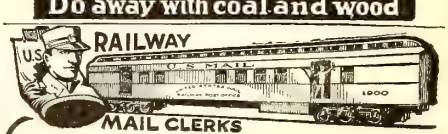
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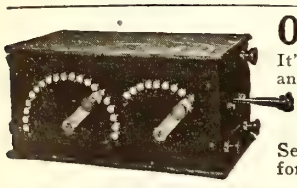
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Building and Testing Small Transformers

(*Continued from page* 534)

spools and bring the end out, marking it P. Commencing about ⅛" from the end of the spool, wind the small wire on evenly, stopping about ⅛" from the opposite end. Cover the layer with paper and proceed in like manner until you have twelve layers on. Now fasten the wire so that it cannot unwind, remove the spool from the block and insert the core pieces from alternate sides. Do not cut the wire, but scrape a small bit of the insulation off and connect the primary coil to the 110 volt A.C. circuit with a 25-watt Tungsten lamp in series. Leave the secondary coil open. If the lamp lights up brightly, you have not enough wire on the primary. Cover the bare spot on the wire with a small piece of paper or silk and wind on two more layers and test again. Now if the lamp does not glow at all, you have enough wire on, but if it still glows a dull red, wind on another layer. When you have sufficient wire on the coil the lamp should show no color at all. Now short-circuit the outside ends of the secondary coil and if the transformer is working properly the lamp will light up quite brightly. Make the terminal at this end of the coil in the same manner as at the beginning and cover the coil with paper or Empire cloth.

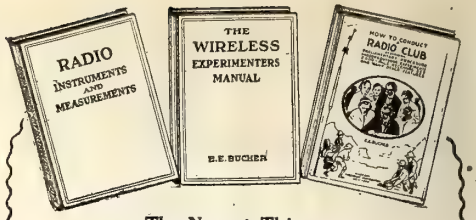
MOUNTING THE TRANSFORMER.

There are several ways of mounting the transformer, but probably the best way is to drill a hole thru each end of the core piece. Do this after the transformer is all assembled. If you place a block of wood under the ends and another over them, clamping the blocks together with screws, you can drill thru the laminations without any trouble. It can now be mounted on a board.

Now as to varying the size and output of a transformer. By keeping the same proportions thruout in making the core pieces, having a difference of eight or ten sizes between the primary and secondary wires and testing as above, you can get almost any voltage you desire. For example, if you wished to make a simple bell-ringing transformer, make the center tongue of the core about ¾" x ⅝" and the other sizes in proportion. Use four layers of No. 26 wire for the secondary and ten or twelve layers of No. 34 wire for the primary. If you wish to make one larger than the one given, make the center tongue 1⅝" x 1⅛", use five layers of No. 16 wire on the secondary and fourteen or sixteen layers of No. 26 wire for the primary.

TWO TRANSFORMERS GIVE GREAT FLEXIBILITY.

A very nice arrangement for the experimenter who desires to have a large range of voltages is to make two transformers like the one given in detail. Make one with no taps off the secondary and the other as described. Mount them on one board and wire up according to the diagram shown in Fig. 7. This will give a range of from 1 to 35 or 40 volts and the system is very flexible. The two primaries are in multiple, and may be used together or separately. The secondaries may be used separately, in series or multiple. The four steps in transformer No. 1 give you four different voltages; in series with No. 2 you get four more; in multiple, four more. Now if you cut in the 25-watt lamp on No. 1 circuit, you will get four still different voltages, and if you replace the tungsten lamp with a 16-candle-power carbon lamp, you will get four lower voltages still, so that you have at your command almost any voltage you wish within the limits of the maximum power of the two transformers.



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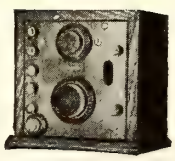
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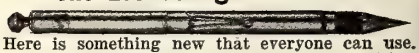
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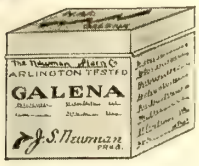
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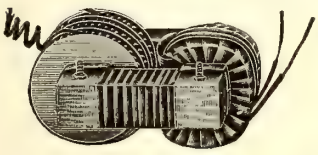
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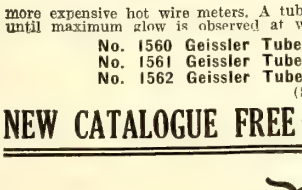
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The Geissler, or Vacuum Tube, is simply an exhausted glass container, provided with suitable electrodes for passing a high tension current thru the residual gases. The discharge is accompanied by a beautiful colored glow, ranging from greenish blue to orange, pink and red, depending on the degree of vacuum and the structure of the residual gas contents. Many beautiful and interesting experiments may be performed with Geissler Tubes.

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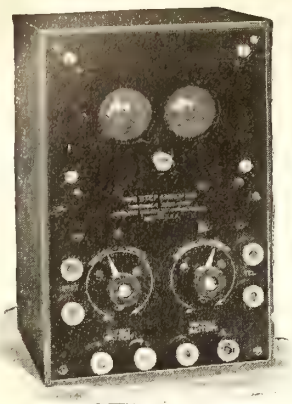
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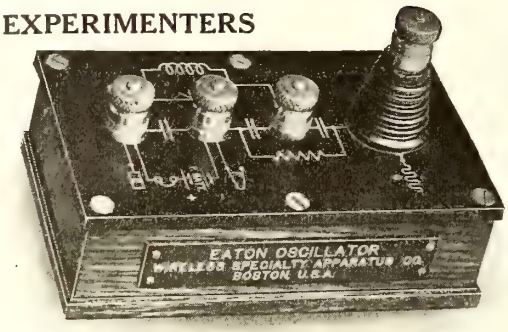
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It will oscillate over a wave length range of 250—25,000 meters.

Requires no adjustments of any kind. Only one variable, the tuning condenser, is required.

The simplest and cheapest way of receiving undamped signals.

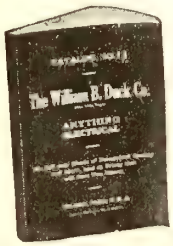


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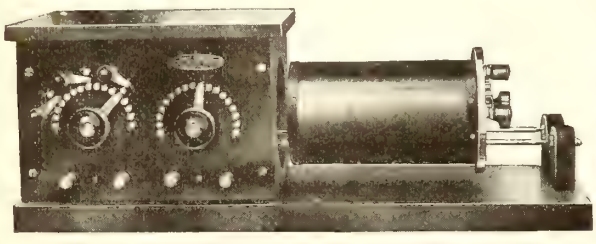
Boston, Mass., U. S. A.



DUCK'S New Big 264-Page Wireless and Electrical Catalog Just Out—Now Ready

It is mailed for 12c in stamps or coin which may be deducted on first order of $1.00. Catalog not sent otherwise.

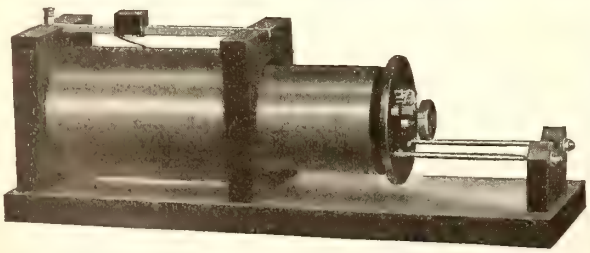
We regard this catalog as our greatest effort. It embraces everything in wireless worth while. 172 pages with no waste space devoted exclusively to wireless instruments. Your amateur friend will tell you that there never has been any wireless catalog to take the place of catalog of this company and above all that you can absolutely depend on our goods. There is no need for any other catalog when you have this big catalog.



NEW MODEL 5BB, NAVY TYPE RECEIVING TRANSFORMER

A big improvement over our former model. Primary divided into two sections, with three dead end switches, greatly improving selectivity.

Secondary divided into three sections, with two dead end switches, eliminating harmonics. By changing the construction of the end piece, there is also greater loose coupling. It is a wonderful improvement over our old model both in performance and appearance. Only $23.50.



OUR IMPROVED ARLINGTON RECEIVING TRANSFORMER

The secondary on our new type Arlington is divided into three sections with two dead end switches, eliminating dead end effect and harmonic and giving greater selectivity. The end support similar to that on our Navy type permitting of greater loose coupling. It is a beautifully finished instrument and will be sold by us at the same price as the old model. $9.00.

THE WILLIAM B. DUCK CO., 230-232 Superior St., Toledo, Ohio

Latest Amateur Radio Receiving Apparatus

(*Continued from page* 542)

with some of the standard type vacuum tubes and having such constants as will give best and most efficient results. A series resistance is inserted in the filament circuits, in such position as to give a negative charge on the grid, thereby eliminating the use of external means of producing this effect necessary in proper amplification work. These resistances are mounted on the vacuum tube holders.

Three jacks are mounted on the lower part of the panel and so connected that with the aid of the jack plug connected to the telephone receiver as shown, it is possible to quickly interchange from the vacuum type receiver circuit to the first or second stage amplifiers as desired simply by inserting this plug in the respective jacks. The jack to the left is used to connect the telephone directly across the vacuum tube detector. The middle jack connects to the first stage amplifier, and the jack to the right connects the second stage amplifier to the telephone. The jacks are so constructed that when the first stage is connected in series the second stage is kept open, thereby eliminating the unnecessary flow of current to the second stage, and when the plug is thrown in the second stage jack the first stage jack is automatically closed, thereby permitting the first and second stage amplifiers to be used simultaneously.

The binding posts to the left are the *input* side to the amplifier and are connected to the telephone side of the vacuum tube receiver. The two lower binding posts to the right are connected to the filament battery, the two center binding posts are connected to the plate battery, while the two upper binding posts to the right are connected directly across the second stage of the amplifier and are used in connection with a loud-talking telephone.

Each vacuum tube has its individual filament rheostat and this is mounted on the outside of the box (as shown in Fig. 3). Two holes, closed by Bakelite covers on top of the box, permit the operator to insert or remove the vacuum tubes from their respective sockets whenever desired.

All of the instruments are of standard height, and each set of binding posts on each respective instrument is so arranged that by means of metallic straps it is possible to connect the receiver, the vacuum tube detector and the amplifier as a complete receiving equipment.

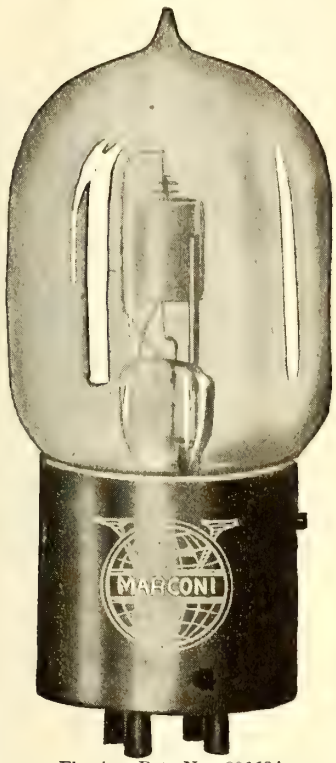
NEW YORK ELECTRICAL SHOW TO BE RESUMED.

The electrical exposition and motor show is to be resumed this year, opening at the Grand Central Palace on September 24th. This will be the first show since 1917, last year's display having been omitted because of the war.

In announcing the resumption, Arthur Williams, President of The Electric Show Company, said that while there had been some uncertainty as to the time and place of the exposition, there had never been any doubt that the first year of peace would see the exposition back in its accustomed place. In fact the show plans began to take form soon after the armistice was signed.

The Grand Central Palace was used during the war as a debarkation hospital. An indication of the importance with which the electrical industry regards this show is seen in the fact that 40 per cent of the space had been assigned to exhibitors before the date of the exposition had been finally settled upon.

THE HEART OF THE WIRELESS



Fleming Pat. No. 803684
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An Amateur Station Without a Vacuum Tube is Years Behind the Times

MARCONI V.T.

$7.00 each

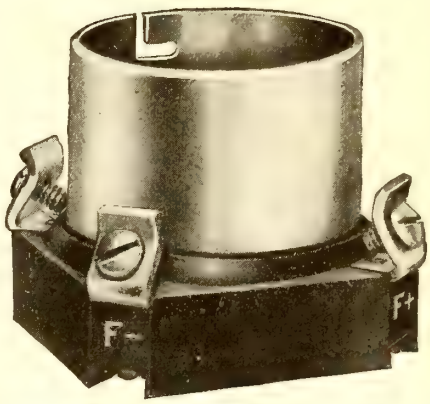
Under agreements recently effected the Marconi V. T. is the only vacuum tube, or audion, which may be sold to amateurs, laboratories, schools of instruction and experimenters.

The approximate operating life of the MARCONI V. T. is 1,500 hours.

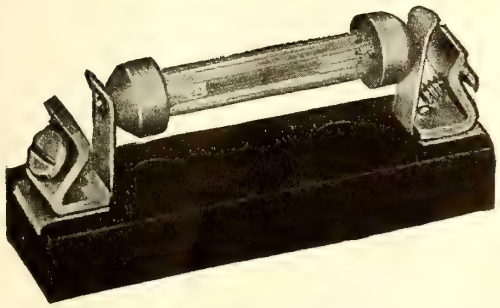
Class I.—Designed for use as a detector; operates with plate potential of 20 to 60 volts.

Class II.—Designed for use as an amplifier; plate potentials from 60 to 110 volts may be applied.

Tubes in either class may be used for detection or amplification, but those of Class I are best as detectors, and Class II tubes are superior as amplifiers.



Standardized Socket $1.50 additional



Standard Resistance, Complete $1.00

The Marconi Resistance, connected in the circuit between the grid and the filament of the Marconi V. T., is made in the following standard sizes:

½ megohm, 1 megohm, 2 megohms, 4 megohms, 6 megohms.

Resistances of any special fractional values up to 6 megohms can be supplied.

Send all remittances with order to COMMERCIAL DEPARTMENT

MARCONI WIRELESS TELEGRAPH CO. OF AMERICA

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PAPER TUBES
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FOR 3500 METER COUPLER
Primary 3¾" outside dia. 7" long—25c
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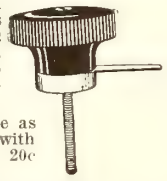
Special Lengths Cut to Order
To 15" long 3¼" dia.—4c per in.
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All tubes have ⅛" wall.
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KNOB AND SWITCH LEVER Mounted on brass bearing and shaft, threaded 6-32, two inches long. Lever securely fastened to knob. Each 40 cents, postage 4 cents.



KNOBS as illustrated above as used on switch 1¼x¾ with hole for mounting, each 20c postpaid.

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CONTACT POINTS 7/32x7/32 Brass with screw for mounting. Postpaid 25c per doz.

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9½ x 19 x ¼ Black XX.....$4.00
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Send 5 cents in stamps for our catalog and get on our mailing list for future bulletins.

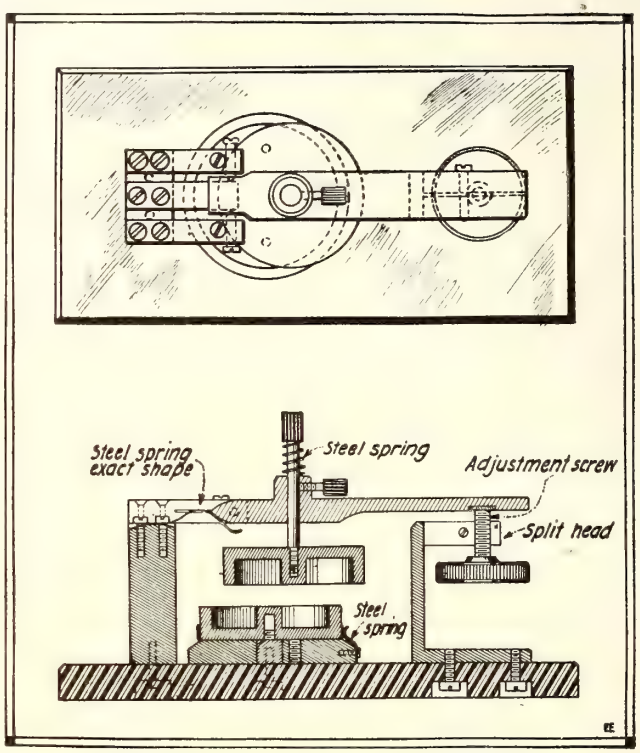
A. H. CORWIN & CO.
924 Kinney Building Newark, N. J.

An Efficient Radio Crystal Detector

By Robert F. Gowen

(*Continued from page* 544)

In conclusion a few remarks regarding the operation of crystal detectors in general may be in order. It is best, of course, to cover over any crystal detector with a glass bell or cup so as to keep it free from dust and the dampness of the atmosphere, which tend to corrode the surface of the metal parts and the crystals, thus impairing the efficiency of the instrument. Another very good thing to watch out for in operating crystal detectors is vibration.



Sectional and Top Views of Crystal Detector.

The Submarine's Under-water Radio

(*Continued from page* 560)

E. B. Rosa, Acting Director, U. S. Bureau of Standards.

SUBMARINE RADIO.

During the past summer (1918) a series of experiments have been carried out by J. A. Willoughby and P. D. Lowell, of the Bureau of Standards, at the submarine base, New London, Conn., with the view of improving, if possible, the present methods of radio communication with submarines. The experiments have shown that communication at sea can be carried on under all conditions, more efficiently with an insulated closed loop than with an ordinary antenna now in general use. The loop is of simple construction, requires no mast and therefore does not interfere with submergence. Under storm conditions or during a submergence where the ordinary antenna is useless, communication by means of the closed loop is perfectly practicable. The following are among the most important results obtained:

A. When the submarine is submerged, any North American or European station can be received as distinctly as when it is on the surface; the maximum depth of submergence, however, is determined by the wave length of the transmitting station. To receive short wave lengths it is necessary that the top of the loop be near the surface of the water, whereas a wave length of 10,000 meters can be received when the top of the loop is submerged twenty-one feet. Still longer wave lengths can presumably be received at still greater depths.

B. Recognition signals can be exchanged (using the standard 952 meter wave length) at a distance of ten or twelve miles when the submarine is completely submerged, the maximum distance being obtained when the top of the loop is practically at the surface, decreasing to two or three miles when the top of the loop is eight or nine feet below the surface.

C. Submergence of the submarine during reception or transmission of message does not alter the wave length, though if the maximum depth for the wave length in question is exceeded, communication of course is interrupted.

D. When the submarine is running awash or on the surface, signals can be transmitted (with a 1-KW. spark set) a distance of at least a hundred miles even under very stormy conditions; grounds or short circuits caused by heavy seas, which render the ordinary antenna useless in stormy weather, do not affect the closed loop.

E. The closed loop can also be used as a direction finder, either on the surface or submerged, the maximum strength of signal being obtained when the long axis of the loop (of submarine) is pointing toward the transmitting station and the minimum signal when it is at right angles to the stations.

(*Continued on page* 590)

CORE WIRE

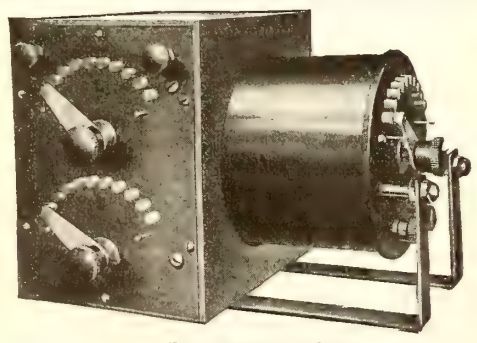
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We have been fortunate in securing thru auction several tons of guaranteed pure, double annealed **Norway Iron Core Wire** and are selling this wire to "Experimenter" readers at 20c lb. This wire is just the thing for spark coils, transformers, etc., and it is, of course, a very much more superior product than the usual iron wire. We have only one size left:

24 INCHES LONG. Thickness about No. 21 B and S

If this size should be too long we advise cutting the wire down yourself by means of shears. As long as the supply lasts we offer this wire as described above to our customers at the very low price of 20c a pound. Add postage or we will ship express collect. Order at once.

ELECTRO IMPORTING CO., 231 Fulton Street, New York City



Type-Y673-Coupler

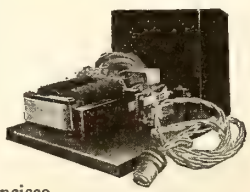
TYPE Y673 Coupler
200 to 3000 meters
Price $12.00

Camb. Rectifier, for storage battery charging
Price $22.00

Three-cent stamp brings bulletins of both these instruments

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Rectifier

What the Entire Amateur Radio-World Has Been Awaiting



A WIRELESS TELEPHONE

that plugs into a lamp socket, at a price you can afford. A genuine DE FOREST UNDAMPED WAVE RADIOPHONE (and telegraph) OPERATING DIRECT FROM YOUR 60 CYCLE 110 VOLT HOUSE CURRENT. NO MOTOR GENERATOR REQUIRED. *JUST PLUG IN AND TALK—SIMPLICITY ITSELF.*

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Tested Ranges { **Telephone 10 to 20 miles** / **Telegraph 50 to 75 miles** } **Depending upon aerial height and terrain.**

Our actual experience with this set indicates that these ranges can be greatly exceeded.

PRICE COMPLETE INCLUDING BULBS, $200.00
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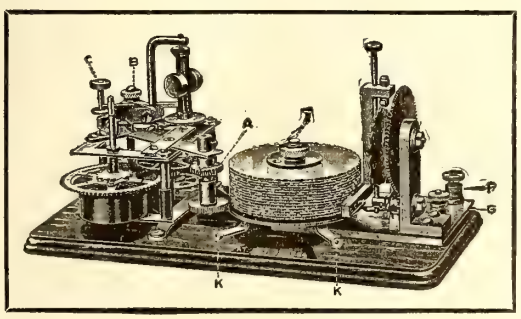
You will eventually use this type of transmitter, now recognized as the most efficient of all low-power systems—so why not now? Order immediately to insure early delivery.

DE FOREST RADIO TELEPHONE & TELEGRAPH COMPANY
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The Omnigraph Automatic Transmitter

will teach you both the Wireless and the Morse Codes, *at home, in half the usual time,* and at the least possible expense. The *Omnigraph* connected with your Buzzer, or with Buzzer and Head Phones, or with Sounder, will send you unlimited Wireless or Morse Code messages by the hour, and at any speed you desire.



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If you are a beginner, it will make you an operator in the shortest possible time.

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Send for free catalog describing 3 different models—$9.00 to $23.00—or order direct through your electrical dealer. We sell the *Omnigraph* with the guarantee that you must be satisfied or your money back for the asking.

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radio school of the world, and this correspondence course is an extension of our activities, a Post Graduate Course in our Washington School being given you free, if you desire. You see we are not *A RADIO SCHOOL*, but actually and absolutely *THE RADIO SCHOOL*—the top one, the biggest one—the one that *HAS BEEN* and *IS* turning out the *WINNERS* every week. You can't compare us with any other school, because we are head and shoulders above all—the very top. You get the idea? You can't get a better or higher course, we are the final—the finish. Act now. Get a grip on yourself—take the big important step. Settle your career today. Our new catalogue, just out of press, will tell you how. Send for it.

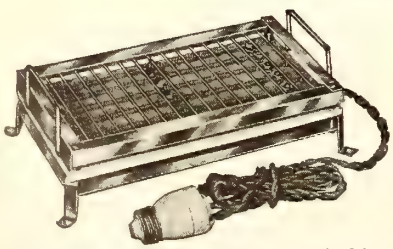
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A SPLENDID GIFT

TOASTS, FRIES, BOILS



Toasts bread as fast as you can Eat It. Attach to your lighting circuit and it is ready for use.

We furnish the parts. You do the assembling and save $2.50. Nothing complicated, anyone can assemble it in 15 minutes. No knowledge of electricity required.

Frame made of Steel, Nickel plated and highly polished. Size 10" long, 6" wide and 3¾" high. Furnished with 6-foot cord and plug.

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You **must** read the book that has been suppressed for over **100 years!** Sent by mail prepaid for only **50c.** If you don't think it is worth **ten times** 50c we will refund your money. **Know the truth!** You will be **startled.** Order at once. **Truth Pub. Co., Dept. A.E., 1400 Broadway, New York.**

Government Radio Control— Once More

(*Continued from page* 541)

cient to maintain contact under all circumstances with American military and naval forces abroad. This was done successfully and as one result this department has had a wide experience in transocean radio communication.

No one thing indicates more clearly the closeness of contact that is surely coming in the world than the fact that it is now quite within the practical to erect a radio station so effectively that its signals can be intercepted in every village in the world. Such an instrumentality can be of incalculable value in bringing the world together and furthering common understandings. The same instrumentality, however, gripped by evil-minded government or private enterprise, is just as available for selfish and dissentious purposes. Yet the risk must not be overlooked and such control must be provided as will lead to its use for social and not antisocial purposes. From the very character of radio its development and control must be considered from a world viewpoint. Messages in the air recognize no boundaries. The full utilization of radio requires world organization and coordination.

From an American commercial point of view, it is evident that the permanent extension of American foreign trade is largely conditioned upon cable and radio communication. Orders are placed and ship movements are directed largely by cable and radio. If other countries have better communication services with lower rates, their nationals have a distinct trade advantage. Further, it has become clear that if the American reader is to have full news reports from all parts of the world, and if American news—the publication of which has very definite commercial and political advantages—is to be printed throughout the world, America must have a highly efficient communication contact with all parts of the world.

As high-power radio is going to play an important part in future commercial development, it is incumbent upon the United States to give immediate consideration to this fact. It would be very detrimental to the interests of the United States were the ultimate control of high-power radio to become lodged in a foreign corporation or in any foreign country or if the United States lagged behind in the utilization of radio.

The Navy Department is required, for purposes of communicating with its ships at long distances and with its outlying bases, to maintain and operate high-power radio stations. These stations are a naval necessity for purposes of national defense. In normal times it is inconceivable that all the available time of these stations will be utilized for Government messages. It seems a comon-sense view that the spare time of these stations should be utilized for the benefit of the American people by handling personal, commercial, and press messages.

Whether the Government should own and operate all transocean radio stations is a subject on which the department, on the basis of its experience, has decided views. Especial considerations enter into radio communication between the United States proper and American possessions. Naval operations and assurance of uninterrupted communication with outlying possessions make essential the further development of these facilities and the maintenance of stations and personnel at highest efficiency. Radio communication at low rates will go far toward linking our outlying possessions to this country. Certainly under no circumstances should such radio communication be allowed to pass into the control—direct or indirect—of foreign corporations or countries.

The immediate problems in connection with transocean radio are: (1) To make available to American commerce and press the present Government-owned stations; and (2) to further the development of transocean radio for the benefit of this country.

Since the Government must have a high-power radio system for its control of the fleet and for other Government business, which includes communication with Army transports, Coast Guard vessels, aircraft, lighthouse tenders, lightships, weather reports, storm warnings, time signal service, hydrographic information and safety of life at sea, it is a needless duplication of capital and effort to permit private stations to operate where they might interefere with each other and with the military and other Government work of stations, and where the Government stations can easily handle commercial work in times of peace; one control only can efficiently manage the variety of communications required.

Radio communication should be considered not alone from the point of view of Government ownership of utilities, but chiefly from the point of view of the best interests of the United States in its international relations. The governments of many of the great powers control wireless either directly or indirectly. The Marconi Wireless Telegraph Co., a British organization, has endeavored to establish a British-controlled wireless circuit of the globe. The high-power Marconi stations in the United States and Hawaii form a part of this system. The high-power stations at Sayville and Tuckerton, as well as those in certain parts of South America, were constructed by German corporations.

The Navy Department is the principal user and

the most extensive buyer of radio apparatus in the United States. It has had the strongest influence in developing apparatus since the early days of the use of radiotelegraphy in this country. It has gained large experience concerning the operative features of radio apparatus, and it is convinced that Government operation and control of all transocean and ship-to-shore stations used for commercial purposes, is necessary on account of present interference between stations, and for other reasons given below:

(*a*) To permit the greatest amount of business, Government and commercial, being done through consistent changes in apparatus, through systematic apportionment of any prompt and frequent changes of wave lengths, and through standardized methods of operating, one management is necessary.

(*b*) Radiotelegraphy has been looked upon as a natural Government monopoly. Since only by the closest regulation can the best use of this art be obtained, not only for commercial and safety at sea, but for military purposes, radiotelegraphy is a strict Government monopoly with the larger number of foreign nations; and, in those countries where commercial stations are permitted, the Government control is generally so strong as to amount to monopoly.

It seems therefore admitted that:

(*a*) Efficient radio communication for military (naval) and other Government purposes is a necessity.

(*b*) Efficient radio communication requires effective control; effective control requires a monopoly and the Government should exercise that control.

(*c*) Military (naval) necessity demands not only efficient and rapid communication, including effective control, but protection of the radio stations from destruction.

(*d*) During periods of strained relations, as well as during war, direct Government control and operation would be the only safe and effective control and operation, as the personnel would be subject at all times to Government supervision and discipline.

(*e*) The commercial interests of the Nation will be served best by having its radio communication facilities under a control that is non-partisan, and one which precludes the possibility of foreign domination or of private domestic monopoly, with consequent liability to preferential treatment by such agencies, of the interests controlling them.

(*f*) The dissemination of news to all countries can be accomplished best and mutual international understandings can be arrived at with more facility through national control of radio.

Radio traffic is very much congested at present; but on account of the centralized control by the Navy at the large ports, there is more traffic being handled than ever before. To turn to the old method of separate control by competing private companies would be disastrous to the merchant marine and the general public.

One central control facilities the coordination of the various systems, i. e., coastal, aircraft, medium power and high power. It enables the proper concentration of radio as an aid to navigation and other radio developments designed to render the life of the mariner more safe.

High-power radio is international in character because it causes interference thruout the world. It is much easier for the Government to regulate international interference than it is for private companies to do so. Most of the countries of the world already own all radio stations within their boundaries, and it is more or less a simple matter for the United States Government to come to an agreement with foreign administrations regarding technical details.

Also, as the art advances and new apparatus is constructed, that will lessen the amount of interference, the international conventions will be modified accordingly. A private radio communication company might not be able, on account of financial reasons, to adopt the more modern apparatus. This might result in complications with foreign countries, and further handicapping of the radio service for the general public might ensue.

In certain localities there are several high-power stations within a small area. When they operate independently the business of all is seriously handicapped. But, on the other hand, when they are operating from a central control, business is expedited, and the general public is able to file more messages. In this connection, it might be said that a station running at full load and handling a maximum amount of traffic is able to give cheaper rates to the general public than those stations which are not running at full capacity on account of interference. The only way to handle transocean radio traffic efficiently is to control all the stations from a central point. A few radio stations controlled in this way will handle more traffic than several cables.

In the above I have endeavored to advance proper arguments which would seem to show the desirability of Government ownership of all radiotelegraph stations which are engaged in ship-to-shore work or long-distance transocean work, and particularly that these should be under the jurisdiction of the Navy Department, which Government department alone has the means and facilities to carry on this work efficiently.

This question of national and international communication by means of radiotelegraphy is particularly prominent at this time, when on ratification of the peace treaty, all restrictions on the use of this art will be removed and many interests will be attracted to this form of investment. It is conceived and shown that ship to shore and transocean radiotelegraphy can only be efficiently carried on under a monopolistic control, and this department contends this should be a Government monopoly, and requests congressional authority to assume this ownership and control. At this time this depart-

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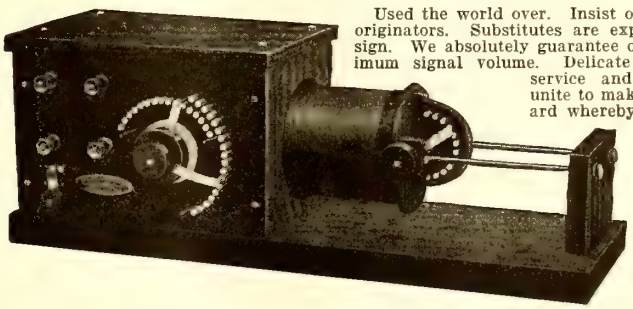
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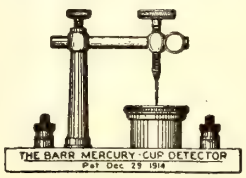
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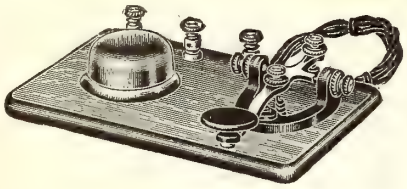
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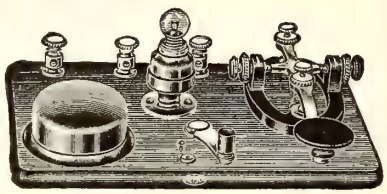
The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

List No.		Price
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Weighs 4 lbs. packed.
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MESCO **Combination Practice Set for Learning the Morse and Continental Visual and Audible Codes**

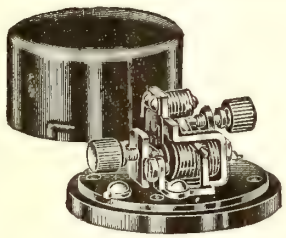
This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.



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ment is confronted with conditions which make it imperative to ask for this monopoly.

Obviously the United States can not own radio stations in other countries. These countries fall into certain groups: (1) Those in which the Government itself maintains a radio monopoly; (2) those in which the Government permits its own nationals, but not foreigners, to own and operate stations; (3) those in which any authorized individual or corporation can erect s ations.

Obviously every encouragement should be given American companies to manufacture and sell radio equipment abroad and to own and operate stations abroad. The American Government-owned stations should exchange traffic with such stations and assist them in any legitimate way. Especially should any patents or improvement controlled by the Government be made available to such American companies under proper safeguards and guaranties.

In conclusion this department recommends that Congress immediately enact legislation regarding radio communication along the following lines:

(1) Either by a committee of Congress or by special designated commission, authorize a comprehensive study of the problems in connection with radio within the United States. This, however, is not of immediate concern to this department. Of course, the department stands ready to give the benefits of its experience and technical knowledge.

(2) Authorization to the President to set aside by proclamation certain bands of wave lengths for ship-to-shore work, for shore to aircraft, and for transocean services in accordance with international conventions and demonstrated needs from time to time.

(3) Constituting ship-to-shore radio service a Government monopoly under the Navy.

(4) Constituting transocean and international radio service a Government monopoly under the Navy.

(5) Authorization for Navy Department to utilize immediately all Navy radio stations for commercial and press business.

(6) Authorize the Navy and other departments to assist American enterprise in the sale of radio apparatus and the development of American-owned radio stations abroad, and especially to authorize the Secretary of the Navy to authorize the use by American companies under proper conditions of Government-owned patents and improvements, to be paid for either in exchange of patent rights or in other suitable ways.

Sincerely, yours,
JOSEPHUS DANIELS.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

Radio Problems in Aviation

By Edward Rice Doyle

(*Continued from page* 543)

factors of capacity on an airplane, since he is used to the high building and tower aërials and the solid capacity of Mother Earth. But the airplane must give its capacity effects with little more than the engine and tank metals for counterpoise. And to build up any additional capacity with lengthened aërial means increased weight and lowered flying efficiency. These considerations have therefor held the aviation radio sets to wave lengths of 300 meters or less. And if any radio engineer was asked to design a transmitting set with a minimum range of 500 miles with 300 meters to work with he would think you had asked the impossible.

It is not so difficult to use loading coils to permit of reception by the radio set in an airplane of longer wave lengths than 300 meters, but the added resistance is always undesirable and for transmission it is impracticable.

And in addition to the head resistance and structural limitations on the radio sets for airplanes we have a number of other complications peculiar to aviation radio, to wit:

The engine noises are always present during flight and make accurate message reading difficult even with "noise-proof" receivers. The army practically never attempted to require aviators to receive messages in the air. All signals to the airplane were visual.

The engine magneto sets up a field which has a marked effect in reducing the transmitting range of the airplane set ahead.

Effective power generation for transmitting means a sacrifice of speed. If coupled

to the engine it means a loss of power and if fan-driven generator is used it must greatly increase head resistance. Storage batteries of sufficient capacity are too heavy.

On account of the narrow range of wave lengths available for airplane radio sets, the possibility of interference is greatly increased.

Since a minimum weight in coils and condensers used in the set itself is necessary, broad tuning is generally used, and this means further difficulty from interference.

Changes of altitude which affect condenser capacity are liable to make prearranged wave length communication difficult where close tuning is required.

Cloud effects are apt to reduce the efficiency of transmission and reception, while static can effect airplane radio communication as disastrously as a land station.

The higher the voltage used on the airplane set the higher the fire hazard. Many precautions against sparks which could be observed in a roomy land station are impossible in the small limits of an airplane cockpit.

Difficulties in controlling the frequency of the generator, especially if fan-driven, involve wave length difficulties not encountered on land.

If in spite of these difficulties some radio engineer can evolve a system that will even partly afford effective radio communication with the airplane, he will find ample rewards awaiting him.

Aside from the structural difficulties presented by the airplane toward experimental work, there is always the actual difficulty of "flying" itself. You can plot an audibility chart for a land station with accuracy, but the airplane is constantly moving while in the air and at every moment it is operating under different conditions. To efficiently experiment, the airplane must proceed thru a given maneuver at a given point several times and the possibilities for error are magnified with speed and distance.

The solution of those problems seems to lie in larger planes. With greater wing spans and greater counterpoise capacity the airplane can attain certain advantages. A plane with a double fuselage, for example, ought to give the best structural advantages both in efficient flying (not to be considered here) and in maximum radio control. (See Fig. 3.)

Note that to obtain directional effect in any point of the compass a maximum change of direction of flight required would be but 45 degrees at most. This is certainly not a serious handicap. Also note the absence of trailing wires.

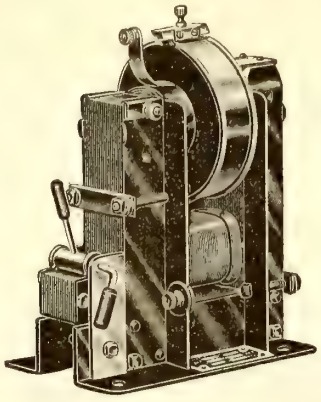
For ideal results, the set would be operated by a storage battery of large capacity, charged by a generator actuated by either of the engines. Thus if the airplane were at rest on the water or land, the set could still be used and any variation of speed or wind would not affect wave length or power input.

Four or five stage amplifications could be used to obtain increased sensitivity of the set to calls, and close tuning would be possible with finely graduated fixt air pressure or oil condensers.

Permanent aërial supports would be built into the airplane by the manufacturer.

DR. GOLDSMITH DIRECTOR OF RESEARCH FOR AMERICAN MARCONI COMPANY.

Dr. Alfred N. Goldsmith, professor in charge of electrical engineering at the College of the City of New York, has been appointed Director of Research of the Marconi Wireless Telegraph Company of America. Dr. Goldsmith is Editor of Publications for the Institute of Radio Engineers, and has recently written an important book on the subject of Radio-telephony.

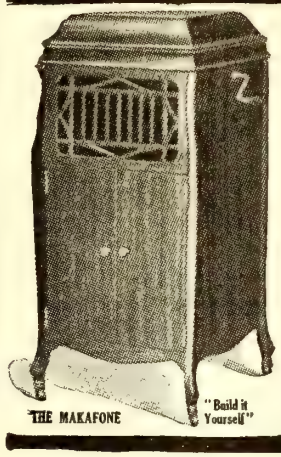


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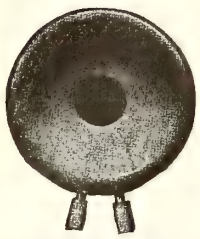
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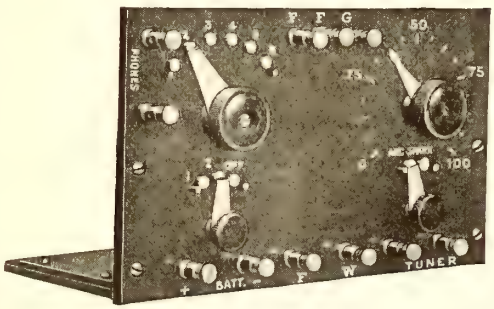
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The Submarine's Under-Water Radio

(Continued from page 584)

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The loop antenna consists of two insulated wires *grounded* at the extreme ends of hull carried over suitable supports to the bridges, and thence thru radio lead-ins to the apparatus.

(1) *Wire.*—Seven strands of No. 14 B. & S. phosphor bronze wire, covered with 40 per cent Para rubber, to a total outside diameter of ½".

(2) *Supports.*—Two substantial masts, triangular or oval in cross-section, 3 feet high with insulators at the top, erected at either end of the boat and braced to withstand considerable strain.

(3) *Stanchions.*—Two stanchions insulated at the top placed high enough to support the wire at least 1 foot above the bridge.

(4) *Radio Insulators.*—An extra radio insulator similar to the one already installed, placed in the space now occupied by the antenna mast (or in any convenient place at least 3 feet away from the other insulator), and extended vertically thru the hull.

(5) *Water-tight Sleeves.*—(To prevent the sea water from working up under insulation on wire.) Brass stock 3" long bored to outside dimensions of insulated wire for 2¾" and drilled dimensions of bare wire for ¼". The wire is stript of insulation for a few inches and is slipt thru the sleeve, the insulated portion being smeared with white lead and the stript portion being soldered to the brass.

(6) *Grounded Connections.*—Lugs on end of wire grounded to hull by bolts.

(7) *Lead-in Joints.*—Junction of insulated wire and radio conductor is made water-tight by marine glue poured in a cylindrical mold.

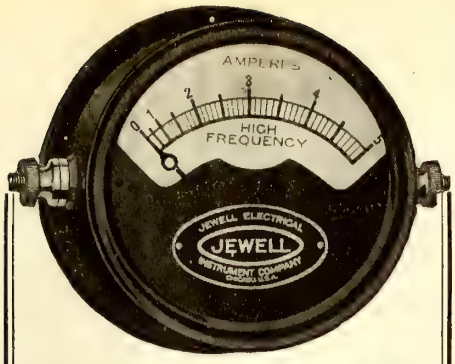
(8) *Wire-tightening Device.*—(*a*) Turnbuckles may be placed at the end of each wire next to ground connections; or (*b*) in order to take up slack on both wires equally it is preferable if construction of boat permits to place one insulated turnbuckle between stanchions on bridge.

(9) *Receiving Apparatus.*—Tuner capable of receiving wave lengths of 300 to 16,000 meters, and oscillation audion detector and three-stage resistance type amplifier of French design. (The Navy standard audion control box type SE 1,000 two-step amplifier cannot be used unless placed in a noise-proof and inductive-proof compartment.)

(10) *Transmission Apparatus.*—Regular quenched spark set, preferably the 1 KW. size. Terminals of loop antenna are connected to the antenna and ground connections, respectively, with a .0005 microfarad condenser in series with the loop. The ground connection on the set being removed.

SENATOR MARCONI A PEACE DELEGATE.

The new Italian Ministry has selected Senator Marconi as one of the Italian peace delegates. The illustrious scientist was appointed a Senator by the King of Italy in 1915 and seems to be entering more and more into the public life of his country. It is surely most fitting that he, whose genius has so greatly contributed to the preservation of human life and the promotion of international communication, should now receive the signal honor of being made a peacemaker. He is shortly to visit America on the subject of the peace treaty and other matters.



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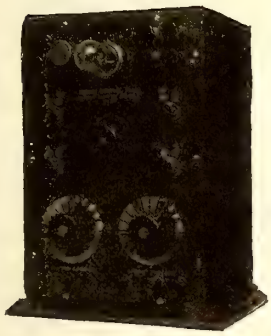
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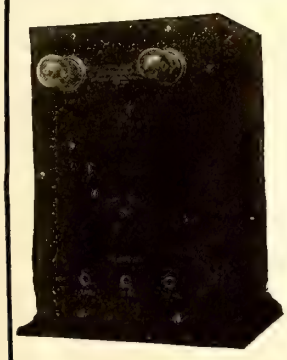
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Can Radio Ignite Balloons?

(*Continued from page* 516)

WHAT NIKOLA TESLA SAYS

Probably no other living electrician could be found today who can more authoritatively state just what effect can be produced at a distance by radio currents, than Dr. Nikola Tesla. He has produced and measured the greatest electrical discharges ever developed by man—sparks 70 to 100 feet in length, which manifested their influence 12 miles and more distant. In a special interview with the ELECTRICAL EXPERIMENTER representative, Dr. Tesla said in regard to the present blimp disaster:

"Referring to electrical or radio wave action at a distance, I know from experience that if proper precautions are not taken, fires of all kinds and explosions can be produced by wireless transmitters. In my experiments in Colorado, when the plant was powerfully excited, the lightning arresters for *twelve miles around* were bridged with continuous arcs, much stronger and more persistent than those which ordinarily took place during an electric storm. I have excited loops (coil aerials) and lighted incandescent lamps at a considerable distance from the laboratory without even using more than five or ten per cent of the capacity of the transmitter. When the oscillator was excited to about 4,000,000 volts and an incandescent lamp was held in the hand about *fifty or sixty feet from the laboratory,* the filament was often broken by the vibration set up, giving some idea of the magnitude of the electromotive forces generated in the space. The accompanying illustration shows one of my experiments in which I lighted several lamps at a distance of 100 feet from the laboratory, purely by wireless energy. Such induced currents might easily fire a gas balloon under the proper conditions. When the large transmitter coil, 51 feet in diameter, which I had in the center of the laboratory, was powerfully energized, butterflies were carried around in a circle as in a hurricane and could not get out, no matter how they tried. I was unable to satisfactorily explain the gyrations in the circle, altho I can well understand that the charged coil might, by repulsion, keep them in the center. Perhaps the most remarkable of all the observations was the production of sparks in the sand when one walked at some distance from the building. At night a continuous stream of tiny sparks could be seen between the heels and the earth and between the grains of sand. Another most curious effect was the action on horses, which shows how very sensitive they are to electric shock. When I operated with undamped waves, the oscillator being perfectly silent (no streamers whatever), a horse at a distance of perhaps *one-half a mile,* would become scared and gallop away the instant the switch was thrown on. I suppose the capacity of the body was sufficiently great to derive a rather strong current thru the legs which would frighten the animal. When using damped waves the roar was so strong that it could be plainly heard ten miles away and despite all precautions, such as using cotton in the ears, one would get a singular sensation in the head as if something was bursting, similar to that I observed with Röntgen Rays in 1896 or '97, when I was operating with a powerful apparatus designed for their production.

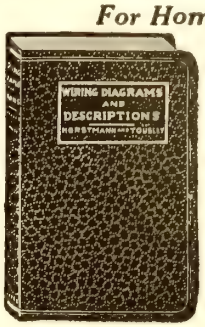
"In my experiments in New York in the laboratories at 35 South Fifth Avenue and at Houston Street, I have exhibited to thousands of people effects of loops or coil antennae. In one experiment, for instance, I would tune a coil about 30 inches in diameter with which I would collect at

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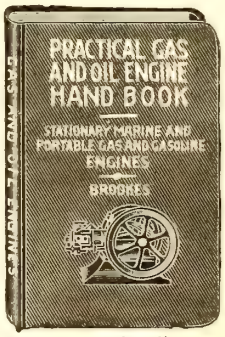


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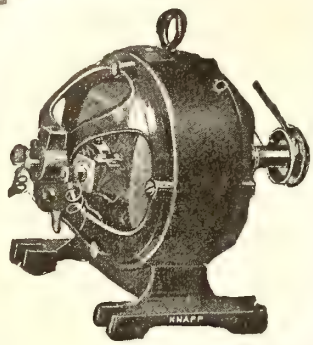
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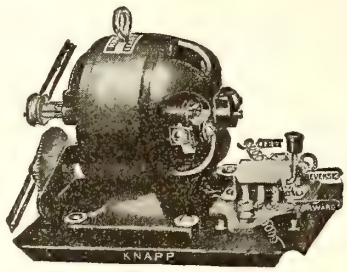
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any place in a large hall, *nearly three-quarters of a horsepower,* lighting incandescent lamps, producing long discharges, streamers, etc. One of my exhibits, which was particularly appreciated, was a coil carried on the head which, when resonantly excited, would develop streamers several feet long.

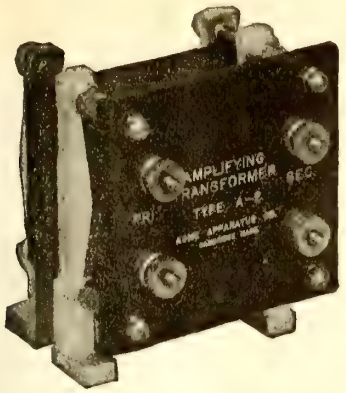
"As regards that deplorable accident to the blimp in Chicago, of course a powerful wireless plant is capable of setting up, at a few hundred feet distance, electro-motive forces of such magnitude that if there is even moderate rise thru resonance, long sparks may result. *In Colorado I drew 1-inch sparks between my body and an iron pipe buried in the ground about 100 feet from the laboratory.* I think it perfectly practicable to produce an explosion by wireless designedly at a considerable distance from a wireless transmitter, and I look upon the accident as very likely having been due to some such cause. By taking proper precautions, however, it is possible to entirely eliminate this danger and I have devoted much thought to the subject, having early recognized the peril to such bags filled with hydrogen. According to my ideas, the accident is not so much chargeable to the plant as to the neglect of proper precautions on the aërial vessel itself. Such a vessel has a considerable span and the guy wires, gondola and other metallic parts constitute a considerable capacity, so that an appreciable amount of energy can be deprived from a wireless plant at a great distance, as it is well shown in the ease with which messages are transmitted to, and received from, aërial vessels.

"Why do the naval and other authorities allow such forms of aircraft to use an explosive gas like *hydrogen?* A short time ago the press was filled with the wondrous stories of how the U. S. Government experts had perfected the manufacture of the new and non-inflammable balloon gas—*helium,* to such an extent that it was very cheap and readily obtainable in quantities. Funny, how these "new" inventions require so long a time to reach the public and those who need them. Helium, extracted from illuminating gas, is not new or wonderful at all. My friend, Sir James Dewar, showed me experiments with it over 20 years ago."

How radio waves, even at distances of several miles, can cause sparks to occur among bales of cotton, baled with wire hoops, etc., is shown in one of the accompanying illustrations. The cotton bale wires have currents induced in them every time a radio message is sent from the ship or in its vicinity. This induced current is practically never strong enough to heat up the wire, but should one of these wires break and form a spark gap, then very often the induced current will cause a spark to jump the gap. That is enough to start a fire. Where wired bales are packed close together in the hold of a steamer, in trains, or warehouses, here also radio waves are liable to cause fairly strong electrical oscillations to be set up by resonance in adjacent loops on the bales, as the diagram shows. Result, a spark occurs, and another fire of "unknown origin" has started.

M. George A. Leroy, a French chemist, in his municipal laboratory at Rouen, France, very ably demonstrated that wireless waves could without doubt cause fires at a distance. His apparatus is shown schematically herewith.

Mr. Leroy's apparatus has been christened by him the "Igniting Resonator." The apparatus he used consists of a glass bulb having four apertures; one at either side and one at the top and bottom, respectively. The substance to be tested with this igniter resonator can be placed in the airtight glass compartment and the two electrodes very accurately adjusted by micrometer screws fitted to them. The transmitter comprises a spark coil giving a 15-to-20-



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inch spark, which was connected with a spark gap, glass plate and tin-foil condenser and a loop antenna or spiral comprising a few turns of heavy wire, about 2 feet in diameter. Several yards distant, Mr. Leroy placed his receiving coil or igniting resonator, which included a loop or heavy copper conductor about three feet in diameter. The action on the device was similar to that of the Hertzian resonator, i. e., whenever the spark coil or transmitting helix were excited, allowing a spark to jump the gap, electromagnetic waves were set up in the intervening ether, causing corresponding currents to be induced or set up in the receiving loop. As in the historic experiments of Hertz, this loop will gather sufficient energy from the etheric waves to cause a small spark to jump a gap connected across the terminals of the loop, as the accompanying diagram clearly shows.

Mr. Leroy carried out many different experiments with his apparatus, placing the glass spark chamber of the igniting resonator in a bath of oil or vaseline, which can be heated when desired by incandescent lamps, etc.

One of the most interesting experiments carried out by Mr. Leroy was that with miniature bales of cotton, which were enclosed in jute wrappers and provided with iron wire bands, in the way cotton is usually packed for shipment. "Spontaneous combustions in cotton warehouses and in shipholds loaded with cotton or similar material, are not always what they seem," says Mr. Leroy, in describing his experiments and results with the radio igniter. One of the hoops encircling the bale of raw cotton may break or become loose under the action of shock or from some other cause, and the gap created by the breaking of the wire, forms a miniature Hertzian resonator. When a wireless station situated in the immediate vicinity, or perhaps at some quite distant point, starts in to transmit (and the more powerful the station the more pronounced the effect and danger from fire of course), currents will be induced in the iron wire around the bales or other packages, and sparks may pass between the various metal members. Especially will they be inclined to jump small gaps in the wire which occur in the immediate loop. We may say right here, that to a layman all of this phenomena may seem somewhat far-fetched, and not within the realm of everyday possibilities, but anyone who has experimented with high frequency currents, as generated from even a small size oscillator, will at once be convinced that these effects can and do take place under most unbelievable conditions. Of course, one objection that the average electrical and radio reader will probably think of, is that if the cotton bales, et cetera, are placed in a steel vessel, that this metallic hull will act as a screen, and that the bales will not have any current induced in their wire loops, but while this may be partially so, in some cases it is not always so by any means; especially when the home transmitting station, such as on ship-board, starts in operating. In this case, the steel hull of the boat is charged whenever the transmitting key is deprest.

The secret, if so we may call it, of the production of inflammatory sparks or discharges in metallic bodies such as here described, lies in the phenomena known as "resonance." This means that the nearer the metallic members come in tune with the radio waves, the more pronounced the induction effects produced in any instance. It is of course readily conceivable that a cargo of cotton bales presents many peculiar conditions of resonance, due to the varying capacities and inductances of the various loops. In fact, so obvious and possible is this condition, that a wooden vessel carrying bales of cotton or other material having wire or metal members to hold them, and providing she is fitted with a

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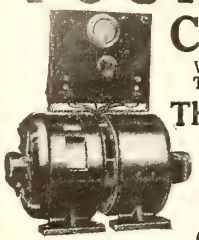
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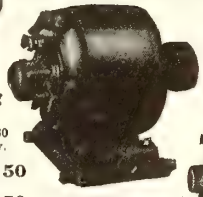
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CINCINNATI, OHIO
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wireless station of even a few kilowatts, that the Editors would prefer to stay on land than go to sea on such a ship.

One of the accompanying photographs shows how a great multitude of close oscillatory circuits are provided unwittingly in all-framed or rigid gas airships, and even in the non-rigid gas airships there is usually a sufficient amount of metal present in the gondola, wires and other fittings to form one or more resonant circuits, which may cause a spark at an imperfect joint or other gap. It should be remembered, as laboratory tests have demonstrated beyond cavil, that it is not necessary to have a metal wire coil *in spiral form* in order to have powerful currents induced of sufficient strength to cause a spark to jump from it; a straight metallic wire, bar or even tools, lying within a few yards of a small high frequency coil, will pick up sufficient energy to cause sparks to jump from them, and they will sometimes glow with a vivid brush discharge when viewed in a darkened room.

NATIONAL INSTITUTE OF INVENTORS.

The installation of the officers of the National Institute of Inventors, 118 Fulton Street, New York City, N. Y., was held at the Broadway Central Hotel recently, in the presence of 1,000 guests and members. After a very fine entertainment in which the well-known coloratura-soprano, Miss Edna Blanche Showalter, had rendered selections, and Miss Cecelia Bornstein executed in remarkable fashion her salome dance, the newly elected officers were installed.

Addresses were given by Prof. Chandler, a chemist of international reputation and patent expert; Joseph H. Choate, Jr., who spoke of the founding of the Chemical Foundation, Inc., to which foundation all the German chemical patents had been turned over by former Alien Custodian, Attorney-General Palmer, and an address was made by Thomas Howard, executive chairman of the institute, on the severance and dissociation of the patent office from the Department of the Interior, and the establishing of a Court of Appeals to pass upon patent litigation. He was presented with a medal for faithful services. Refreshments were served and the guests danced until the wee hours of the morning.

The newly elected officers, to serve until 1920, were L. J. Wing, President, pioneer inventor of exhaust fans; Carl Schonert, manufacturer of automobile accessories, of Newark, First Vice-President; Robert C. Lafferty, architect, New York City, Second Vice-President; George Julian Houtain, attorney at law, of 44 Court Street, Brooklyn, Third Vice-President; Milton F. Williams, manufacturer of pulverizers, St. Louis, Mo., Fifth Vice-President; W. H. Kennedy, Recording Secretary; Nathan Langer, Treasurer; Paul Revere Fay, one of the fighting Sixty-ninth, Executive Secretary, and R. Nerenstone, Assistant Executive Secretary.

On the Board of Governors to serve for five years were elected: David Moss, New York City; L. Kenner, New Orleans; Julius Glantz, New York City; Michael Quinane, Paterson, N. J.; J. M. Harding, New York City.

AND WOMAN IS LUCKY TO MAKE ONE MATCH.

One of our newspaper friends—the Oklahoma City *Times*—quotes us as follows:

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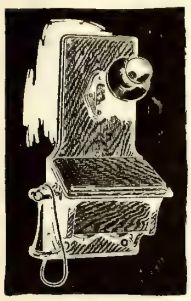


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Dept. W Elmira, N. Y.

Experimental Mechanics

By Samuel D. Cohen

(*Continued from page 579*)

ing oil just above the work. A small brass pipe is soldered into the bottom of the can and leads down to a point just above the tap. By fitting a small valve or stopcock to the bottom of the brass pipe the amount of oil fed onto the tap may be regulated to any degree desired. In threading holes in this manner in the lathe, the tap is very easily backed out by reversing the shift lever on the lathe or counter-shaft, so as to reverse the direction of the chuck, when the threaded object will unwind itself from the tap. In performing this reverse operation to remove the tap, the tail-stock should of course be backed away from the tap so that no pressure whatever is on the tap or otherwise the thread may be ruined, due to the tap being jammed into the threads.

Holes often have to be tapt in very inaccessible locations and for such work a machinist usually provides himself with a long tap wrench. In fact a very good stunt for this work is to arrange a standard tap wrench, so as to fit several different lengths of threaded extension rods, and in this way such out-of-the-way holes can readily be threaded. (*To be continued.*)

Diam. Tap	Thds. per In.	Size of Drill	Diam. Tap	Thds. per In.	Size of Drill
3/32"	48	No. 50	19/32"	12	31/64"
3/32"	52	No. 50	19/32"	14	1/2"
3/32"	54	No. 49	5/8"	10	31/64"
3/32"	56	No. 49	5/8"	11	1/2"
3/32"	60	No. 48	5/8"	12	33/64"
7/64"	32	No. 50	21/32"	10	33/64"
7/64"	36	No. 49	21/32"	11	17/32"
7/64"	40	No. 47	21/32"	12	35/64"
7/64"	48	No. 44	11/16"	11	9/16"
7/64"	56	No. 43	11/16"	12	37/64"
1/8"	32	No. 44	23/32"	11	19/32"
1/8"	36	No. 43	23/32"	12	39/64"
1/8"	40	No. 42	3/4"	10	39/64"
1/8"	42	No. 41	3/4"	11	5/8"
1/8"	48	No. 39	3/4"	12	41/64"
9/64"	30	No. 41	25/32"	10	41/64"
9/64"	32	No. 40	25/32"	11	21/32"
9/64"	36	No. 37	25/32"	12	43/64"
9/64"	40	No. 34	13/16"	10	43/64"
5/32"	30	No. 33	27/32"	10	45/64"
5/32"	32	No. 32	7/8"	9	23/32"
5/32"	36	No. 31	7/8"	10	47/64"
5/32"	40	No. 30	29/32"	9	3/4"
11/64"	32	No. 30	15/16"	9	25/32"
11/64"	36	No. 29	31/32"	9	13/16"
11/64"	40	No. 28	1"	8	53/64"
3/16"	24	No. 29	1 1/32"	8	55/64"
3/16"	28	No. 28	1 1/16"	8	57/64"
3/16"	30	No. 27	1 3/32"	8	59/64"
3/16"	32	No. 26	1 1/8"	7	59/64"
3/16"	36	No. 24	1 1/8"	8	61/64"
13/64"	24	No. 26	1 5/32"	7	61/64"
13/64"	28	No. 22	1 5/32"	8	63/64"
13/64"	32	No. 20	1 3/16"	7	63/64"
13/64"	36	No. 18	1 3/16"	8	1 1/64"
7/32"	24	No. 20	1 7/32"	7	1 1/64"
7/32"	28	No. 17	1 7/32"	8	1 3/64"
7/32"	30	No. 16	1 1/4"	7	1 3/64"
7/32"	32	No. 15	1 9/32"	7	1 5/64"
15/64"	24	No. 16	1 5/16"	7	1 7/64"
15/64"	28	No. 12	1 11/32"	7	1 9/64"
15/64"	32	No. 10	1 3/8"	6	1 1/8"
1/4"	18	No. 17	1 13/32"	6	1 5/32"
1/4"	20	No. 14	1 7/16"	6	1 3/16"
1/4"	24	No. 9	1 15/32"	6	1 7/32"
9/32"	16	No. 10	1 1/2"	6	1 1/64"
9/32"	18	13/64"	1 17/32"	6	1 9/64"
9/32"	20	No. 3	1 9/16"	6	1 21/64"
5/16"	16	No. 1	1 19/32"	6	1 23/64"
5/16"	18	15/64"	1 5/8"	5	1 21/64"
11/32"	16	F	1 5/8"	5½	1 23/64"
11/32"	18	17/64"	1 21/32"	5	1 23/64"
3/8"	14	J	1 21/32"	5½	1 25/64"
3/8"	16	L	1 11/16"	5	1 25/64"
3/8"	18	19/64"	1 11/16"	5½	1 27/64"
13/32"	14	N	1 23/32"	5	1 27/64"
13/32"	16	P	1 23/32"	5½	1 29/64"
13/32"	18	21/64"	1 3/4"	5	1 29/64"
7/16"	14	R	1 25/32"	5	1 31/64"
7/16"	16	S	1 13/16"	5	1 33/64"
15/32"	14	3/8"	1 27/32"	5	1 35/64"
15/32"	16	W	1 7/8"	4½	1 35/64"
1/2"	12	25/64"	1 7/8"	5	1 37/64"
1/2"	13	X	1 29/32"	4½	1 37/64"
1/2"	14	13/32"	1 29/32"	5	1 39/64"
17/32"	12	27/64"	1 15/16"	4½	1 39/64"
17/32"	13	27/64"	1 15/16"	5	1 41/64"
17/32"	14	7/16"	1 31/32"	4½	1 41/64"
9/16"	12	29/64"	1 31/32"	5	1 43/64"
9/16"	14	15/32"	2"	4½	1 43/64"

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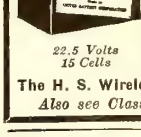
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Name_____
Present Occupation_____
Street and No._____
City_____ State_____

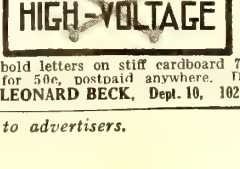
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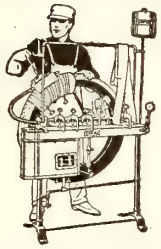
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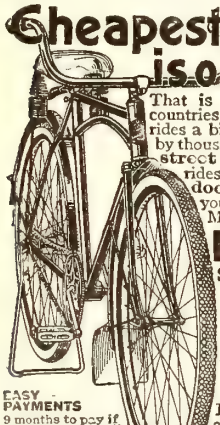
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To Europe in Three Hours

(*Continued from page* 575)

fair, not to be compared with our passenger carrying types of lighter-than-air aircraft, which incorporate the important factor of having a "dead load" (crew, engines, fuel, etc.); this takes a very large proportion of the total lifting effort exerted by the balloon envelope. In the testing balloon the ratio of "dead lift" to the weight of the balloon itself is very much less, and if some of the gas originally put into the bag has to be dissipated by an automatic valve, to keep the balloon from bursting, there will still be sufficient gas left in descending to lower levels to sustain the recording instruments carried, owing to two reasons, viz.: the greater free expansibility of the small, simple balloon of this type, whose diameter may have increased at the higher altitudes to four or five times its normal inflated diameter at sea level; and again due to the low ratio of the "dead weight" to the balloon weight proper.

High Altitude Airplanes

When it comes to operating airplanes at high altitudes several factors confront us. Some of these factors we have already mentioned in the foregoing text—such as increasing the wing-spread and the total exposed area of the wings; improving the thrust of the propellers by lengthening them and possibly increasing their speed; utilizing air-compressors for the pilot's cab and carburetor systems of the engines; using "vacuum bottle" cabs for the crew, etc. Variable pitch propellers are being strongly advocated by altitude fliers nowadays, including Major Schroeder. These would seem to improve the climbing and propelling efficiency.

As Mr. Harry E. Dey has pointed out, the reduction in the weight of the air falls off as we go up in the atmosphere; at say 3½ miles altitude the weight of the air is about one-half that at sea level, and the resistance has reduced to approximately one-half also. The airplane at this level should therefore, as Mr. Dey also believes and states, be accelerated to *double* its sea level velocity, which let us consider as having been 200 miles per hour. Here then the plane should travel at 400 miles an hour. Some one objects, however, that altho this may be quite true, the supporting power of the air has fallen to about one-half. True; it has decreased one-half for the *former* 200-mile-per-hour speed, but this loss has been neutralized by the *increased velocity,* 400 M.P.H., with the result that the net buoyancy is the same as formerly.

Reasoning on this basis of reduced weight and less air resistance at the higher altitudes, it becomes possible to attain some real hair-raising speeds in an airplane. For example, if we consider the weight of the air at eight miles altitude to be but (approximately, to simplify matters) one-fifth of that at sea level, then the speed which an airplane attaining 200 M.P.H. at sea level, would attain at this altitude (about 42,000 feet) figures to the astounding velocity of 1,000 *miles per hour.* According to this method of reasoning, as followed by Mr. Dey, Europe is only a stone's throw away from us, and we can call up Cousin John or Aunt Kate in London and tell them to hustle over for Sunday dinner. They'll be with you in your New York city apartment and raving over your wife's salad, *just three hours later!* 1,000 M.P.H. divided into 3,000 miles=3; simple, ain't it? Gad, tho, this is awful; our wife's folks will *all* be with us every week-end! Get that!!! You know there's such a thing as "too much speed." What?!

Q. S. T.

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30x3½	2.00	5.00
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Size	New Tube	Price
35x4½	$3.00	$10.25
36x4½	3.50	10.50
35x5	3.75	11.00
36x5		11.50
37x5	4.00	12.00

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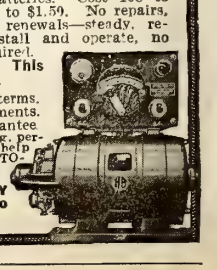
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And think of inviting your Aunt Kate or Cousin Myra, from London to make the aërial trip over the pond in three hours! Did you think of the catastrophe that might await you?! No? Well, listen Lester: your aunt, and the rest of the family tree hailing from "dear ol' Lunnun" would be eating your "dinner" at *their* "supper time," and the Sunday visitor from London! Can you imagine him arriving on the morning (at New York) aërial boat at 7 o'clock A. M. He left London at 9 o'clock, traveled over in three hours, which makes it 12 o'clock noon by his turnip; wherefore, and hence—Mr. England would have to sit down with you and eat his *breakfast* all over again, and at "dinner time," at that. It's not as bad as it sounds—the sea air would make it possible.

The Story of Rohlfs—New American "Altitude Flier."

Among other things, Roland Rohlfs, the new American altitude record holder, recently stated:

"I shall take every precaution on my next trial. In order to obviate the trouble I had in keeping my motor warm shutters will be provided, and the gasoline pump, which became airbound, making it necessary for me to pump by hand nearly two hours, has been adjusted. I shall also make more careful selection of the gasoline I use. In my last attempt I used a high test gas and I failed to get within 200 revolutions per minute what I got the first time.

"I shall also wear more clothing. My hands got very cold, in spite of the fact that I had on several pairs of gloves and mittens. I shall also try more oxygen, for on both my flights my supply has given out. I always try to be as sparing as possible, not using it until I reach approximately 23,000 feet.

"What is the purpose of altitude flights? I suppose most people think they are made merely to satisfy the vanity of the pilot or the airplane designer—something like the automobile speed race. Not at all. It has a distinct scientific value. It gives invaluable data to the meteorologist and will be of infinite value when the time comes for the establishment of air lanes of travel for airplanes.

"At the present time our knowledge of conditions is based largely on observations made from kites and from balloons, but these are stationary and, for the most part, the information gained is applicable only to localities in which the tests are made. With the airplane one can cruise about in the thin upper strata of the air and actually chart the conditions that can be expected to prevail there. It will enable us to make certain lanes of travel for airplanes of various types, say the upper levels for the speedier planes and the lower levels for the slower going machines.

"We also get valuable information concerning the kind of planes and motors that will have to be built for use at various air levels. It gives us data concerning the way motors act under certain conditions and at certain levels, how the machine maneuvers, what sort of wing construction is necessary.

"It also gives us valuable medical data concerning the effects of different altitudes on different people.

"It is almost impossible for us to conceive that six miles above one of our bathing beaches, six miles above cities where people are sweltering in the heat, the temperature is twenty-five degrees below zero and that a wind of from 100 to 200 miles an hour is blowing. That information in itself will be important when commercial aviation gets to be a regular thing. With all this information at hand, think how easy it will be for us to go up in a specially-

(*Continued on page* 599)



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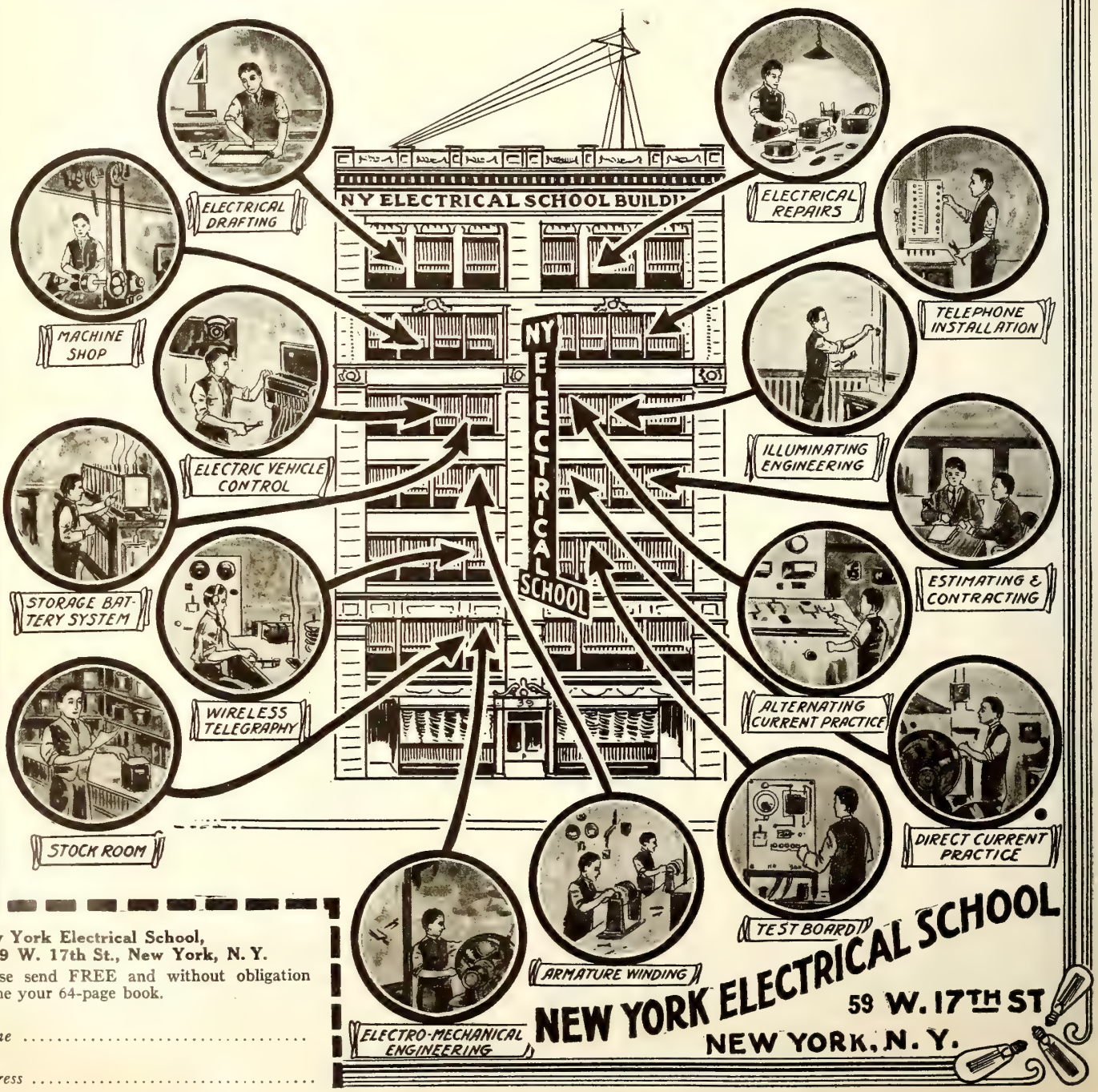
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To Europe in Three Hours

(*Continued from page* 597)

constructed machine, the body built perhaps on the principle of the *vacuum-bottle*, take advantage of the 200-mile-an-hour wind which prevails from the east, *and land in Europe in half a day.* Because, with a wind of that velocity, you can conserve gasoline and simply let the wind blow you where you want to go. You can get the wind-direction at various levels by means of observation kites.

"Speeds greater than we have ever thought of will be attained and commercial aviation will take advantage of them sooner or later."

Rohlfs flew a Curtiss Wasp biplane equipt with a twelve-cylinder 400 horsepower Kirkham motor. The biplane weighed 1,900 pounds and had a wing span of 32 feet and half an inch and measured 23 feet over all in length. He tried out the climbing powers of the machine in an unofficial flight, in which he reported reaching a height of 31,000 feet. Numerous witnesses were called after his official altitude climb, to make the flight official, and the barograph was signed by Major J. T. Roessel, Major H. F. Miller, Lieut. Col. W. L. Moose, Jr., Captain A. F. Simonin, Colonel Archie Miller, Augustus Post, on behalf of the Aero Club of America; John T. Tarbox, Secretary of the Aero Club of America, and the pilot himself.

New Altitude Record with Passenger.

A new world's altitude record of 30,000 feet is said to have been establisht for an airplane with passenger by Lieutenant Weiss, the pilot, and Mechanician Begue, according to a message from Paris dated August 13. The flight, which took fifty-two minutes, was made at Villacoublay, near Paris. The aviators' instruments showed that they experienced a temperature of more than 25 degrees Fahrenheit below zero. The official figures on the ascent will be made public later.

ELECTRICITY STEERS BLIND MAN.

(*Continued from page* 530)

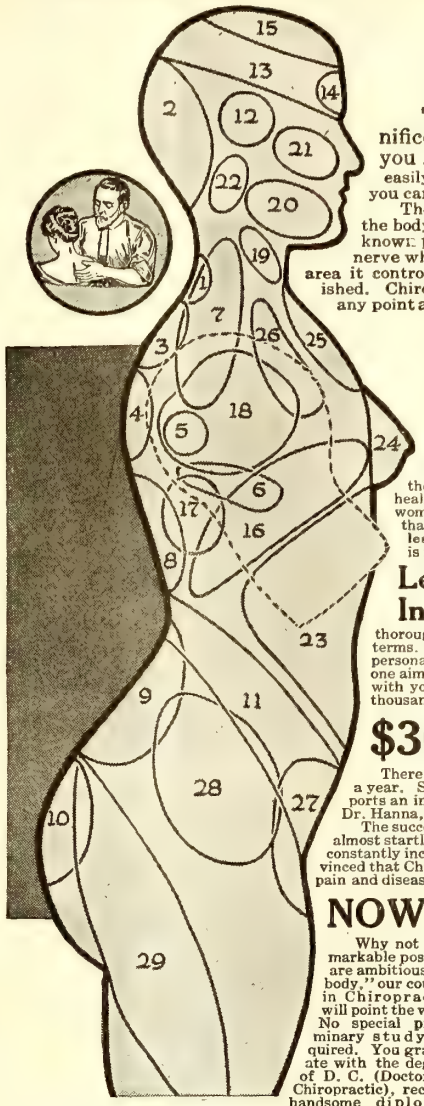
Not only is it possible to set the compass by touch or by sight so as to travel due north, south, east or west, by the four notches in the adjustable lid, but it is also possible to set the compass so as to maintain a course in any given direction. This is accomplisht by setting the compass so that the point on the compass which would point north with the needle when the instrument is in a natural position is pointed in the direction desired. The two contact pins are then dropt over the compass needle by means of the lid or cap.

It is difficult for men traveling in the woods or on the desert to maintain a set direction. But with the direction indicator attached to his belt, the wearer could set the compass before starting out—changing it when he desires—and it would warn him every time he deviated from the determined course.

The instrument can be used on boats to automatically maintain a desired course, and this development is being worked out by its inventor. It would also be practicable for aircraft. Instead of sounding an alarm, the device would result in throwing over a rudder, and the boat or aircraft would at once resume its predetermined direction. Especially valuable would the device be for torpedo or bombing craft that are automatically controlled, says its inventor.

Contributed by L. W. PADRONE.

Learn to Treat Disease This Way



This is a small reproduction of one of 22 magnificent charts **all of which** we want to send you **ABSOLUTELY FREE,** just to show you how easily you can master Chiropractic and how successfully you can treat disease by this modern drugless healing method. These charts show the different pain and nerve areas of the body. The science of Chiropractic is based upon the well known principle that when there is bone pressure on a trunk nerve where it leaves the spinal column there will be pain in the area it controls: and that by relieving the pressure the pain is banished. Chiropractic teaches you how to locate nerve pressure at any point along the spinal column and how to relieve it.

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Advanced Science of Spinal Adjustment

The great profession that within the past few years has taken the longest forward strides ever known in the history of drugless healing. It has called to its ranks thousands of ambitious men and women from every walk of life. Today it is calling more insistently than ever because **the tide has turned strongly in favor of drugless healing. Right now** the demand for Doctors of Chiropractic is far greater than the supply.

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The American University method of teaching enables you to study by mail or in class and obtain a complete mastery of Chiropractic in the shortest time consistent with thoroughness, while you hold your position. You can pay on easy terms. From the day you enroll your instruction will be under the personal direction of a splendid faculty of Chiropractic experts. Our one aim will be to make you successful. We will work whole-heartedly with you to advance your interests so that in a short time you, like thousands of Chiropractors, can earn a good income.

$3000 to $5000 a Year

There are many instances of Chiropractors earning from $3000 to $5000 a year. Some upwards of $10,000. Dr. M. D. Moore, of Kentucky, reports an income of $9,000 a year. Dr. L. H. Roche, New Jersey, $5,000; Dr. Hanna, of Kentucky, over $5,000 yearly.

The success of Chiropractors in many cases has come so quickly as to be almost startling. And yet, it is not to be wondered at when you consider the constantly increasing number of intelligent, thinking people who are now convinced that Chiropractic is the common-sense and really scientific way to relieve pain and disease and who, therefore, **demand the services of Chiropractors.**

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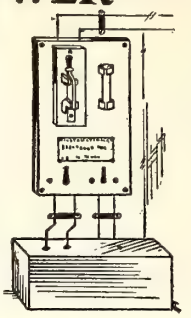
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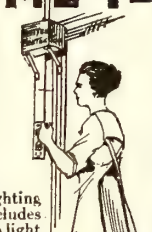


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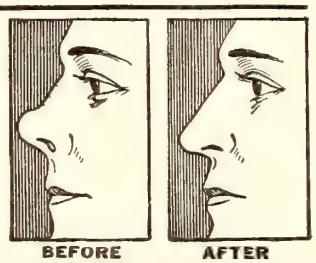
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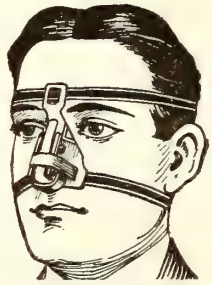
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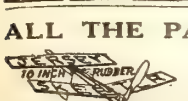
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My Inventions

By Nikola Tesla

(*Continued from page* 556)

this is also true, and perhaps more so, of certain defects in the brain which deprive the automaton, more or less, of that vital quality and cause it to rush into destruction. A very sensitive and observant being, with his highly developed mechanism all intact, and acting with precision in obedience to the changing conditions of the environment, is endowed with a transcending mechanical sense, enabling him to evade perils too subtle to be directly perceived. When he comes in contact with others whose controlling organs are radically faulty, that sense asserts itself and he feels the "cosmic" pain. The truth of this has been borne out in hundreds of instances and I am inviting other students of nature to devote attention to this subject, believing that thru combined and systematic effort results of incalculable value to the world will be attained.

Dr. Tesla's First Automaton.

The idea of constructing an automaton, to bear out my theory, presented itself to me early but I did not begin active work until 1893, when I started my wireless investigations. During the succeeding two or three years a number of automatic mechanisms, to be actuated from a distance, were constructed by me and exhibited to visitors in my laboratory. In 1896, however, I designed a complete machine capable of a multitude of operations, but the consummation of my labors was delayed until late in 1897. This machine was illustrated and described in my article in the Century Magazine of June, 1900, and other periodicals of that time and, when first shown in the beginning of 1898, it created a sensation such as no other invention of mine has ever produced. In November, 1898, a basic patent on the novel art was granted to me, but only after the Examiner-in-Chief had come to New York and witnesst the performance, for what I claimed seemed unbelievable. I remember that when later I called on an official in Washington, with a view of offering the invention to the Government, he burst out in laughter upon my telling him what I had accomplished. Nobody thought then that there was the faintest prospect of perfecting such a device. It is unfortunate that in this patent, following the advice of my attorneys, I indicated the control as being effected thru the medium of a single circuit and a well-known form of detector, for the reason that I had not yet secured protection on my methods and apparatus for individualization. As a matter of fact, my boats were controlled thru the joint action of several circuits and interference of every kind was excluded. Most generally I employed receiving circuits in the form of loops, including condensers, because the discharges of my high-tension transmitter ionized the air in the hall so that even a very small aerial would draw electricity from the surrounding atmosphere for hours. Just to give an idea, I found, for instance, that a bulb 12" in diameter, highly exhausted, and with one single terminal to which a short wire was attached, would deliver well on to one thousand successive flashes before all charge of the air in the laboratory was neutralized. The loop form of receiver was not sensitive to such a disturbance and it is curious to note that it is becoming popular at this late date. In reality it collects much less energy than the aerials or a long grounded wire, but it so happens that it does away with a number of defects inherent to the present wireless devices. In demonstrating my invention before audiences, the visitors were requested to ask any questions, however involved, and the automaton

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would answer them by signs. This was considered magic at that time but was extremely simple, for it was myself who gave the replies by means of the device.

At the same period another larger tetautomatic boat was constructed, a photograph of which is shown in this number of the ELECTRICAL EXPERIMENTER. It was controlled by loops, having several turns placed in the hull, which was made entirely water-tight and capable of submergence. The apparatus was similar to that used in the first with the exception of certain special features I introduced as, for example, incandescent lamps which afforded a visible evidence of the proper functioning of the machine.

Telautomatics of the Future.

These automata, controlled within the range of vision of the operator, were, however, the first and rather crude steps in the evolution of the Art of Telautomatics as I had conceived it. The next logical improvement was its application to automatic mechanisms beyond the limits of vision and at great distance from the center of control, and I have ever since advocated their employment as instruments of warfare in preference to guns. The importance of this now seems to be recognized, if I am to judge from casual announcements thru the press of achievements which are said to be extraordinary but contain no merit of novelty, whatever. In an imperfect manner it is practicable, with the existing wireless plants, to launch an aeroplane, have it follow a certain approximate course, and perform some operation at a distance of many hundreds of miles. A machine of this kind can also be mechanically controlled in several ways and I have no doubt that it may prove of some usefulness in war. But there are, to my best knowledge, no instrumentalities in existence today with which such an object could be accomplished in a precise manner. I have devoted years of study to this matter and have evolved means, making such and greater wonders easily realizable. As stated on a previous occasion, when I was a student at college I conceived a flying machine quite unlike the present ones. The underlying principle was sound but could not be carried into practice for want of a prime-mover of sufficiently great activity. In recent years I have successfully solved this problem and am now planning aerial machines devoid of sustaining planes, ailerons, propellers and other external attachments, which will be capable of immense speeds and are very likely to furnish powerful arguments for peace in the near future. Such a machine, sustained and propelled entirely by reaction, is shown on one of the pages and is supposed to be controlled either mechanically or by wireless energy. By installing proper plants it will be practicable to project a missile of this kind into the air and drop it almost on the very spot designated, which may be thousands of miles away. But we are not going to stop at this. Telautomata will be ultimately produced, capable of acting as if possesst of their own intelligence, and their advent will create a revolution. As early as 1898 I proposed to representatives of a large manufacturing concern the construction and public exhibition of an automobile carriage which, left to itself, would perform a great variety of operations involving something akin to judgment. But my proposal was deemed chimerical at that time and nothing came from it.

At present many of the ablest minds are trying to devise expedients for preventing a repetition of the awful conflict which is only theoretically ended and the duration and main issues of which I have correctly predicted in an article printed in the *Sun* of December 20, 1914. The proposed League is not a remedy but, on the con-

(*Continued on page* 603)

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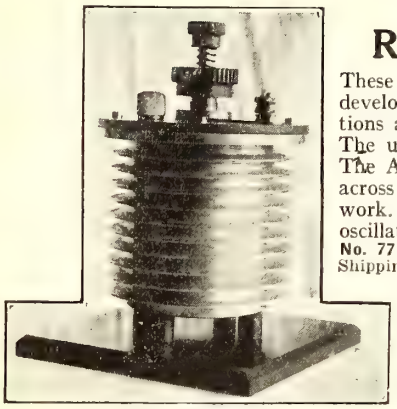
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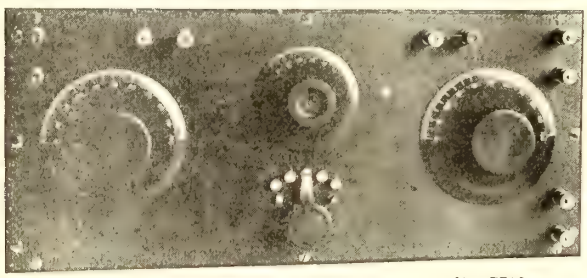
No. 7710—½ K.W. Sustained Wave Generator, as illustrated, operates on 110 V D.C. Size 6½ x 6½ x 8½. Shipping weight, 35 lbs.; price.....**$50.00**

This complete ***Radiophone Transmitter*** is unquestionably one of the finest pieces of Radio apparatus ever placed on the market. A Radiophone might have been sold heretofore; but it was felt that in justice to the purchaser, no instrument of this nature should be sold unless it were possible to obtain efficient results therefrom. This transmitter is the result of great effort expended in the design of a Radiophone set which should meet all requirements as to practicability and compactness combined with highest efficiency. It includes all apparatus necessary for transmission. The Arc is similar to the one illustrated elsewhere on this page.

No. 7711—Complete Sustained Wave Radiophone and Telegraph Transmitter, inclosed in a beautifully finished cabinet; size 14½ x 9 x 12½"; weight 50 pounds; as illustrated; price.....**$150.00**



No. 7711



No. 7712

The Short Wave Regenerative receiving cabinet shown is built in accordance with the most modern methods of reception. In work with oscillating audions it is necessary that all losses be diminuated as it was found that tuning should preferably be done with inductance alone, without using variable condensers.

This Receiving set will be found fully up to the mark in comparison with the highest priced set on the market to-day, yet its cost is well within the reach of all.

No. 7712—Regenerative Receiving Cabinet set, as illustrated; size 16¾ x 7⅝ x 8"; weight 25 pounds; price.....**$50.00**



No. 7715

The Vacuum Tube Socket illustrated was designed to be used by those who are desirous of assembling their own vacuum controls and who need a good socket to hold the bulbs. It is well designed, durable and reasonably priced.

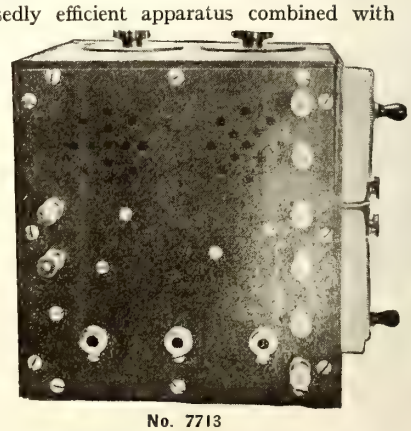
No. 7715—Vacuum Tube Socket; 2¼ x 2¼ x 1½"; weight 1 pound; price.....**$1.50**

This Tube socket is adaptable for both receiving and transmitting tubes.

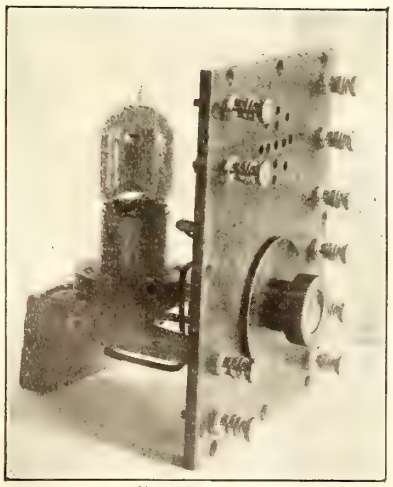
The Two Step Amplifier illustrated is undoubtedly one of the finest instruments offered to the experimenter. It is an example of unsurpassedly efficient apparatus combined with exceptional mechanical skill in its design and construction. Two Vacuum Tube sockets are mounted within the cabinet which also contains the two amplifying audio-frequency transformers which were especially designed for this instrument. It is of great consistance in amplifying live and radio telephone currents.

The telephones are plugged in any of three jacks mounted on the panel, permitting the use of either one or two steps of the amplifier or simply cutting the amplifier out entirely.

No. 7713—Two Step Amplifier, as illustrated; size 7⅝ x 7¼ x 8"; weight 7 pounds; price.....**$55.00**



No. 7713



No. 7714

The Vacuum Tube Control Cabinet is one of the essential instruments of the modern radio station. The Vacuum Tube holder, filament, rheostat, grid condenser and grid leak are mounted within the cabinet, the only part on the exterior being the rheostat control knob and dial. The construction throughout is on the same high level of excellence with the other instruments illustrated on this page.

No. 7714—Vacuum Tube Control Cabinet, as illustrated; size 6 x 7⅝ x 6¾; weight 5 pounds; price.....**$25.00**

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My Inventions

By Nikola Tesla

(*Continued from page* 601)

trary, in the opinion of a number of competent men, may bring about results just the opposite. It is particularly regrettable that a punitive policy was adopted in framing the terms of peace, because a few years hence it will be possible for nations to fight without armies, ships or guns, by weapons far more terrible, to the destructive action and range of which there is virtually no limit. Any city, at a distance, whatsoever, from the enemy, can be destroyed by him and no power on earth can stop him from doing so. If we want to avert an impending calamity and a state of things which may transform this globe into an inferno, we should push the development of flying machines and wireless transmission of energy without an instant's delay and with all the power and resources of the nation.

What the X-Rays Show

(*Continued from page* 510)

hardly ever be suspected as being caused by the small and apparently infinitesimal "toothache." The modern dentist not only needs an X-ray, but he practically *must* have one of these scientific apparatus in order to be sure that every tooth is sound,

In figure 10 is shown one of the latest advances in X-rays—the "Movie X-ray." This branch of X-ray science has only been developed to a very slight extent, and gives promise of really wonderful possibilities in the near future. A year or so ago there was exhibited before a body of surgeons and physicians in New York City an *X-ray motion picture* in which the action of various organs, functioning in a live person, were shown, a bismuth meal having first been ingested; the intestines were shown functioning as well as the heart. It is not commonly known that with the modern X-ray, provided with an up-to-date tube of the Coolidge tube, and excited by a 5 to 10 kilowatt, 100,000-volt transformer, and the other necessary appurtenances, practically every part of the body and its organs may be seen on the fluoroscope, or otherwise on the photographic negative or skiagraph. This includes the heart, lungs, stomach, ulcers of the stomach, the intestines, the appendix, gall stones, the gall bladder, and many other ailments and organs within the body which sometimes have to be diagnosed and operated on in a very short length of time, or otherwise the death of the person would often result. *X-ray-therapy* is a new field being investigated today, and gives much promise in the treatment of cancer and various skin diseases.

X-raying tobacco in order to kill organisms, especially the *tobacco weevil,* has been carried on for several years in a number of large tobacco establishments. In this case, the tobacco in large bales is wheeled into an X-ray examination chamber on small trucks, see figure 12. In this manner the tobacco can be very rapidly X-rayed. The powerful rays from the bulb have the effect of killing the weevil even in its primary germinating state.

There are many other industrial uses of the X-ray which space does not allow us to mention here, but among which we may mention the X-raying of steel and copper ingots to analyze the structure and to detect flaws, such as cracks and air-pockets, and of coal for the purpose of extending our knowledge of geology.



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$10 Daily refinishing chandeliers, brass beds, automobiles by new method, without capital or experience. Free particulars and proofs. Write today. Gunmetal Co., Ave. D, Decatur, Ill.

Agents Wanted—To sell Tubes, Tires and other automobile accessories. DePalma & Main Co., 1105 Fourth St., Braddock, Pa.

Walk Agents—Men with spare time and specialty venders make $5 per day upward canvassing office buildings, banks and business offices selling the famous Calumet Piecepipe (three pieces), genuine French Briar. Put up in attractive individual package. Its sensible construction makes cleaning easy and appeals to everybody. Send for proposition. 10,000 Bankers Have Bought and Recommended It. The Calumet Co., Dept. Q, Mail Sales Division, Cincinnati, Ohio.

Agents—Here's the best line of food flavors, perfumes, soaps, toilet preparations, etc., ever offered. No capital needed. Complete outfits furnished free to workers. Write today for full particulars. American Products Co., 1499 American Bldg., Cincinnati, Ohio.

Insyde Tyres, inner armor for automobile tires, double mileage and prevent punctures and blowout. Quickly applied. Costs little. Demand tremendous. Profits unlimited. Details free. American Automobile Accessories Co., Dept. 54, Cincinnati, O.

$100 Reward if you pick our Keyless Door Lock. New invention. Put on in ten seconds without nails or screws. A handsome brass lock guaranteed at low price of 15c each, coin. Agents wanted. Lock Company, 1551 West Washington, Springfield, Ohio.

Agents, Free Sample Outfit, Greatest Washing Tablet Proposition. Enormous profits, as much as 18c on 25c sale. B. Thayer, 2140 T Claybourn Ave., Chicago, Ill.

Agents Wanted.

Every Woman Wants Silvoplate—Magic Cleaner that never fails. Sure, easy sales plan; main or sideline; quick profits; prepaid deliveries. Sample 10c; dozen $1.60. L. B. Sutton, Manufacturer, D-5, New Canaan, Conn.

Make $30 Next Saturday. Agents, Salesmen, District Managers, brand new invention selling like wildfire. Sell Speederator for Fords. So good it's used by 17 officials of Ford Motor Co. Makes any Ford run like a Packard. Stops stalling and bucking. Put on quick—no special tools or holes to bore. Instant satisfaction. Listen, make money quick—sell ten to twelve a day easy. McAllister, Ill., sold four first afternoon; profit $12. Helton, Utah, makes over $300 every week. Dane, W. Va., $55 a week spare time only. Hurry, write quick for details and exclusive territory. Address Perrin Company, 1017 Hayward Bldg., Detroit, Mich.

Powerene is Equal to Gasoline at 5c a Gallon. Salesmen and agents wanted. Exclusive territory granted. Powerene is guaranteed to be harmless, to remove and prevent carbon, doubling life of all gasoline motors, saving repairs, adding snap, speed, power. An amount equal to 20 gallons of gasoline sent to any address in the United States, charges prepaid, for $1. W. Porter Barnes, Santa Rosa, Calif. Dept. B-18.

Beginners. Complete "Mail Order System." C, Box 1005, Atlantic City.

Agents—New Invention; wonderful chemical cloth; works like magic; one rub over rain or snow blurred windshield, street car or locomotive window, presto! glass stays clear 24 hours; can't blur; world's fastest seller; 30,000 first month; exclusive territory free—worth fortune. Security Mfg. Co., Dept. 156, Toledo, Ohio.

Signs for Store and Office Windows. $50 week easily made. Chicago Sign System, G 326, River St., Chicago, Ill.

500 Agents Wanted at Once to take orders and sell Mitchell's Magic Marvel Washing Compound; 300% profit; enormous repeater. Own your own business. Astounds and delights every woman who uses it. Nothing like it on the market. Splendid proposition for general agents. We grant exclusive territory and absolutely protect our agents. No license required. Free samples furnished to boost sales. We positively guarantee the sale of every package. Our compound is nature's mightiest cleanser. Contains no lye, lime, acid or wax. Wonderful sales plan furnished free. You cannot fail to make big money. Hurry, hustle, grab this chance. Send for free sample and proof. Better still, send $1 for 10 full sized packages and samples sent by prepaid parcel post. You will make 100% profit on this small order. Territory going fast. Get busy at once. L. Mitchell & Co., Desk 318, 1312-1314 E. 61st, Chicago.

Motors, Engines and Dynamos.

Small Motors and Generators from bankruptcy and receivers' sales. Motors for all phases of current. Immediate delivery. Less than one-half regular prices. See display ad on page 594. Johnston, West End, Pittsburgh, Pa.

For Advertisers.

"Quick-Action Advertising—How it is Building Business for the Progressive Advertisers of America"; A little story of results told by the advertisers themselves—not the publisher. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 West 39th St., New York.

Money Makes Money. So does Good Advertising. Get wise. Jacobus Ads. Pull. Write Jacobus Advertising Service, Irvington, N. J.

Help Wanted.

Are You Satisfied with your position and prospects? If not, whatever your occupation, investigate your chance in Government Service. Just ask for Form RL 2081, free. Earl Hopkins, Washington, D. C.

Earn $25 Weekly, spare time, writing for newspapers, magazines. Experience unnecessary; details free. Press Syndicate, 5665 St. Louis, Mo.

Wanted—Hundreds men—women—18 up. U. S. Government office and outside positions. $1,100 year. Write for list positions now open. Franklin Institute, Dept. K.26, Rochester, N. Y.

American Made Toys Wanted. An opportunity for homeworkers on small scale and manufacturers on large scale. Unlimited quantities needed of Toy Soldiers. Army, Navy, Marines, Cannons, Machine Guns, Warships and other Toys and Novelties. Greatest chance for industrious people for independent business. Enormous demand and future in American Made Toys, all over United States, Canada, Mexico and South America with over 50,000 10 cents stores and toy dealers. This new American industry stands out conspicuously. Factories are established, people trained, machineries made. Christmas Sets needed in millions this year. The great hit for 1919 without any competition. We are buyers of these goods all year, paying fixed prices. Attractive prices offered for painted goods. Experience or tools unnecessary. Hundred and more made complete per hour. Casting-form outfits from $3.00 up. If you mean business, send for booklet and information free. Toy Soldier Manufacturing Co., 32 Union Square, New York.

Government positions highly desirable; thousands appointed annually through frequent examinations everywhere; prepare immediately for Post Office Clerk, City or Rural Letter Carrier, Railway Mail Clerk, Washington Departmental Clerk, Stenographer-Typist; unexcelled correspondence instruction, $5. Request particulars concerning position desired. Federal Civil Service School, 602 Kellogg, Washington, D. C.

Artists in Great Demand. Big salaries paid for full or part time. Learn quickly at home in spare time. Commercial Art, Cartooning, Illustrating, Designing. Outfit free to new students. Send for handsome Free Book. Write Now. Washington School of Art., Inc., 1449 H St., N. W., Washington, D. C.

Learn Commercial Wireless by Mail in Ten Weeks. Thousands of positions now open for men and boys, ages 16 to 45, as Radio Operators, Electricians, Mechanics, Inspectors and Radio Draftsmen. Salaries for beginners now averaging $190 per month. Opportunity to travel and see the world or locate at one of many land radio offices. We train you by mail or at our local school to qualify for official license and help you secure position. No previous experience or wireless (radio) education necessary. Oldest and largest correspondence radio school in America. Established 1914. (Write for FREE Booklet.) Wireless outfit free to students for home practice. Write for Free Booklet. National Radio Institute, Dept. 137, 14th and U. T. St., Washington, D. C.

Become Auto experts. Hundreds needed. $35.00 week. Earn while learning. Franklin Institute, Dept. K 806, Rochester, N. Y.

Secret Service Operatives and Detectives are in demand. Earn Big money. Travel everywhere. Fascinating work. Learn this profession by home study. Particulars free. American School of Criminology, Dept. E., Detroit, Mich.

Salesmen Wanted.

Side-Line Salesmen—We have an attractive line of premium assortments for live salesmen. Commission from $5.00 to $20.00 per order. If you want an up-to-date line, write today. Canfield Mfg. Co., 4003 Broadway St., Chicago, Ill.

House-to-House Salesmen, why not the line that sells and repeats every 90 days? Our Sanitary brushes, mops and dusters pay big commissions, and we protect you in good territory. Only live ones wanted. Every promotion for producers. If you know and admit that you're good, write us. North Ridge Brush Co., 114 Clark Ave., Freeport, Ill.

Business Opportunities.

Detectives make big money. Travel, be your own boss. Either sex. We instruct; small cost. Write Johnson's Detective School, 232 Sheldon Ave., Grand Rapids, Mich., Dept. A.

Chiropractic—The New Profession. You can learn and earn your way. Practitioners earning $3,000 a year and upwards. Proficiency quickly acquired. Send card for information. Howard College, 515-25 S. Ashland Blvd., Chicago.

Breed Canaries. Profitable pastime. Particulars free. Bird Farm, Lynnhaven, Virginia.

Make Big Money Opening Safes and setting Combination. Wayne Strong, Box 1430, Los Angeles, Cal.

Money-Talks Magazine. Published for progressive men. Send for sample copy. 70-B Park Place, Newark, New Jersey.

$50 to $100 weekly writing moving picture plays in spare time. You can write them. We show you how. Experience unnecessary. Send for free book, valuable information and special prize offer. Photoplaywright College, Box 278, EE, Chicago.

Salesmen—New proposition that nets $100 to $200 weekly. Give moving picture shows at schools, colleges, universities, chuches, Y. M. C. A's, clubs, lodges, societies and homes. We furnish complete outfit. Write for particulars. W. H. Wade, Dept. 5, 14 N. Michigan Ave., Chicago.

Money-Making Farms. 19 States. $10 to $100 acre. Stock, tools, crops, often included to settle quickly. Write for big illustrated catalog. E. A. Strout Farm Agency, 150 E C Nassau St., New York.

Enter a New Business. Earn $3,000 to $6,000 yearly in professional fees making and fitting a foot specialty, openings everywhere with all the trade you can attend to; easily learned by anyone at home in a few weeks at small expense; no further capital required; no goods to buy; job hunting, soliciting or agency. Address Stephenson Laboratory, 18 Back Bay, Boston, Mass.

$30 a Week. Evenings I made it with a small Mail Order Business; continued my regular job daytime. Free Booklet Tells How, 2c postage. Albert W. Scott, Cohoes, N. Y.

Substantial manufacturing corporation wants capable men to establish branch and manage salesmen; $300 to $1,500 necessary. You handle own money. Will allow expenses to Baltimore if you will qualify. For particulars address Secretary, 416 N. Howard St., Baltimore, Md.

Build Up an Income in Oil. Others are doing it—Why not you? Today is the opportunity. Join our easy monthly payment plan now—it may mean hundreds in profits. Write for information. National Oil Drilling Co., Dept. K, Houston, Texas.

Dollars Yearly in Your Back Yard. No ginseng, mushroom dope. New ideas. Investigate. Particulars free. Metz, 313 East 89, New York.

5 Big Money-making Schemes. $13.50 less than original price. Postpaid, 50c. Edgar James, 315 Douglass, Indianapolis, Ind.

Advertise. 24 words in 100 magazines, $1. Lists free. Stanford Company, Pittsburgh.

Just one Moment, please! Are you artistically inclined? Would you like to be one of the many well-paid Showcard Writers or Designers? Turn your idle moments into dollars. We will teach you THOROUGHLY, Showcard Writing, Lettering, and Designing by our special method of personal correspondence. Why not make $35 to $75 a week if you have talent? Write for FREE DETAILS NOW! Commercial School of Lettering, Wausau, Wisconsin.

Wanted—A man to organize branch office, engage salesmen, etc., for our indelible ink, which takes the place of check protector. This is a big money-making proposition to the right man. Must invest at least $100 for goods, etc. Attorney's Ink Co., 53 West 125th St., New York City.

Victory. Mechanical Toy Soldier window attraction. 30 inches high. Salutes, turns head, points with finger, etc., as set. Well made, nicely dressed officers, privates, Uncle Sam, etc. Electrically operated. Does some stunt every half minute or oftener as set and will salute soldier and pay no attention to other if desired. Representative wanted in each city and town. Write for prices. The John M. Biggs Co., Box 324, Chattanooga, Tenn.

"Quick-Action Advertising—How It Is Building Business for the Progressive Advertisers of America"; A little story of results told by the advertisers themselves—not the publishers. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 W. 39th St., New York.

Exchange Ads.

For Sale—$120.00 I. C. S. Electrical Engineering Course (Complete), $42.00. $60.00 I. C. S. Interior Wiring Course, $25.00. $120.00 I. C. S. Analytical Chemistry Course, $42.00. Many others. Send for list. Courses bought. W. J. Benson, 3722 "M" Str., Philadelphia, Pa.

For Sale cheap, anything electrical you want. Perry Leaphart, Jr., Pendleton St., Columbia, S. C.

For Sale—Three International Chicken Hovers. Used little. J. R. Simpson, Piermont, N. H.

For Sale—X-Ray tubes, high frequency and other apparatus. Write for list and description. Roy Black, Jefferson St., Madison, Ind.

For Sale—Camera and outfit, $15. Hawkins Guides (new), $7. Exide Battery, $10; Vesta Battery, $7. B Flat Cornet, $15. Weston Ammeter, $3. 250 W stepdown transformer, $10. C. W. 6V. 8A motor, $5. Write for description. Wm. Rudolphsen, 1807 S. Turner Ave., Chicago, Ill

Sell. 2½ Horse motor. Polished insulation marble, $.50 ft. Clarence Kositzky, 1602 Poplar, Lincoln, Nebraska.

For Sale—$25 Lionel Electric Train, $15; $3.00 steam engine, $1.50; New Murdock 43 plate variables, $4.00; Holtzer Cabot 3000 ohm lightweight receivers, while they last, $11.75. Big list free. King, Box 42, Mattoon, Ill.

1 Brand-new Lyon & Healy B flat, high pitch, Alto Saxophone, Silver plated sand blasted finish, gold plated bell, pearl buttons; beautifully engraved, leather carrying case with full outfit; cost $165.00; sells to first buyer for $120.00. 1 brand-new L. C. Smith visible typewriter, cost $115.00, sells $75.00. 1 set Eisner drafting and drawing instruments, 15 pieces with solid ivory handles, heavily nickel plated, in fine velvet case, never used; cost $34.00, sells for $15.00. Set new Ford coils, very good condition, $8.00. One Ford master vibrator, cost $12.00, sells $5.00. 1 U. S. Training Rifle, new, exact duplication of U. S. Army Springfield, $5.00. All these articles are wonderful bargains and will be shipped C. O. D. at price stated, with 20% down with order. H. O. Holm, Ryder, N. D.

For Sale—Mignon RW3, seal unbroken, $75. Mignon RJ1 Transmitting cabinet, new, $60. Electro Oscillation Transformer, $4. Duck Navy Type Receiving Transformer, $12.50. Burrows Rogers, Cainsville, Missouri.

For Sale—New Omnigraph and small Radio Receiving Outfit. Milton Jacobs, 428 Fourth Ave., City.

For Sale—Complete $150 ½ K.W. sending, 3,500 meter, bulb receiving set for $80. Write for separately listed prices. Stuart Nivling, 130 Aberdeen St., Rochester, N. Y.

For Sale—Set of Chemicals and Apparatus. Stamp brings particulars. Box 163, Beverly, N. J.

Bargain—Receiving set of phones, loose-coupler, detector, condenser, buzzer, $15. Set of Hawkins Electrical Guides, $7. Or will sell together for $20. M. W. Green, R No. 4 Dowagiac, Mich.

Sell—RLC5 Mignon Cabinet, $30. Audion, $10. Crystaloi Detector, $2.50. Brandes Superiors, new, $5.00. Audio Tron Bulb, $4.00. Money order acknowledged. E. Schuessler, 2209 Wheeler St., Cincinnati, O.

Sell—Large Supply electrical, wireless goods, cheap. Stamp for list. Walts, 2842 Market St., Louisville, Ky.

Swap! Buy! Sell! Free Advertising 3 months. Dime. Trade Topics, Detroit, Mich.

For Sale—Transmitting and receiving apparatus. Everything necessary to build a set. Includes brass, copper, fibre, screws, bolts, rods, binding posts, wire and complete apparatus. Very cheap. Write for list. Edw. C. Schurch, Deer Lodge, Mont.

For Sale—Wireless Mast—84 ft. sectional, built of northern fir, A-1 condition, with weatherproof guys, $30.00. F.O.B. Seneca Falls, N. Y., Loose Coupler, $8.00; New Audion Cabinet, Hard rubber front, New B bats less bulb, but including galena detector, $12.00. W. H. Stevens, The Edgeton, Philadelphia, Pa.

Sell—Cyclopedia Applied Electricity, $12.00; Steven's "Favorite" .22 rifle, $4.00 Electro Chemical Laboratory, $2.00. Schreyer, 72 Ridgewood Place, Staten Island.

Sell—Twin Motorcycle engine, $20; $65 aviation Course, $15. Wilson Ross, Laurelville, Ohio.

For Sale, less than half price, rebuilt chemical and electrical apparatus, also materials. Send 5 cents for list. A. L. Pouleur, Norton, Mass.

Gilbert Wireless. Skinderviken button. Bike-lamp. Telegraph. Printing press. Self-filler pen. Pool, Broadmoor, Colorado Springs.

Sale or Trade—Wireless outfit; Violin; Pyrometer; Foot Switch. Joe Richter, West Allis, Wisconsin.

For Sale. Blue prints for connecting A.C. motors. See ad under "Blueprints." Charles Chittenden.

Sell—Telescope. New. Cost $25. Highest offer takes. Huston Murdock, 734 Grant St., Johnstown, Pa.

Exchange Ads. (Cont'd.)

For Sale—Brand-new E. I. voltmeter, $2.00; jeweler's lathe, foot pedal wheel, $2.00. Geo. Koresh, 219 50th Ave., West Allis, Wisconsin.

Exchange, Buy, Sell. Wireless, electrical goods, etc. Large list 6c. State what you have and want. Zehrbach, Box 250, Hiram, O.

For Exchange—Want Smith motor wheel, good condition, for set of History of Civil War—beautiful books, splendid pictures, cost $30.00, or what have you—motors, etc. B. W. Earl, Edgewater Park, N. J.

For Sale—Complete set 160 ohm phones, $3.25. Shirley Hurlbut, Ilion, New York.

Exchange. Pair New telephones—cost $20.00. Want small gasoline motor. What have you? B. Earl, Edgewater Park, N. J.

For Sale or Exchange. Have fine little cycle car. Reversing gear and new body, 40 tread. Everything practically new. Am building larger car—want Smith motor wheels—Smith Flyer, or what have you? B. W. Earl, Edgewater Park, New Jersey, Burlington County.

Sell—Splendid Smith Premier typewriter, $25; Exchange—Good .22 Stevens rifle for 43 plate variable. Wilkes Dearing, Covington, Tenn, R. 2.

Must Sell. Send stamp for list of electrical goods. Earl Cook, Bernardston, Mass.

Exchange—3,000 meter wireless receiving outfit. Richard Christy, Ferris, Ill.

Aerial Wire—7 strands number 22, pure copper. Highest conductivity and strength. Supply limited at this price. 1c per foot—$9.00 per thousand. L. A. Bates, 8 Moen St., Worcester, Mass.

Exchange—Tesla Coil for Rotary Variable Condenser, or what have you, Wireless or Electrical? John Burke, Geldard St., Valley Falls, R. I.

Miscellaneous.

Wanted. Small gasoline and steam engines, small lathes, drill presses and other light machinery. Will pay high cash prices for good material. Johnston, West End, Pittsburgh, Pa.

Send Stamp for catalog. Chicago Aero Works, 328 River St.

Key Ring Tags, 20c; silver name plates for umbrellas, canes, etc., 20c; skeleton keys, 10c. Send coin. Albert Feth, Dayton, Ohio. (124 Lincoln St.)

"How to Read Thoughts"—Mind Reading at any distance, 20c; "How to Hypnotize"—Cure Diseases, Give Astounding Exhibitions, $1.00; "Silent Friend"—Key to Rapid and Honest Wealth, $1.00; "How to Win," 362 pages—success assured, $2.00; "Health Culture"—Insures Vital Strength, 25c; 5 dozen Money Makers, 30c. Catalogue gratis. Science Institute, E1336 Morse Ave., Chicago, Ill.

"Uncle Sam to the Front," brilliant March, Piano, 10c; "Town Talk," latest Rag Hit, Piano, 15c. Catalogue free. Quincke, Box 48, Station C, Los Angeles, Cal.

Shoes for All the Family, reasonable prices. Educational, business books, etc., Send for descriptive circulars. Retail only. Central Sales Co., 509 Ninth Ave., New York.

Song Poems.

Song-writers' Manual and Guide Sent Free! Contains valuable instructions and advice. Submit song-poems for examination. We will furnish music, copyright and facilitate publication or sale. Knickerbocker Studios, 319 Gaiety Bldg., New York.

Write the Words for a Song. We write music and guarantee publisher's acceptance. Submit poems on war, love or any subject. Chester Music Co., 920 So. Michigan Ave., Room 265, Chicago, Ill.

Write the Words for a Song. We revise poems, write music and guarantee to secure publication. Submit poems on any subject. Broadway Studios, 197C Fitzgerald Bldg., New York.

Song-writers. You can't afford to miss our proposition. Reference, any bank or first-class sheet music house. Warner C. Williams & Co., Dept. L, Indianapolis, Indiana.

Song-writers. Market your compositions. Our successful plan brings results. Work examined free and honest advice given. Morrison Music Shop, Dept. E, Indianapolis, Indiana.

Wanted to Buy.

Cash for Old False Teeth—We pay up to $35.00 per set (broken or not). Also buy discarded gold jewelry, gold crowns, bridges, platinum, diamonds, watches and silver. Send now. Cash by return mail. Package held 5 to 10 days for sender's approval of our offer. U. S. Smelting Works, Dept. 73, Chicago, Ill.

Continued on Page 606

Wireless.

Wireless Bargain Sale. Here is your opportunity to buy first-class Clapp-Eastham wireless apparatus at prices that you will never be able to buy again. These instruments were owned by a commercial company which is now out of business, after being in operation for only six months. Following articles are absolutely brand-new, never used: 3 K.W. Clapp-Eastham condenser in polished case, $40; cost $110. 2 K.W. Clapp-Eastham condenser in polished case, $25; cost $55. Two 3 K.W. Clapp-Eastham spark gaps in polished cases, $15 each; cost $60 each. 3 K.W. Clapp-Eastham "Boston" Key, $3.85; cost $9.00. Two hundred "Electrose" Ball insulators, 15c each; cost 30c each. One hundred "Electrose" ten-inch insulators, 30c each; cost 60c each. No order accepted for less than one dozen either size insulators. Six extra large "Electrose" ball insulators, 30c each. Clapp-Eastham glass plate condenser sections, each 85c; cost each, $3.50. No order accepted for less than three sections. Following articles slightly used, but are in just as good condition as the new instruments described above: 5 K.W. Clapp-Eastham oscillation transformer, edge-wise wound heavy copper strip on heavy rubber pillars, $10.00. 3 K.W. Clapp-Eastham oscillation transformer, wound with one inch wide copper ribbon, coils mounted on heavy rubber sheets, $4.00. 3 K.W. Clapp-Eastham Type "E" transformer in polished case with variation switch on end, $60.00; cost $150.00. 2 K.W. Clapp-Eastham condenser in polished case, $20.00; cost $55.00. Three early type Clapp-Eastham receiving sets in polished cabinets with loose coupler of variometer type; each set has two large variable condensers; set with genuine Periken detector, $20.00; set with Silicon detector, $15.00; set with part of mineral detector, $13.50. These sets cost more than $100.00 each when first placed on sale by Clapp-Eastham Co. 10 K.W. early type Clark wireless transformer sealed in oak case. Hardly used. A gigantic bargain at the very low price of $90.00. 30 ampere "Roller" hot wire meter, $6.00. 3 K.W. 1,800 RPM Eck Rotary Converter, 4-pole, takes 115 volts D C., gives 60 cycles, 75 volts, single phase, 40 amperes, A. C. Absolutely like new. With starting box, $75. Cost over $200. Brandes Navy Type 3,000 ohm receivers, $4.50. Brandes 2,800 ohm receivers, $3.50. Western Electric 2,000 ohm receivers, $2.75. All above F.O.B. San Antonio. No trades considered. Personal checks not accepted. Remit by money order. Considering the extraordinary cheap prices on this fine wireless apparatus, these great bargains will not last long, so send in your order today. Sydney Friedrich, 350 East Commerce Street, San Antonio, Texas.

Amateurs! Special seamless cardboard tubing 5" x 5¾" diameter, 25c per foot. One pound, postage extra. Send stamp for price list. Maier & Co., 335 East 93rd St., N. Y.

Panel Wireless Sets and Parts. Heavy rubber knobs 2¼", 26c; 1¼", 16c. Polished Formica Panels, ⅛ x 8 x 12", $1.10. Post extra. Klaus, Eureka, Ill.

Radio Apparatus of Quality manufactured to your own specifications. Radio Engineering Company, Baltimore, Md.

Transcontinental wireless receiving outfit, $20.00; 7x7x7 Wall Tent, $6.00, and No. 7 American Builder, $7.00. All three in excellent condition. Reason for selling is want of use. Adam S. Hahn, Jr., Hamburg, Pa.

Switch Points. Binding posts, switch levers, and small parts, send 2c. for catalogue describing these and other goods. A. W. Bowman & Co., 23 Church St. (Harvard Square), Cambridge, Mass.

Stamps & Coins.

California gold, quarter size, 27c. Half Dollar size, 53c. Columbian nickel and catalog, 10c. Norman Shültz, King City, Mo.

Free Set State Rev. Approvals, 50% discount. Browne, 111 Willow St., Wallaston, Mass.

Stamps—61 All Different Free. Postage, 3c. Mention paper. Quaker Stamp Co., Toledo, O.

61 different foreign stamps from Russia, Brazil, India, etc., free to applicants for our fine approvals. Send 2c postage. E. W. Spafford & Co., Martville, N. Y.

300 different stamps, 50c. Fred Onken, 630 79th St., Brooklyn, New York.

Free. 25 different stamps and lists, 2c postage. 100 different stamps, 10c. Nutley Stamp Ex., Nutley, N. J.

100 Different Stamps, 12c.; 200, 27c. Michaels, 5600 Prairie, Chicago.

South America. Buy direct. 1,000 fine assorted Paraguay, Uruguay, etc., for $2 bill. Exchange rare stamps with collectors and dealers. Lots or on sheets. C. P. Mego, Necochea 193, Lomas Dezamora, Argentine Republic.

Special Variety packets, 15c each; three for 40c. 50 Orientals, 40 Japanese, 30 South and Central American. Lionel Smith Stamp Co., Box 407 Hartford, Conn.

Best One Cent Approvals in America. F. P. Hand, 1117 So. 60th St., Philadelphia, Pa.

Stamps. Send 15c for 30 stamps, all different. Including war issues. W. Baumann, 1033 Levick St., Philadelphia, Pa.

Electrical Supplies & Appliances.

Boys—Here is the simplest and cheapest electric telegraph ever devised. With the "K" Applicator you need no batteries. Get electricity free, instantly, anywhere, at any time. Send 30c (postal money order) for full instructions how to make the "K" applicator and how to operate an electric telegraph without batteries. Is easier to make and requires less material than you would use in making a kite. Gives constant, smooth, even current day and night, never runs down, even upon closed circuit. Works on any metallic line, even barbed wire fence, as no insulators necessary. The "K" Applicator, Missouri Valley, Iowa.

Radio Paint Glows at night. Bottle, 20c. Box 3613 Kens. Station, Philadelphia.

Storage Batteries. Make the plates yourself, we will tell you how. Sample plate, 40c. Windsor Specialty Co. (not incorporated), 5419 Windsor Ave., Chicago, Ill.

Castings, Blueprints, Engines—Gas and Steam, ⅛ H.P. up. Gears, Pulleys, Pumps, Fittings, Small Boilers. Complete circulars for stamp. Latest models. Universal Gas Motor Co., 364 Monadnock Block, Chicago.

Magnets: Large Horseshoe Magnets. Will lift 12 lbs. Mail $1, stamps or Money Order. Parcel Post Prepaid to all parts of U. S. or Canada. West Side Novelty Co., Drawer No. 8 Wabash P. O., Pittsburgh, Pa.

Electrical Workers and all others who are interested in Electrical Work in the Reconstruction that is taking place. To send us their name and receive descriptive literature of our Modern Blue Print Chart Method of Electrical Wiring. Souvenir information card included. Electrical Wiring Diagram Co., Box C. 173, Altoona, Pa.

Lava Insulation is not molded but individually sawn, lathe turned, milled, drilled, threaded. No limitation on form, only on size. Kilned at two thousand degrees. Hard, strong, accurate, fire, acid proof. Ask for book. American Lava Insulator Company, Chattanooga, Tenn.

Battery Charging pays big profits with HB Equipment. Electric Light Generators and Motors can also be furnished on easy payments. Full information free. Hobart Brothers, Troy, Ohio.

Motor Winders. See ad under "Blueprints." Charles Chittenden.

Electric Lighting Outfit for Sale—35 H.P. two-cylinder Fairbanks heavy duty engine, direct connected to C. & C. 27 K.W. generator. Engine runs with either gasoline, artificial gas, or natural gas. Weight, complete, about 12,500 lbs. Run about six months. Like new. Has carried 3,200 ten-watt lamps. Price $2000.00. Maning Cleveland, Room 4 Cleveland Bldg., Academy St., Poughkeepsie, New York.

Blueprints

Blue Prints, 236 A.C. diagrams, contains 54 single phase, 42 two phase, 50 three phase Star, 40 Delta, 12 Star-Delta. Appendix 68 changes of voltage, phases, speed, cycles, etc. 10 samples 25c. Particulars free. Charles L. Chittenden, 811 West 18th Street, Kansas City, Missouri.

Printing.

1,000 Letterheads, Envelopes, Typewriter Letters, $2. Circulars, Labels, $1; samples. M. Lomond, 65 Broadway, Brooklyn, N. Y.

Printing? Good printing is the stepping stone to big business. We do it right. Send for quotations and samples. Parcel Post Printery, Dept. K, Kinmundy, Ill.

Your Stationery Printed. Good grade, $1.00. The Star Print Shop, Charlotte, Mich.

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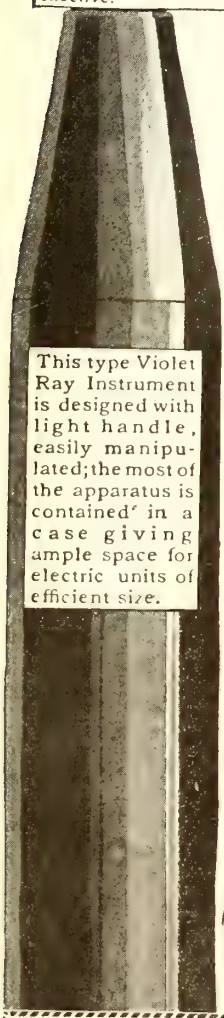
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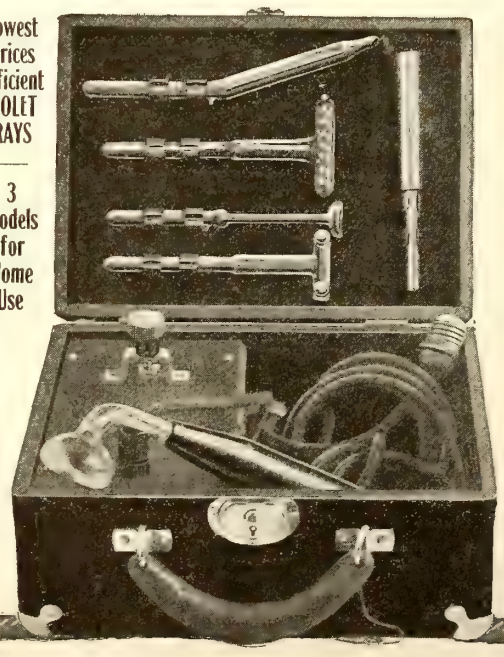
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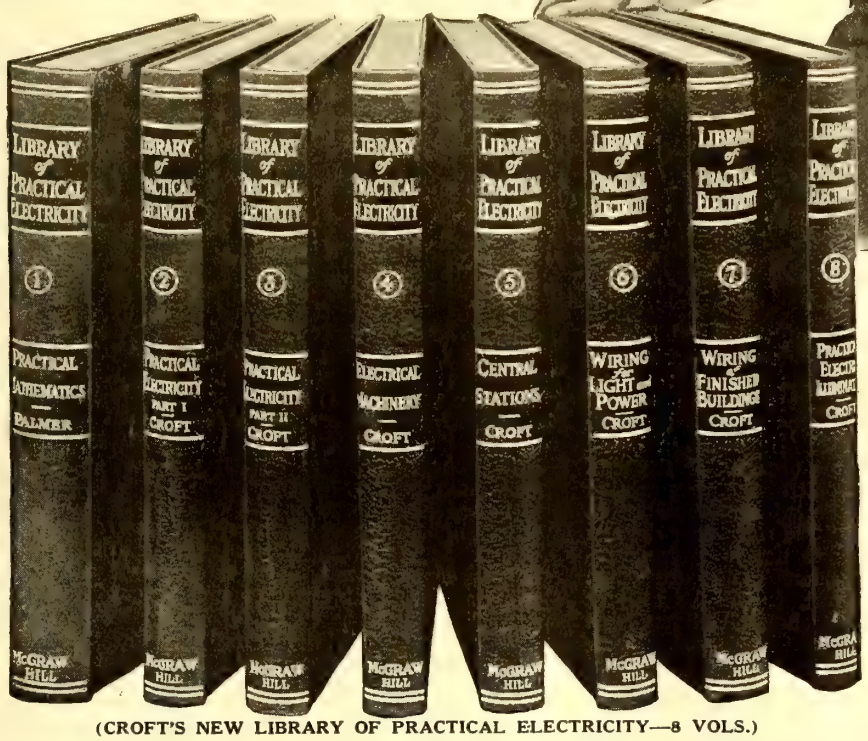
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EDITORIAL

Gravitation and Light

AT the joint meeting of the Royal Society and the Royal Astronomical Society of London, Sir Joseph Thomson recently announced the correctness of the famous Einstein theory. Photographic plates made by British astronomers in northern Brazil on May 29th of this year, at the occasion of the total solar eclipse, showed that the light of the stars passing close by the sun *had been deflected considerably*. In other words the photographs of the stars near the sun revealed the fact that they were not in their accustomed stations, but at a considerable distance away.

If Einstein's theory is correct, it will be seen at once that for one thing our astronomical atlases must be revised and corrected to a certain degree. Every star, as is well known is a huge sun. This means that stars closely together—or rather if they are in a line as viewed from earth may not be where we think they are. They would be further apart in certain cases.

Many new puzzles will have to be worked out by astronomers. For instance our present figures as to the distance of stars are all wrong if Einstein's theory holds. All our former calculations are based upon the assumption that a ray of light is a mathematically straight line. If it is not, how are we now to determinate the parallax of a certain star? If gravitation affects light, the same as wind affects a long jet of water, how can we possibly know what we are doing? Suppose we wish to determine the distance of a star. That star is billions upon billions of miles distant, and if its light rays pass near one or more dead (dark) suns, *which consequently cannot be seen* by us, how then will we calculate our distance? For the dark stars will deflect the light rays several times *unbeknown to us!* The case thus seems hopeless.

While Einstein's theory is sound, real proofs are still wanting despite what the photographic plate shows. To elucidate: When a light ray passes from one medium to another, it is refracted or bent in its course. Thus, it is well known that due to the earth's atmosphere, we never *actually* see the sun either rise or set. Now the sun too has a gaseous envelope just like the earth, only much more so. In fact, it has several: the corona, the chromosphere and the photosphere. The corona reaches several million miles away from the sun's surface. Any light ray passing thru these intensely heated gases must be bent considerably. Hot gases refract light rays more than cold ones, as anyone knows who has looked over a hot stove plate or thru a bonfire. It is reasoned therefore that the photographic proof is really no proof at all, as the bending of the distant star's light might be caused by the sun's chromosphere.

This immediately brings many questions to mind. If Einstein's theory is correct, and if light rays are affected by gravitation, why then for instance could we not measure the deflection, of a light ray coming from one of Jupiter's moons as it shoots past the huge mother planet?

It should be—theoretically—far easier to prove Einstein's theory within the realms of our planetary system. Here we know the distances accurately because we know the exact orbital time periods down to the smallest fraction of a second, of all planets and their sattelites.

If the objection is made that the case of Jupiter cited above might prove fallacious due to the fact that this planet has a gaseous envelope, or an atmosphere, which would refract and bend the light rays, we still have the reverse case of a light ray coming from a planet as it passes one of its moons, which we know possesses no atmosphere. However, due to the small gravitational influence of such a moon, we would require very sensitive measuring instruments to detect the exceedingly small deflection of the light rays.

Another thought: Faraday over 100 years ago deflected a light ray by means of a small magnet. Gravitation—which has been proved to be of an electrical nature, should not act differently.

H. GERNSBACK.

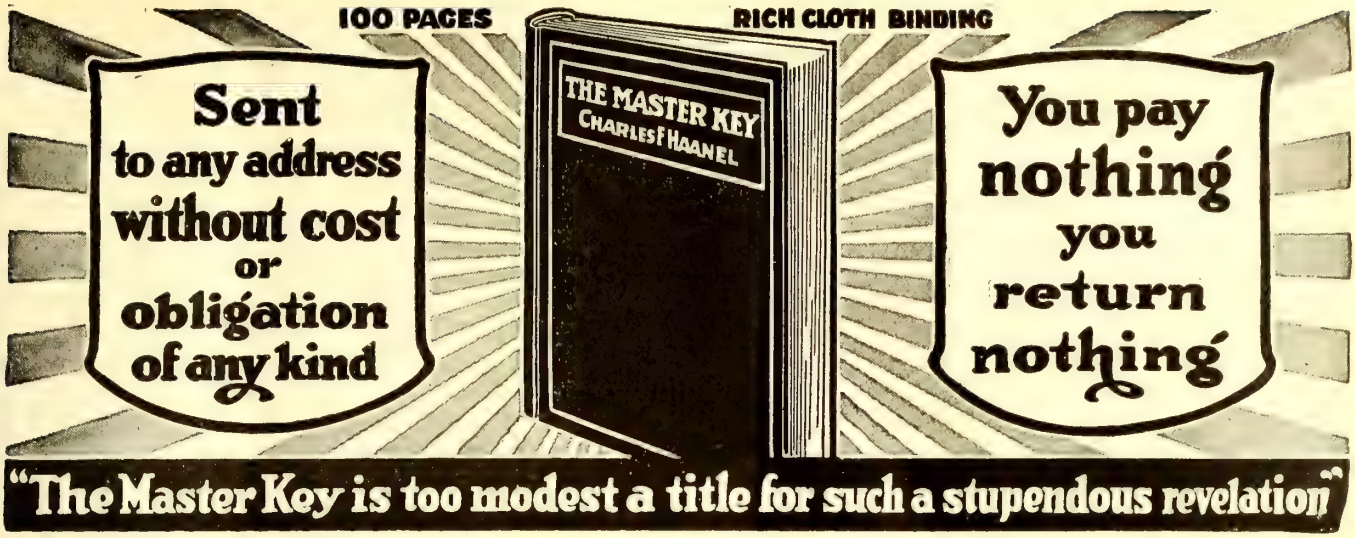
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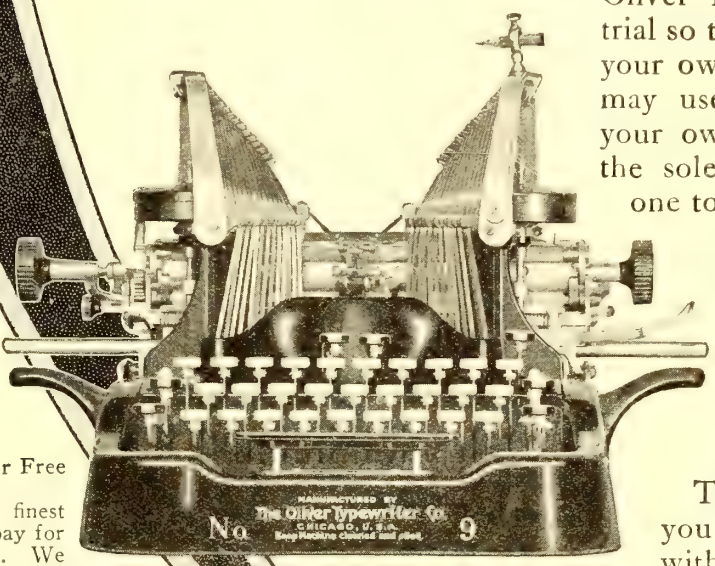
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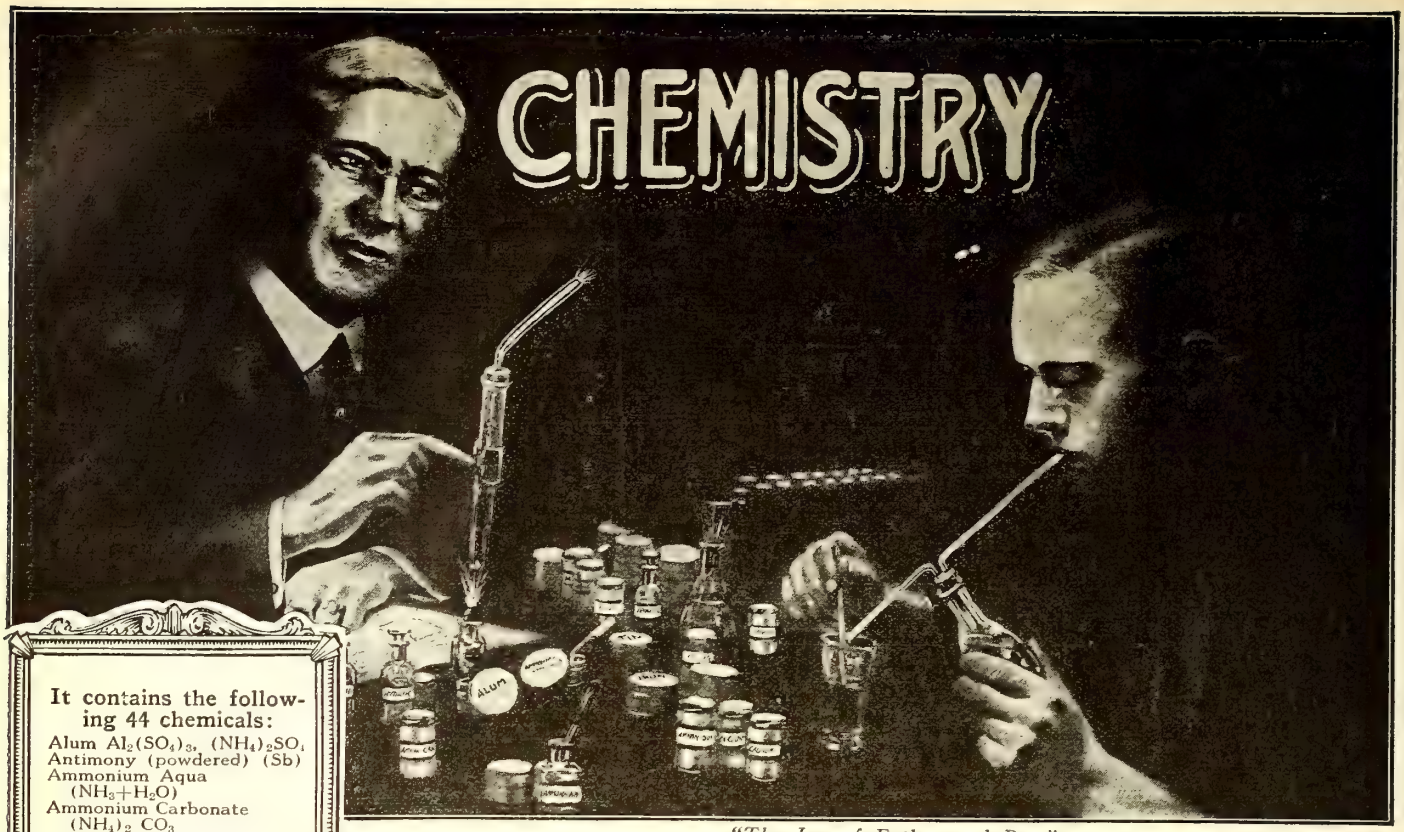
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Ammonium Sulphate $(NH_4)_2SO_4$
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Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride ($CaCl_2$)
Calcium Oxide (CaO)
Calcium Sulphate ($CaSO_4 2H_2O$)
Charcoal (Carbon) (C)
Chloride of Zinc ($ZnCl_2$)
Copper Sulphate ($CuSO_4$)
Ferrous Sulphate ($FeSO_4$)
Ferrous Sulphide (FeS)
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Iodine (I)
Iron Chloride ($FeCl_2$)
Iron Oxide (Fe_2O_3)
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The assurance of this speaker—in the crowded corridor of the Hotel McAlpin—compelled me to turn and look at him, though I must say it is not my usual habit to "listen in" even in a hotel lobby.

"He is David M. Roth, the most famous memory expert in the United States," said my friend Kennedy, answering my question before I could get it out. "He will show you a lot more wonderful things than that, before the evening is over."

And he did.

As we went into the banquet room the toastmaster was introducing a long line of the guests to Mr. Roth. I got in line and when it came my turn, Mr. Roth asked, "What are your initials, Mr. Jones, and your business connection and telephone number?" Why he asked this, I learned later, when he picked out from the crowd the 60 men he had met two hours before and called each by name without a mistake. What is more, he named each man's business and telephone number, for good measure.

I wont tell you all the other amazing things this man did except to tell how he called back, without a minute's hesitation, long lists of numbers, bank clearings, prices, lot numbers, parcel post rates and anything else the guests gave him in rapid order.

* * * *

When I met Mr. Roth—which you may be sure I did the first chance I got—he rather bowled me over by saying in his quiet, modest way:

"There is nothing miraculous about my remembering anything I want to remember, whether it be names, faces, figures, facts or something I have read in a magazine.

"*You can do this just as easily as I do.* Anyone with an average mind can learn quickly to do exactly the same things which seem so miraculous when I do them.

"My own memory," continued Mr. Roth, "was originally very faulty. Yes it was—a really *poor* memory. On meeting a man I would lose his name in thirty seconds, while now there are probably 10,000 men and women in the United States, many of whom I have met but once, whose names I can call instantly on meeting them."

"That is all right for you, Mr. Roth," I interrupted, "you have given years to it. But how about me?"

"Mr. Jones," he replied, "I can teach you the secret of a good memory in one evening. This is not a guess, because I have done it with thousands of pupils. In the first of seven simple lessons which I have prepared for home study, I show you the basic principle of my whole system and you will find it—not hard work as you might fear—but just like playing a fascinating game. I will prove it to you."

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When I tackled the first lesson, I suppose I was the most surprised man in forty-eight states to find that I had learned in about one hour—how to remember a list of one hundred words so that I could call them off forward and back without a single mistake.

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> "May I take occasion to state that I regard your service in giving this system to the world as a public benefaction. The wonderful simplicity of the method, and the ease with which its principles may be acquired, especially appeal to me. I may add that I already had occasion to test the effectiveness of the first two lessons in the preparation for trial of an important action in which I am about to engage."

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The Roth Course is priceless! I can absolutely *count* on my memory now. I can call the name of most any man I have met before—and I am getting better all the time. I can remember any figures I wish to remember. Telephone numbers come to mind instantly, once I have filed them by Mr. Roth's easy method. Street addresses are just as easy.

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Now I am sure of myself, and confident, and "easy as an old shoe" when I get on my feet at the club, or at a banquet, or in a business meeting, or in any social gathering.

Perhaps the most enjoyable part of it all is that I have become a good conversationalist—and I used to be as silent as a sphinx when I got into a crowd of people who knew things.

Now I can call up like a flash of lightning most any fact I want right at the instant I need it most. I used to think a "hair trigger" memory belonged only to the prodigy and genius. Now I see that every man of us has that kind of a memory if he only knows how to make it work right.

I tell you it is a wonderful thing, after groping around in the dark for so many years to be able to switch the big searchlight on your mind and see instantly everything you want to remember.

This Roth Course will do wonders in your office.

Since we took it up you never hear anyone in *our* office say "I guess" or "I think it was about so much" or "I forget that right now" or "I can't remember" or "I must look up his name." Now they are right there with the answer—like a shot.

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VICTOR JONES.

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Are You a Blond?

The Secret of Making People Like You



Gloria Swanson
In "Male and Female"
Paramount-Artcraft Picture

THE greatest asset any man can possibly have is the faculty for making people like him. It is even more important than ability.

The secret of making people like you lies in your ability to understand the emotional and mental characteristics of the people you meet.

Did you know that a blond has an entirely different temperament than a brunet?—that to get along with a blond type you must act entirely different than you would to get along with a brunet?

When you really know the difference between blonds and brunets, the difference in their characters, temperaments, abilities and peculiar traits you will save yourself many a mistake—and you will incidentally learn much you never knew before about yourself.

* * * * * * * * *

PAUL GRAHAM was a blond, and not until he learned that there was all the difference in the world between the characteristics of a blond and those of a brunet did he discover the secret of making people like him.

Paul had been keeping books for years for a large corporation which had branches all over the country. It was generally thought by his associates that he would never rise above that job. He had a tremendous ability with figures—could wind them around his little finger—but he did *not* have the ability to mix with big men; he did *not* know how to make people like him.

Then one day the impossible happened. Paul Graham became popular.

Business men of importance who had formerly given him only a passing nod of acquaintance suddenly showed a desire for his friendship. People—even strangers—actually went out of their way to do things for him. Even *he* was astounded at his new power over men and women. Not only could he get them to do what he wanted them to do, but they actually anticipated his wishes and seemed eager to please him.

From the day the change took place he began to go up in business. Now he is the Head Auditor for his corporation at an immense increase in salary. And all this came to him simply because he learned the secret of making people like him.

You, too, can have the power of making people like you. For by the same method used by Paul Graham, you can, at a glance tell the characteristics of any man, woman or child—tell instantly their likes and dislikes, and YOU CAN MAKE PEOPLE LIKE YOU! Here is how it is done:

Everyone you know can be placed in one of two general types—blond or brunet. There is as big a difference between the mental and emotional characteristics of a blond and those of a brunet as there is between night and day. You persuade a blond in one way—a brunet in another. Blonds enjoy one phase of life—brunets another. Blonds make good in one kind of a job—brunets in one entirely different.

To know these differences scientifically is the first step in judging men and women, in getting on well with them; in mastering their minds; in making them like you; in winning their respect, admiration, love and friendship.

And when you have learned these differences—when you can tell at a glance just what to do and say to make any man or woman like you, your success in life is assured.

For example, there's the case of a large manufacturing concern. Trouble sprang up at one of the factories. The men talked strike. Things looked ugly. Harry Winslow was sent to straighten it out. On the eve of a general walkout he pacified the men and headed off the strike. And not only this, but ever since then, that factory has led all the others for production. He was able to do this, because he knew how to make these men like him and do what he wanted them to do.

Another case, entirely different, is that of Henry Peters. Because of his ability to make people like him—his faculty for "getting under the skin" and making people think his way, he was given the position of Assistant to the President of a large firm. Two other men, both well-liked by their fellow employees, had each expected to get the job. So when the outside man, Peters, came in, he was looked upon by everyone as an interloper and was openly disliked by every other person in the office.

Peters was handicapped in every way. But in spite of that, in three weeks he had made fast friends of everyone in the house and had even won over the two men who had been most bitter against him. The whole secret is that he could tell in an instant how to appeal to any man and make him well-liked.

A certain woman who had this ability moved with her family to another town. As is often the case, it is a very difficult thing for any woman to break into the chill circle of society in this town, if she was not known. But her ability to make people like her soon won for her the close friendship of many of the "best families" in the town. Some people wonder how she did it. It was simply the secret at work—the secret of judging people's character and making them like you.

* * * * * * * * *

YOU realize, of course, that just knowing the difference between a blond and a brunet could not accomplish all these wonderful things. There are other things to be taken into account. But here is the whole secret.

You know that every one does not think alike. What one likes another dislikes. What pleases one offends another. And what offends one pleases another. Well, there is your cue. You can make an instant "hit" with anyone if you say the things they want you to say, and act the way they want you to act. Do this and they will surely like you and believe in you and will go miles out of their way to PLEASE YOU.



Wallace Reid
Star in "The Valley of the Giants"
A Paramount-Artcraft Picture

You can do this easily by knowing certain simple signs. In addition to the difference in complexion, every man, woman and child has written on them signs as distinct as though they were in letters a foot high, which show you from one quick glance exactly what to say and to do to please them—to get them to believe what you want them to believe—to think as you think—to do exactly what you want them to do.

Knowing these simple signs is the whole secret of getting what you want out of life—of making friends, of business and social advantage. Every great leader uses this method. That is why he IS a leader. Use it yourself and you will quickly become a leader—nothing can stop you.

You have heard of Dr. Blackford, the Master Character Analyst. Many concerns will not employ a man without first getting Dr. Blackford to pass on him. Concerns such as Westinghouse Electric and Manufacturing Company, Baker, Vawter Company, Scott Paper Company and many others pay Dr. Blackford large annual fees for advice on dealing with human nature.

So great was the demand for these services that Dr. Blackford could not even begin to fill all the engagements. So Dr. Blackford has explained the method in a simple, seven-lesson course, entitled, "Reading Character at Sight." Even a half hour's reading of this wonderful course will give you an insight into human nature and a power over people which will surprise you.

Such confidence have the publishers in Dr. Blackford's course, "Reading Character at Sight," that they will gladly send it to you on approval, all charges prepaid. Look it over thoroughly. See if it lives up to all the claims made for it. If you do not want to keep it, then return it and the transaction is closed. And if you decide to keep it—as you surely will—then merely remit five dollars in full payment.

Remember, you take no risk, you assume no obligation. The entire course goes to you on approval. You have everything to gain—nothing to lose. So mail the coupon NOW and learn how to make people like you, while this remarkable offer is still open.

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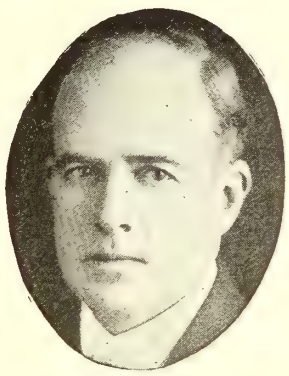
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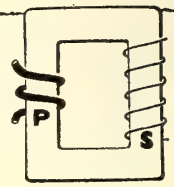
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I wish to take this opportunity to thank you for the instruction given me, and to say that I believe you have exceptional ability along educational lines. Yours, very truly,

E. DICKEY, *Asst. Chief Engineer,*
The Domestic Engineering Company.
Dayton, Ohio.

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How "Silent Simms" Became a Master of Speech

BY MARTIN M. BYRON

"YOU are exasperating beyond words," shot out Mr. Worden. "Why didn't you keep Mr. Truesdale here? You knew I would be back in ten minutes."

Harry Simms gulped hard, and replied weakly, "I did try to keep him here, Mr. Worden, but he wouldn't stay."

"What? Wouldn't stay even ten minutes? Why you could have kept him that long without his realizing it. Why didn't you *talk* to him about the weather, about peace, about the price of potatoes, about *anything?*"

This wasn't the first calling down I had heard Simms get. He had been with the firm for eight years and had reached the point where he was as much a fixture around the office as the desk or the chairs. He was a slow-going, steady plugger, earning $40 a week. He managed to keep busy in the Sales Department, keeping records of salesmen's reports. No one around the office seemed to notice him. He was so quiet that the only things that would start him talking were such momentous events as the beginning of the war or the end of the war. Even when his baby was born, Harry said only three words—"It's a boy."

It wasn't long before we nicknamed him "Silent Simms."

Yet the "Silent Simms" of two years ago is now our Sales Manager, regarded as one of the most brilliant men in our organization, getting an annual salary that runs close to five figures, and is slated for the vice-presidency!

How all this happened in so short a time makes one of the most remarkable stories of success I have ever heard. But let Harry tell the story as he told it to me when I asked him point-blank what sort of magic he used in transforming himself.

"Well," said Harry, "you remember when Mr. Truesdale came in that day and I could not hold him for ten minutes until the Chief got back? And when the Chief came back and found Truesdale gone, how he bawled me out? *That incident marked the turning point of my life.* I made up my mind that I was going to live down the nickname of 'Silent Simms,' that had fastened itself upon me to a point where I hardly spoke to my wife. I was just afraid. I had almost forgotten how to use my tongue. Perhaps I got that way because every time I opened my mouth I 'put my foot in it.' I was always getting in wrong. I would give instructions and then have to spend twenty minutes trying to explain them. I would dictate a letter and then have to write five more to explain the first one. I would try to explain an idea to the Chief and would get so flustered that I couldn't make myself understood at all. In my social life I became almost a hermit. We never went out because I was like a sphinx among people. I was the best listener you ever saw and the *worst talker.*

"Well, when the Chief called me down that day it was the 'straw that broke the camel's back.' It was the most humiliating experience I ever went through. I had been with the firm 8 years—was getting $40 a week—and was the office 'football.' I went home that night determined to learn how to talk convincingly, interestingly, and forcibly, so that I could hold people spellbound, not only for ten minutes, but by the hour. No more of the silent stuff for me. I had no more idea of how to do it than I have of how to jump across the ocean, but I knew that I wanted to do it, and I knew that I would never get anywhere until I did do it. It took a shock to make me realize what it was that was holding me down to the grind of detail work, but when I finally realized why I was called 'Silent Simms' I began to investigate all that had been written on the subject of talking. I did not want to become a public speaker—what I wanted was the ability to talk as a business asset. I bought numberless books on public speaking, but they all taught oratory, and were so complicated that I gave up almost in discouragement. I continued my search, however, and was rewarded a few weeks later by hearing about the work of Dr. Frederick Houk Law, who was conducting a course in business talking and public speaking.

"You may be sure that I lost no time in attending the lectures. I went after them as eagerly as a hungry wolf goes after food. To my great surprise and pleasure I grasped the secret of being a convincing talker—the secret I had needed all my life—almost in the first lesson.



—the chief wired me to come back and gave me Morgan's job as the sales manager.

"Almost at once I learned why I was afraid to stand up and talk to others. I learned how to talk to a number of people at the same time. I learned how to make people listen to every word I said. I learned how to say things interestingly, forcibly and convincingly. I learned how to listen while others talked. I learned how to say exactly what I meant. I learned when to be humorous with telling effect, and how to avoid being humorous at the wrong time.

"More important than these vital fundamentals were the actual examples of what things to say and when to say them to meet every condition. I found that there was a knack in making reports to my superiors. I found that there was a right and wrong way to make complaints, to answer complaints, to give estimates, to issue orders, to give opinions, to bring people around to my way of thinking without antagonizing them, and about how to ask banks for a loan. Then, of course, there were also lessons on speaking before large audiences, advice on how to find material for talking and speaking, actual rules on how to talk to friends, to servants, and even to children.

"And the whole thing was so simple that in a single evening I learned the secrets that turned me into a very dynamo of ambition. I knew that I had at last found the road to Mastery of Speech. I began to apply the principles at once, and found that my words were electrifying people. I began to get things done. I began to put a new kind of ginger into my letters, into my memoranda, into my talks with customers, and with people in the office. In a little three minute talk with the Chief I nearly floored him with some ideas that had been in my mind for years, but which I had always been afraid to mention. It wasn't long before I was taken off my old desk and put at the city salesman's desk. You know how I made good. Seems almost like a dream now. Then, a short time later, I was given Roger's job on the road, in the hardest territory we have. And when I began to break records there the Chief wired me to come back and gave me Morgan's job as the sales manager when Morgan was put in charge of the Seattle office.

"This great change came over me simply as a result of my having learned how to talk. I imagine there are thousands of others who are in the same boat in which I found myself and who could become big money-makers if they only learned the secret of being a convincing talker."

When Harry Simms finished, I asked him if I could not have the benefit of Dr. Law's Course and he told me that only recently Dr. Law had prepared a complete course in printed form which contained exactly the same instructions as he had given in his lectures. I sent for it and found it to be exactly as he stated. After studying the eight simple lessons I began to realize that Simm's success was the natural outcome of real ability to talk. For my own success with the Course has been as great as his. I can never thank Simms enough for telling me about Dr. Law's Course in Business Talking and Public Speaking.

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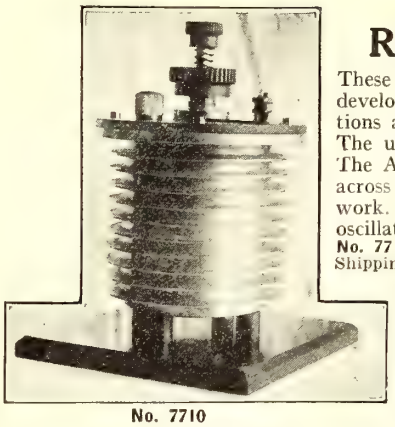
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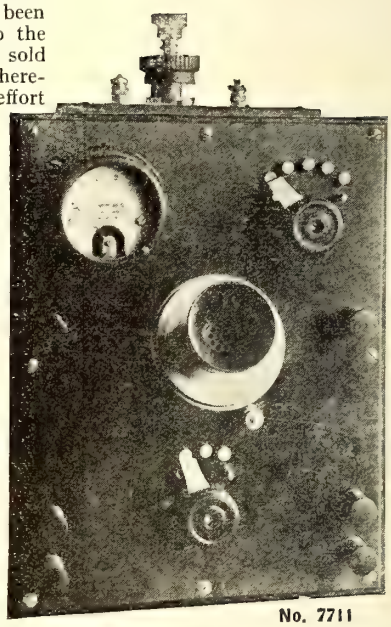
Arc for Generating Undamped Waves for Radio Telephonic & Telegraphic Transmission

These instruments are the acme of perfection in Radio Transmission. The latest and best developments in Radio during the *Great War* are embodied in this apparatus. Educational Institutions and Laboratories can now procure the most modern Radio equipment at a reasonable cost. The undamped *Wave Generator* illustrated is exceptionally well constructed of heavy aluminum. The Arc chamber is flanged in order to offer the greatest cooling surface. The Arc takes place across two solid special Tungsten electrodes which have been found particularly efficient for this work. The electrodes are fully adjustable, permitting very precise adjustment of the emitted oscillatory currents.

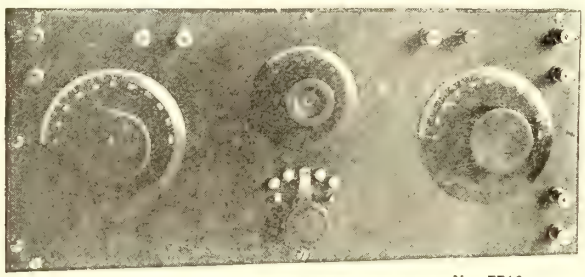
No. 7710—½ K.W. Sustained Wave Generator, as illustrated, operates on 110 V D.C. Size 6½ x 6½ x 8½. Shipping weight, 35 lbs.; price.....**$50.00**

This complete ***Radiophone Transmitter*** is unquestionably one of the finest pieces of Radio apparatus ever placed on the market. A Radiophone might have been sold heretofore; but it was felt that in justice to the purchaser, no instrument of this nature should be sold unless it were possible to obtain efficient results therefrom. This transmitter is the result of great effort expended in the design of a Radiophone set which should meet all requirements as to practicability and compactness combined with highest efficiency. It includes all apparatus necessary for transmission. The Arc is similar to the one illustrated elsewhere on this page.

No. 7711—Complete Sustained Wave Radiophone and Telegraph Transmitter, inclosed in a beautifully finished cabinet; size 14½ x 9 x 12½"; weight 50 pounds; as illustrated; price.....**$150.00**



No. 7711



No. 7712

The Short Wave Regenerative receiving cabinet shown is built in accordance with the most modern methods of reception. In work with oscillating audions it is necessary that all losses be diminuated as it was found that tuning should preferably be done with inductance alone, without using variable condensers.

This Receiving set will be found fully up to the mark in comparison with the highest priced set on the market to-day, yet its cost is well within the reach of all.

No. 7712—Regenerative Receiving Cabinet set, as illustrated; size 16¾ x 7⅝ x 8"; weight 25 pounds; price.....**$50.00**

The Vacuum Tube Socket illustrated was designed to be used by those who are desirous of assembling their own vacuum controls and who need a good socket to hold the bulbs. It is well designed, durable and reasonably priced.



No. 7715

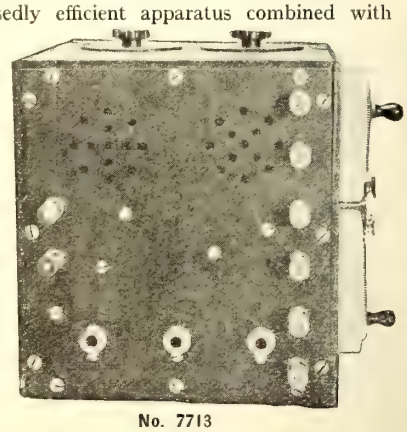
No. 7715—Vacuum Tube Socket; 2¼ x 2¼ x 1½"; weight 1 pound; price.....**$1.50**

This Tube socket is adaptable for both receiving and transmitting tubes.

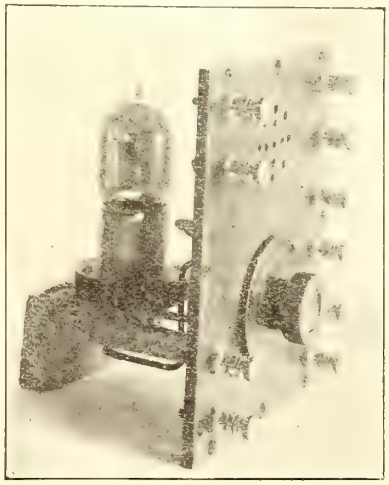
The Two Step Amplifier illustrated is undoubtedly one of the finest instruments offered to the experimenter. It is an example of unsurpassedly efficient apparatus combined with exceptional mechanical skill in its design and construction. Two Vacuum Tube sockets are mounted within the cabinet which also contains the two amplifying audio-frequency transformers which were especially designed for this instrument. It is of great consistance in amplifying live and radio telephone currents.

The telephones are plugged in any of three jacks mounted on the panel, permitting the use of either one or two steps of the amplifier or simply cutting the amplifier out entirely.

No. 7713—Two Step Amplifier, as illustrated; size 7⅝ x 7¼ x 8"; weight 7 pounds; price.....**$55.00**



No. 7713



No. 7714

The Vacuum Tube Control Cabinet is one of the essential instruments of the modern radio station. The Vacuum Tube holder, filament, rheostat, grid condenser and grid leak are mounted within the cabinet, the only part on the exterior being the rheostat control knob and dial. The construction throughout is on the same high level of excellence with the other instruments illustrated on this page.

No. 7714—Vacuum Tube Control Cabinet, as illustrated; size 6 x 7⅝ x 6¾; weight 5 pounds; price.....**$25.00**

P. S. No Tubes furnished by us with these instruments.

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ALSO SEE OUR FULL PAGE "AD" ON PAGE 614

How We Stopped the Leaks That Kept Us Poor



How Howard Lindsay and His Wife Discovered an Easy Way to Save One-Third of Their Income. A Secret That Applies to Any Income

By HARRISON OTIS

WHO should walk into the room but Howard Lindsay! Of all men perhaps he was the last I had expected to find as the president of this great new company. They had told me that Mr. Lindsay, of the Consolidated, was looking for a fine country home and was interested in buying the Dollard Place in Englewood; so as executor of the Dollard estate I had come to discuss the terms with him.

But Lindsay! Surely some miracle had happened. For it was the very man who had come to me "dead broke" about four years back and had asked me to help him get a new job.

"You are surprised, Mr. Otis, I can see that without your telling me. Let that real estate matter rest for a moment while I tell you how the change happened. It won't take five minutes. It all seems simple as A B C, as I look back on it now.

How It All Began

"Our new life began when we discovered *how to save money.* That happened soon after I started in the new job you helped me secure. And it all came about right in my own home. Our sole source of supply was my salary of $3,000. That first year we didn't save one cent. Besides that, we woke up on New Year's day to find a big bunch of unpaid bills to be taken care of somehow or other out of future salary checks.

"When I asked myself the reason for all this I found that I did not *know* the reason, and no more did my wife, because we hadn't the faintest idea what our money had been spent for.

"Then we looked around among our friends and learned a great lesson.

"The Weeds, I knew, were getting more than $5,000 a year. They lived in a modest apartment, did not wear fine clothes, seldom went to the theatre, did little entertaining, yet we knew they barely had enough money to pay current bills.

"In the case of the Wells, I found a very different story and one that set me thinking hard. Their income was $2,000 a year, yet, to my amazement, they confided to us that they had saved $600 a year ever since they were married. They didn't have any grand opera in their program—except on their little Victrola—but they did go to the theatre regularly, they wore good clothes, entertained their friends at their home and were about the happiest and most contented couple of all our married friends.

"The difference between these two families was that in one case the expenditures were made without any plan—while in the other the income was regulated on a weekly budget system.

"We sat down that evening and made up a budget of *all* our expenses for the next fifty-two weeks. We discovered leaks galore. We found a hundred ways where little amounts could be saved.

"In one short month we had a 'strangle hold' on our expenses and knew just where we were going. In one year my wife proudly produced a bank book showing a tidy savings account of $800.

My New Grip on Business

"In the meantime an extraordinary change had come over me in business.

"I didn't fully realize this until the president called me in one day and said, 'Lindsay, you have been doing exceptionally well. I have been studying your work for the last year and you have saved the company a lot of money. We have decided to give you an interest in the business.'

"So there you are. It is wonderful, isn't it? I often wish I might tell my story to the thousands of young married couples who are having the hardest time of their lives just when they ought to be having the best time."

So now I have the opportunity and you are lucky, if only you will act on the wonderful message this story contains. HARRISON OTIS.

The Magic Budget Plan

The Ferrin Money Making Account System is built on the experience of Howard Lindsay. This system, which is simplicity itself, comprises:

The Ferrin Money Making Account Book.

The Ferrin Kitchen Calendar (for the household).

The Ferrin Pocket Account Book.

The Ferrin Investment and Insurance Register.

The Ferrin Household Inventory and Fire Insurance Record.

Compact information is given on Making a Budget, Keeping Expense Accounts, Making Safe Investments, Making an Inventory of Household Goods.

There is no red tape or complicated bookkeeping in this system—it is so simple that anyone can keep it—so convenient that you will not notice the few moments of your time required to make entries. The Pocket Account Book (price when sold separately 50 cents) contains *printed* slips so that you have only to jot down the amounts of your daily expenditures. The Kitchen Calendar (price 50 cents) keeps track of household expenses. At the end of each week or month these amounts are transferred to the Money Making Account Book, which contains 112 pages, size 8¼x10¾ inches, and is bound in half blue Silk Cloth Back—Cadet Blue Cover, Paper Sides—Turned Edges, semi-flexible, stamped in gold on Front Cover. This book has been prepared by an expert to fit any salary from the smallest to the largest. Incorporated in it is a recapitulation for every month of the year, which shows at a glance the Budget and the amounts paid out during the month for the various classified items of expense. It is the only book to our knowledge which has a Budget column for every month. Special columns are provided for items on which an income tax does not have to be paid, so that these amounts may be deducted at the end of the year.

One Money Saving Feature

A war tax is now levied on almost every kind of article you buy. Few people know that the amounts so paid on daily purchases may properly be deducted from their income tax report. By keeping track of these war taxes on the pages for daily expenditures, and transferring the weekly or monthly totals to the Money Making Account Book, you will effect a saving on your income tax that will surprise you and that will pay the small price of the System many times over.

The Ferrin Investment Insurance Register is designed to keep an accurate record of your investments, insurance policies, etc. Contains 32 pages, size 5x8 inches, price separately, 50c. The Ferrin Inventory and Fire Insurance Record will enable you to make and keep a complete inventory of every room in the house; also provides for record of your fire insurance policy. It is an absolute necessity in case of a fire. It may save you many thousand times the cost, which is 50c when sold separately.

Two Minutes a Day

The Ferrin Money Making Account System takes only two minutes a day. Any bright grammar school boy or girl can keep the accounts. This method is not a hard task.

Now you need not worry about the money you spend for clothes, food, rent or the theatre. You will spend it freely because you will know how much you can afford to spend.

The Ferrin Money Making System is a most practical gift to any newly married couple. Many people use them for Christmas gifts.

Send No Money

See how magically the Ferrin Money Making Account System works, no matter how much or how little your income. We know what you will think of it when you see it. So we are willing to send you the complete system without your sending us any money in advance. Just mail the coupon, and back will come the system by return mail. If you feel that you can afford *not* to have it, simply send it back and you will owe nothing.

But when you have seen what big returns the Ferrin System will pay you, you will surely want to keep this wonderful aid to money-making, especially as we are now making a special, short-time offer of only $3 for the complete system.

You will appreciate what a remarkable offer this is when you consider that other expense account books are sold for $3 and cover a period of only two years. The Ferrin Money Making Account Book covers four years, and therefore has twice the value, $6. And in addition you get the Ferrin Kitchen Calendar, the Ferrin Pocket Account Book, the Ferrin Investment and Insurance Register, the Ferrin Household Inventory and Fire Insurance Record, each worth 50c, or $2.00. You have the opportunity, therefore, of securing $8 value for only $3.

But we can make this special combination offer only for a limited time. We expect to place this System in one hundred thousand homes this year. We want your home to be one of them. You are therefore urged to mail the coupon now—to do so costs nothing and does not obligate you in any way, and it may be a revelation to you of how much more you can get out of your income.

READ!

Letter from Head of Financial Department of Largest Corporation of Its Kind in the United States.

Independent Corporation

Gentlemen:

I consider your account book a remarkable contribution to the people of this country at this time.

In our company we have 5000 employes and it was a revelation to me in giving them advice in regard to the making out of their income tax returns to find how few had any intelligent idea of their income and their living expenses.

The simplicity of your plan which by comparison with previous methods of account keeping would seem to be wellnigh automatic appeals to me strongly.

They say you can't teach an old dog new tricks, but I will say to you that I am going to use the Ferrin Book for my own family expenses, and consider it will make money for me right from the start.

(Signed) D. S. BURTON

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Publishers of The Independent Weekly

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"THE 100% WIRELESS MAGAZINE"

Partial CONTENTS OF NOVEMBER ISSUE:

"Why I Am Opposed to Government Radio Control."
By Dr. Lee de Forest and G. W. Pickard

"Developing an Audion for the Amateur."
By E. T. Jones

"A 170-25000 Meter Receptor."
By Francis R. Pray

"Second Prize Award—Radio Contest."
"Junior Radio Course."
By W. A. Heppner, Associate Editor

"Audio Frequency Wireless Telephone."
By E. T. Jones

"Local Forecast—Stormy."
By Dorothy Kantro

"The Third Pill."
By J. K. Henney

"How Manufacturers Work 'Formica' and 'Bakelite.'"
By J. Stanley Brown

"Ideas—2nd Spasm."
By Thos. W. Benson

"Notes on Crystal Detectors."
By C. H. Byron

"Your 'Fist.'"
By C. H. Pfeiffer

"Destruction of the Brussels Station in 1914."
By Henry M. de Gallaix

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With its fifth issue RADIO AMATEUR NEWS holds the field undisputedly as the greatest radio magazine in print today. In point of circulation, number of articles, illustrations, RADIO AMATEUR NEWS now leads all other wireless magazines. Take for instance the November issue with its fifty-six pages; there were fifty-one separate purely radio articles and 112 illustrations. *Over twenty-seven thousand copies were printed and circulated.*

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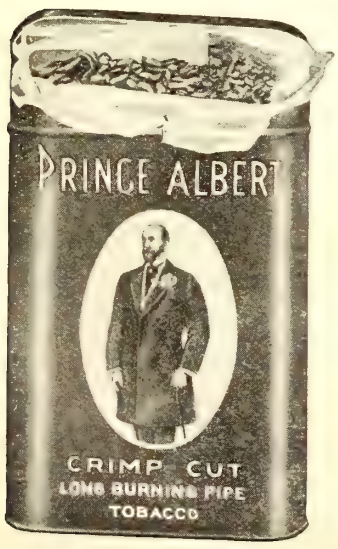
the national joy smoke



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Smoking Prince Albert is just about twins with having the top time of your life on each fire-up! *It gives you a brand new idea of how delightful a pipe smoke really can be!* Such flavor and fragrance and coolness; such freedom from bite and parch! Prove personally that Prince Albert's exclusive patented process *really does cut out bite and parch!*

Talk about ringing the bell every time you take *just one more little smoke!* You'll agree with your old fellow citizen, General Approval, that Prince Albert puts a man on the firing line with a jimmy pipe, *and keeps him there;* that it sends all previous smoke setto records to the rear-ranks; that it just slams in one good time on top of another so fast, so happy-like, you realize that heretofore you've been hunting regular-man-sport with the wrong ammunition!

Spectacular Tesla Experiments

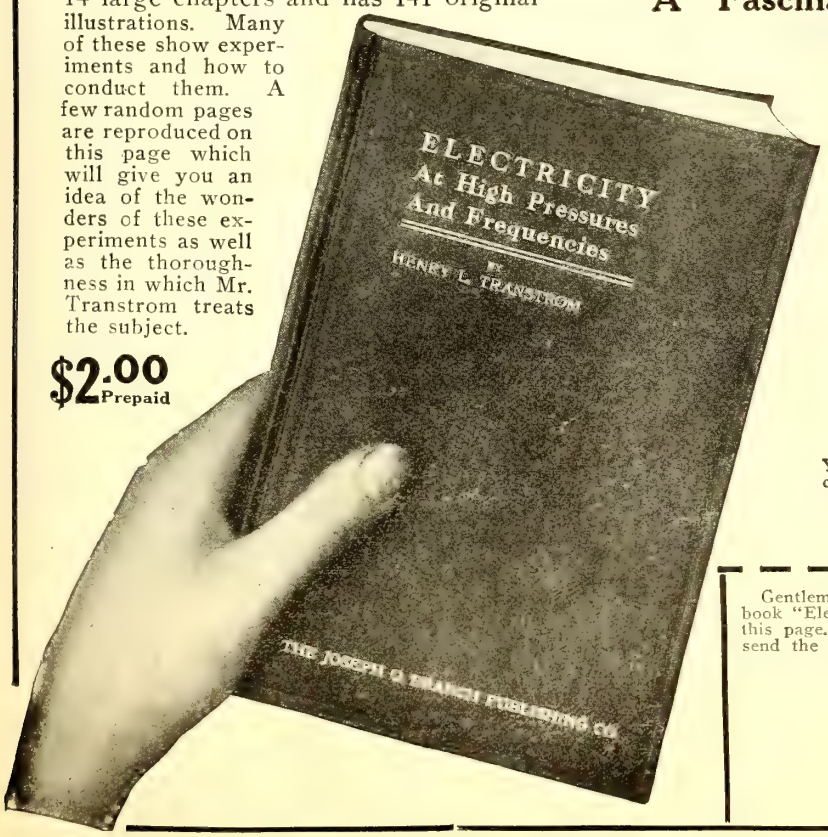
High Frequency Currents

There is possibly no more fascinating branch of the electrical art than the high frequency currents or electricity at high pressures and frequencies. The subject is one that fascinates every student of electricity. Moreover these most wonderful experiments can be performed by anyone at but small expense.

The trouble in the past was that very little has been printed how to actually conduct these experiments outside of magazine articles. Few books are in existence today that treat on the subject.

It will therefore come as a pleasant surprise that Henry L. Transtrom, an expert on high frequency currents, has written a comprehensible book of 250 pages on high frequency currents, which we know will be in every laboratory of every experimenter worthy of the name. Mr. Transtrom's book contains 14 large chapters and has 141 original illustrations. Many of these show experiments and how to conduct them. A few random pages are reproduced on this page which will give you an idea of the wonders of these experiments as well as the thoroughness in which Mr. Transtrom treats the subject.





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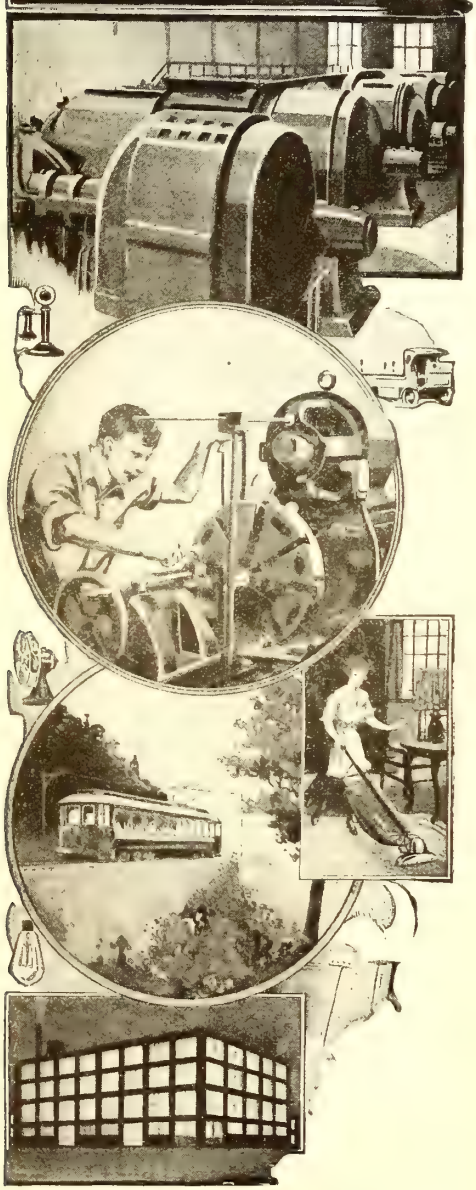
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Vol. VII. Whole No. 79 NOVEMBER, 1919 No. 7

NEW ARC RIVALS SUNLIGHT

Moving Picture Photography Obtains Remarkable Results Thru the Use of 100,000 Candle-Power Arc

UTILIZING arcs for the taking of motion pictures and for general illumination in theaters has long been possible. However, the old style arcs consumed too much current, and did not meet the demands of the photoplay producers. This new "sunlight arc," however, is superior to anything yet produced along the line of illumination, inasmuch as one single unit will give the same amount and better illumination than the sixteen units which are now used in producing a photoplay. By its use photographs may be taken by day or night, and the same effect obtained as if the sun were shining brightly. In proof of this, one of the accompanying photographs is of Marguerite Clark, the famous moving picture actress, enjoying the beautiful "sunlight," thanks to the Sunlight Arc which made this possible.

The Sunlight Arc is a mechanism arranged in such a manner that an operator can handle several arcs at the same time, unless it is necessary to shift them constantly. The arc itself consists of a positive carbon of special composition, which is rotated by a motor, and a negative carbon, which is likewise of special composition. When a 24-inch parabolic mirror is used in order to throw a *spot-light*, the extent of the beam spread may be adjusted to wide limits; in other words, the beam can be made to cover a distance of 130 degrees, and by moving the lamp arcs, in respect to the reflector, this tremendously strong flood-light, which can be used for interiors of ball-rooms and the larger stage sets, can be narrowed down to three degrees. The maximum candle-power of each beam is 120,000,000. This beam has been photographed while passing thru the air, and has been used to wonderful advantage in producing fog, moon and sunbeam effects. Motion pictures have been taken with this lamp, *one-fourth mile away*, shining upon the scene of action. If the ground glass and iris diafram are used, and the diafram is stopt way down and then gradually opened so as to form one of those fade-in pictures in which the head of the person is first seen, the picture then gradually developing itself, the illumination from the smallest opening to the largest is absolutely equivalent; in other words, there is no change whatever in the intensity of illumination as the stop is opened. One very re

(Continued on page 696)

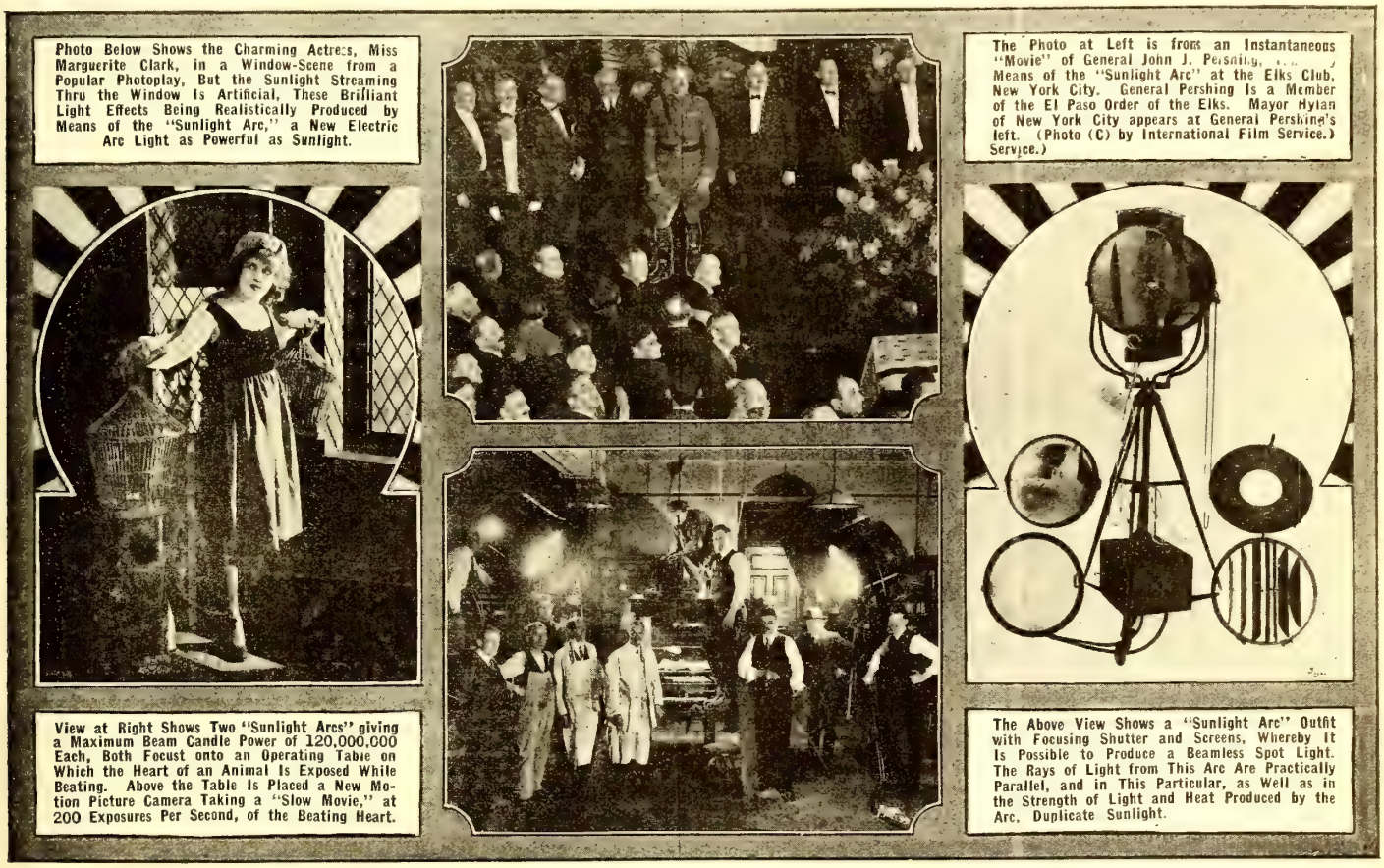


Photo Below Shows the Charming Actress, Miss Marguerite Clark, in a Window-Scene from a Popular Photoplay, But the Sunlight Streaming Thru the Window Is Artificial, These Brilliant Light Effects Being Realistically Produced by Means of the "Sunlight Arc," a New Electric Arc Light as Powerful as Sunlight.

The Photo at Left is from an Instantaneous "Movie" of General John J. Pershing, ... Means of the "Sunlight Arc" at the Elks Club, New York City. General Pershing Is a Member of the El Paso Order of the Elks. Mayor Hylan of New York City appears at General Pershing's left. (Photo (C) by International Film Service.) Service.)

View at Right Shows Two "Sunlight Arcs" giving a Maximum Beam Candle Power of 120,000,000 Each, Both Focust onto an Operating Table on Which the Heart of an Animal Is Exposed While Beating. Above the Table Is Placed a New Motion Picture Camera Taking a "Slow Movie," at 200 Exposures Per Second, of the Beating Heart.

The Above View Shows a "Sunlight Arc" Outfit with Focusing Shutter and Screens, Whereby It Is Possible to Produce a Beamless Spot Light. The Rays of Light from This Arc Are Practically Parallel, and in This Particular, as Well as in the Strength of Light and Heat Produced by the Arc, Duplicate Sunlight.

The Eiffel Tower Illuminated



Photo—France-America Corporation

The Famous "Eiffel Tower" in Paris, France, Illuminated on the Night of the Bastile Parade, and Forming a Veritable Blazing Torch of Liberty and Victory, 1,000 Feet in Height.

The accompanying photo shows something of interest to all Americans, especially at this time when the bonds of friendship and patriotism between the two great republics—La République Française and the United States of America—is many times stronger than it ever was previously. This photograph shows the sky-piercing *Eiffel Tower*, one of the greatest engineering masterpieces in all Europe, illuminated at night and forming veritably a blazing torch of liberty and victory, nearly 1,000 feet in height. The illumination here shown occurred on the night of the Bastile parade in Paris. The gigantic steel structure of the Eiffel Tower was illuminated by thousands of lamps, both of the incandescent and arc type, and due to the rays of light shining thru the steel work, a very beautiful and inspiring sight was the result. It represents, when illuminated, undoubtedly one of the finest examples of modern engineering in Europe, even in the world.

How would you have liked to have been in Paris the night peace was signed, the day—*le jour de la victoire?* You can bet your last dollar you would, for nobody can beat the French when it comes to entertaining and enjoying themselves. Take it from an ex-marine, who told the writer a short time ago that he never saw anything like it in his career. The American, French, Belgian, Italian and British soldiers hauled the great camouflaged German field guns down the boulevards while the French mademoiselles mounted the gun barrels. Searchlights flashed across the sky until it was as bright as day. The restaurants and cafés were illuminated as never before, and believe the story, friends, of one of your own all-American "devildogs"—the French cognac ran up hill and down again. They say liquids never run up hill, but this was a night of exceptions.

Contributed by LUTHER YOUNG.

Sun Signals for Fighting Forest Fires

By Frank C. Perkins

THE accompanying illustration shows the heliograph used by the Forest Service lookouts for sending sunlight signals in fighting forest fires.

Herbert A. Smith, Editor of the *Forester* of the U. S. Department of Agriculture, states that the heliograph is ordinarily used only at stations where telephone communication is impracticable and that its great value consists in establishing a system of communication with isolated forest fire "lookouts" on the tops of high mountains where the expense of building telephone lines would be prohibitory.

These lookout stations are used by the Forest Service to detect forest fires. They are placed on the tops of the highest peaks and during the fire season are occupied constantly by trained observers. Each "lookout man" has before him the best obtainable map of the surrounding country, on which the exact location of his station is shown. Around the point representing the station there is a circle graduated in 360 degrees. When a smoke is seen the lookout man ascertains its exact bearing upon his station and at once gets into communication with headquarters. Every effort is made to have at least two lookout points overlook the same section of country, and consequently it is usually possible to ascertain almost the exact location of a fire by the intersection of angles.

It is, of course, highly important that the lookout points be kept in close touch with headquarters, since success in fire-fighting depends largely on getting at the fire while it is small. For this reason the heliograph is not altogether satisfactory, because it can be used only on sunny days, and is of no use during cloudy weather or at night.

Attention is called to the fact that the heliograph instrument as a means of communication has been used for a great many years, but its use has been almost entirely restricted to the Army. Interesting and successful experiments, however, were recently conducted by the United States For-

(Continued on page 703)



Science on the Mountain Tops—The Telephone and Heliograph or "Sun Mirror," Used in Signaling the News of Forest Fires in Our Great Timber Sections of the West and Northwest.

Married by Radiophone While Flying

"I DO"—answered the blushing bride, by wireless telephone, as she flew thru the air, piloted by her newly acquired husband.

Fifteen hundred feet above Sheepshead Bay Speedway Park, the two airplanes circled together slowly, like bird mates. On the ground below 200,000 people watched them and listened to the droning of large megaphones attached to the ground station of a wireless telephone. At 5:40 o'clock a woman's voice was transmitted to them and her words were, "I do." The first aerial wedding ceremony had been performed.

Miss Emily Schaeffer of Sea Gate, L. I., and Lt. George Burgess of Brooklyn, N. Y., were the principals in the ceremony that featured the second of the two Police Field Days recently held at Sheepshead Bay, near New York City. They flew in a plane piloted by the groom, who is an aviator attached to the Mineola forces. In the second plane the Rev. Alexander Wouters of the Edgewood Dutch Reformed Church, the first real "sky pilot," flew, with Lt. Eugene Barksdale, the best man, as pilot. A long streamer of bunting indicated the bride's plane.

The two planes rose from the inclosure of the speedway at 5:10 o'clock, each being supplied with a wireless telephone transmitting and receiving outfit. In front of the grandstand was a third station, at which Miss Doris K. Schob, the bridesmaid, sat. Extensions carried receivers to other members of the bridal party, Mrs. Katherine Schaeffer, mother of the bride; Mr. and Mrs. Andrew Mills, Sgt. William B. Stewart, U. S. M. C., and others. A fourth station connected with amplifying 'phones distributed among the boxes.

At 5:25 o'clock the 'planes had reached 1,500 feet altitude, and began to circle above the field. The wireless telephone began to talk.

"Station 3, can you hear me?" asked the groom of the minister's machine.

"Station 1 is O. K.," responded Lt. Barksdale, speaking for Dr. Wouters.

"Hello, Dr. Wouters," spoke the groom, "we are now ready."

"Hello, George," came again from the best man. Speak to Dr. Wouters."

"Dr. Wouters, we are ready for the ceremony," replied Lt. Burgess.

Without further conversation, Dr. Wouters began to read the ceremony from the Common Prayer. The voices came distinctly to the telephone listeners on the ground, and every response from the couple was carried clearly to the section of the boxes immediately adjacent to Gov. Smith's box.

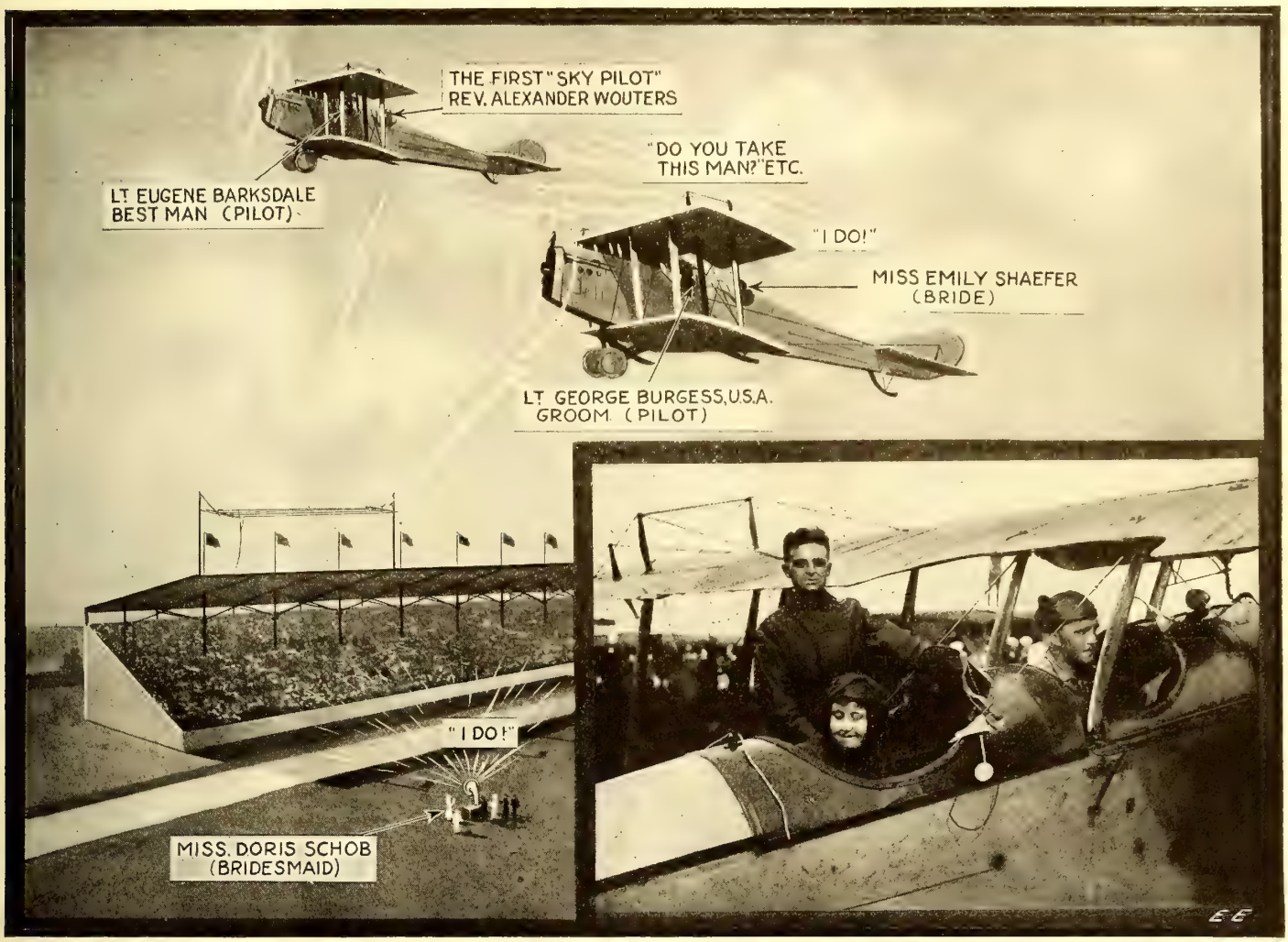
At 5:40 o'clock Dr. Wouters' voice came: "Do you take George Burgess to be your lawful wedded husband?"

The bride responded: "I do," and a cheer arose from the enormous throng that must have reached the two planes. "I pronounce you to be man and wife," said Dr. Wouters. Then followed a prayer and finally—"Amen." Then congratulations and responses between the two planes were passed, mostly unintelligible to the listening congregation. Then silence.

"We are coming down," called the 'planes to the ground station.

Circling slowly, lower and lower, the two planes, now escorted by two more, past over the grandstand twice and each time they were greeted with applause and a sea of waving hats and hands. From the 'plane with the streamers, a white-gloved hand waved its greeting to the ground. Then the 'planes glided to the field, and Lt. and Mrs. George Burgess stept out and awaited the congratulations of Dr. Wouters and Lt. Barksdale.

Then, for the third time, the bridal party, now riding in automobiles, past the stands while the Police Band played the wedding march.



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Lt. George Burgess and Miss Emily K. Schaefer, the First Couple to Be Married in Air. The Ceremony Was Performed by Chaplain Alexander Wouters Who Was Flying in Another Plane. The Ceremony Was Conducted by Wireless Telephone. The Wedding Was the Feature of the Police Field Day Meet at Sheepshead Bay Speedway, near New York City.

The Electrically Driven U. S. S. New Mexico

By Brewster S. Beach

I RECENTLY paid a visit to the battleship *New Mexico,* which is one of the latest dreadnoughts to join the fleet and the first and only one of any nation to have *electrically operated* propelling machinery" said Josephus Daniels, Secretary of the Navy, in recent testimony before a congressional committee. "On this account she has been an object of surpassing interest to the officers of our own navy and to those of foreign navies as well, and to electrical engineers in general.

"The result was satisfactory from every point of view and confirmed the judgment of all who were in any way concerned in its design and adoption. There was not the slightest mishap with any part of it, everything worked to perfection, and the crew was as enthusiastic over the performance of the machinery as is the department proud in the possession of such an efficient dreadnought.

"When we entered into contract for the machinery of the *New Mexico,* we stipulated that, in addition to being capable of developing the maximum power, she should also give an economy at cruising speed very much superior to that obtainable with the turbine installations that we had previously used, and I am happy to say that this stringent requirement was also met. As a matter of fact, the *New Mexico* will steam at 10 knots on less fuel than the best turbine-driven ship that preceded her.

"On the whole, I think the country has cause to be proud of this achievement in engineering not alone because of the pronounced success in this particular instance, but because of the assurance it gives us of the superiority of our capital ships to those of foreign nations."

Secretary Daniels' expressions noted above, have served to create of late considerable interest in the electrical propulsion of ships. Altho the subject has been discussed widely in the technical press for several years, no popular explanation of this invention has appeared.

One of the oldest practical examples of the electrically propelled vessel in this country is to be found in the fire boats of the city of Chicago, Ill., where the first boat was equipt in 1908. Chicago was the first municipality to accept the theory of electric drive for boats of this class.

Now the popular mind, no doubt, conceives an electric ship as like an electric automobile or truck—something that stores the energy necessary to its operation, carries it along and draws upon it as occasion may demand.

But this is not so. It may, therefore, be of interest to explain briefly what an electric ship really is.

WHAT AN ELECTRICAL SHIP IS.

In the first place, electric current must be generated within the ship in order that this energy may be put to its proper use in propelling the vessel.

The current is usually produced by a steam turbine which turns a generator. The apparatus is called a *turbo-generator* and this unit together with the usual engine room auxiliaries constitutes the power plant. The electric current thus generated is led thru copper cables and suitable control apparatus to electric motors and it is these motors which actually drive the propellers of the ship. Thus electricity acts as a connecting link between the steam or other motive force and the propellers. The internal combustion engine, which is somewhat similar to ordinary gasoline engine, is also coming into prominence as a power for the generation of electricity. This apparatus, whether it be a steam turbine or an oil engine, is called the *prime mover.*

The question, "What is a steam turbine?" may well be asked at this point. Conceive an enclosed water-wheel with steam playing against the paddles instead of water and you have a simple elementary idea of what a turbine is and how it operates.

NO MECHANICAL GEARS.

Next, there need be no gears in the electrically driven ship. The function usually performed by gears (that is, to make a connection between the turbine, which to be efficient must revolve at a relatively high speed, and the propeller, which to be also efficient must rotate relatively slowly) is accomplished electrically, thus permitting both turbine and propeller to operate at high efficiency.

Just as in the automobile it is desirable to "shift gears," it is also desirable at times to accomplish the same result on board ship, though not necessarily for the same reason.

Electricity lends itself admirably to effecting these changes, whereas no practical means has yet been found to accomplish this mechanically in large ships.

In addition to this factor, electric drive has appealed especially to naval men from a military point of view.

NAVAL ADVANTAGES OF ELECTRIC DRIVE.

The primary naval advantage of the electric ship, as recently pointed out by Commander S. M. Robinson, U. S. N., rests on the ability to arrange the propelling machinery in a number of separate watertight compartments thruout the ship placed near the center so that they may be protected from damage due to torpedo attack, shell fire, grounding, collision, etc.

The U. S. S. battleship *New Mexico* weighs 32,000 tons and requires 28,000 H. P. —nearly one H. P. for every ton of weight.

She is of the oil burning type with a total oil capacity of 3,400 tons, or 6,800,000 pounds, or about one million gallons.

The oil burners heat nine steam boilers, each of which can deliver 4,000 H. P. at a pressure of 250 lbs. to the square inch. The steam from these boilers operates two turbo-generators which constitute the power plant, each capable of producing 14,000 H. P. The current generated from the turbines operates 4 motors—one for each propeller. The motors are twelve feet in diameter. They are operated from a central switchboard or control station, where the engineers, on receipt of instructions from the ship's bridge, can start the ship forward, or backward, run the propellers at different speeds in either direction. They can run all four motors from one turbo-generator or they can run the two port motors from one generator and the two starboard motors from the other generator.

If one of the propellers breaks down, by simply disconnecting the motor circuit, the power of the two power plants can be used to operate the remaining three propellers. There are only a few of the various combinations of control and operation which form one of the main features of the electric ship.

Among other battleships being equipt with electric drive are the *California, Tennessee, Maryland, West Virginia, Colorado* and *Washington.*

The large calibre guns of the *New Mexico* are fired by electricity; ammunition is hoisted from the magazines by electric motors and some of the guns are loaded by electricity.

The ponderous rudder is moved into any desirel position by the simple turn of a controller on the navigating bridge, which sets in motion machinery in the hold of the vessel for this purpose. There are several steering stations located in various parts of the ship where this operation may be performed in case one station should be disabled. In all, there are five different ways of steering the *New Mexico,* one of which is the hand method, *which requires the exertions of six men.* Think of it!

The ventilation and heating of the ship is by air—cold air forced into the vessel in warm weather and hot air during the winter months. The air is forced thru pipes by blowers operated by electric motors.

There is a completely equipt electric carpenter shop, machine shop, foundry, laundry, hospital operating room, and bakery where bread is baked in electrically heated ovens, while the galley or kitchen is steam operated, the ranges burn oil instead of coal, and there are big steam pots for heating.—*Photos courtesy of General Electric Company.*

WHAT Secretary of the Navy Josephus Daniels Thinks of the Electrically Driven U. S. S. "New Mexico"

For "December"

"Flash and Sound Ranging with the A. E. F." Special feature article written by army officer in charge of this work. By Col. Augustus Trowbridge, Professor of Physics, Princeton University.

"The Helicopter or Vertically Rising Airplane." It stays stationary in the air. Special article by the inventor of a successful helicopter—W. J. Beach.

"The Human Aerial Rocket." A sky rocket that carries passengers.

"Magnetic Storms." Did you know that wind, sunset, et cetera, affect the magnetic compass? Interestingly told by Prof. Lindley M. Pyle, of Washington University.

What Atomic Forces Could Do. The inconceivable power locked up in the atom. Illustrated by diagram and picture.

Is There a Sub-Electron? By Rogers D. Rusk, M. A. A scientific conjecture of timely interest.

Rochelle Salt Crystals Talk. Special article by the scientist that accomplished the trick.

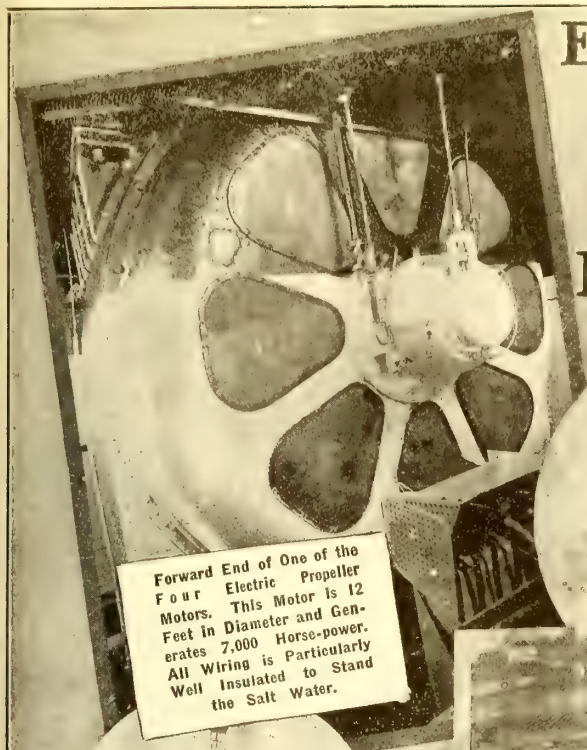
Submarines Raise Sunken Ships. By George Wall. An original and novel scheme for salvaging the hundreds of vessels sunk by the piratical U-boats.

Guiding Vessels Thru Fog and Darkness by Electrified Cable. The remarkable invention of a California genius—Earl S. Hanson.

Electrical Tricks of Stage-Craft. By H. Winfield Secor. A score of stage secrets which you have pondered over are here illustrated and described.

The Moss Airplane Supercharger. It gives the engine the same power at 35,000 feet as at sea level. By Charles M. Ripley.

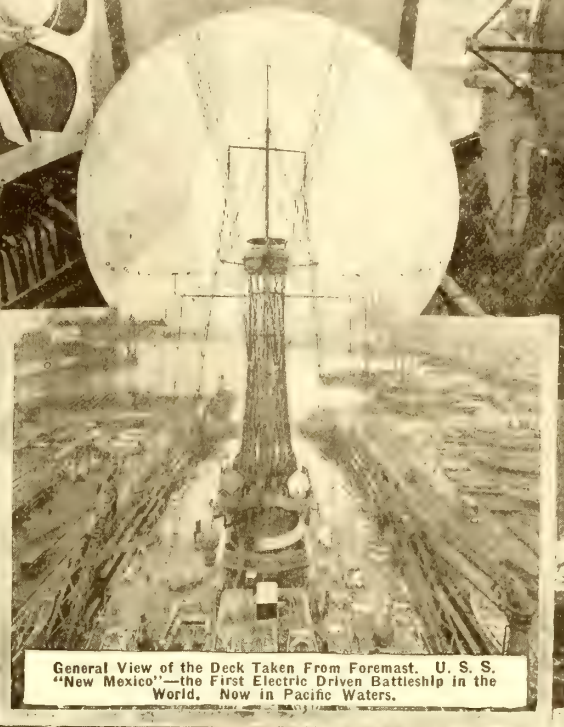
ELECTRIC DRIVE on U.S.S. NEW MEXICO



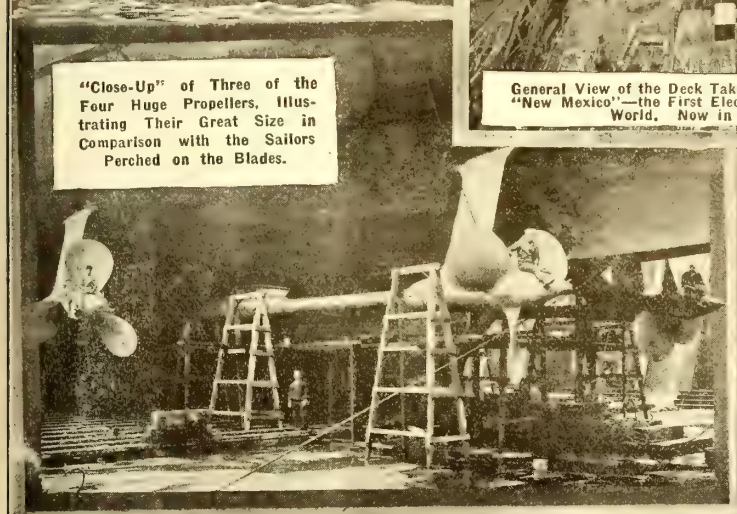
Forward End of One of the Four Electric Propeller Motors. This Motor is 12 Feet in Diameter and Generates 7,000 Horse-power. All Wiring is Particularly Well Insulated to Stand the Salt Water.



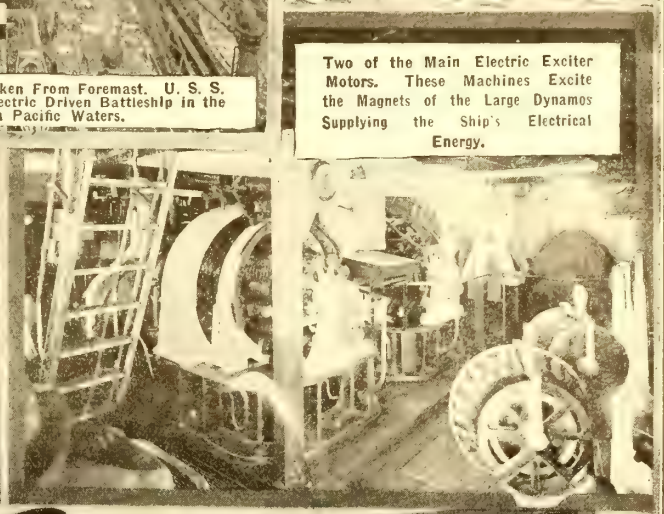
View of One of the Powerful Searchlights of the Ship—the Two Eyes of the Vessel Which Can See for Miles in Inky Darkness. This is One of Eight Similar Lights.



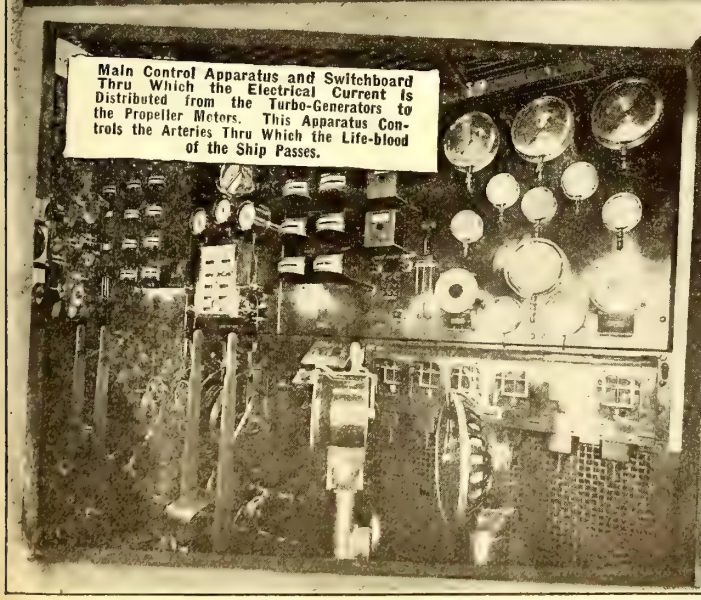
General View of the Deck Taken From Foremast. U. S. S. "New Mexico"—the First Electric Driven Battleship in the World. Now in Pacific Waters.



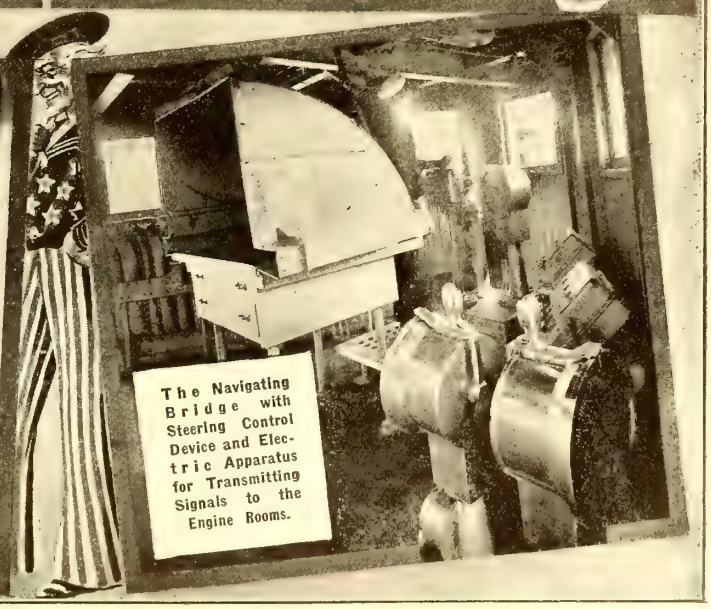
"Close-Up" of Three of the Four Huge Propellers, Illustrating Their Great Size in Comparison with the Sailors Perched on the Blades.



Two of the Main Electric Exciter Motors. These Machines Excite the Magnets of the Large Dynamos Supplying the Ship's Electrical Energy.



Main Control Apparatus and Switchboard Thru Which the Electrical Current is Distributed from the Turbo-Generators to the Propeller Motors. This Apparatus Controls the Arteries Thru Which the Life-blood of the Ship Passes.



The Navigating Bridge with Steering Control Device and Electric Apparatus for Transmitting Signals to the Engine Rooms.

"Cold Fire"

By H. Gernsback

Charging the Body with High Frequency Currents.

EVER since Nikola Tesla began experimenting with the high frequency currents which bear his illustrious name, the world has stood aghast at the many and wonderful effects made possible only by his discoveries.

Most of our readers are no doubt familiar with nearly all high frequency "stunts," emanating either from the stage or from the laboratory, and not much that is new can be written upon the subject.

But not so long ago the writer, while waiting for an electric train out on Long Island, amusedly watched two boys who took turns in jumping upon a live third rail, carrying 500 volts. They would jump upon the rail with both feet at once, and then balanced themselves upon the rail. There is, of course, no danger to this as long as *both* feet are on the rail. One foot on the rail with the other foot on the ground means certain death. The explanation, as most of our readers know, is that when you stand on the rail with both feet, there is *no return circuit*. The body in this case takes on a charge of 500 volts, which, however, is not felt at all by the experimenter, the same as you are not conscious that over 14 pounds of weight are pressing down upon your body on every square inch of you at all times, due to atmospheric pressure.

This made the writer wonder what would happen if you stood on one pole of a very powerful Tesla coil. In a recent conversation with Dr. Nikola Tesla, the inventor pointed out that he had indeed performed many such experiments in his Colorado laboratory many years ago. The currents which he then used were far greater and higher than those produced anywhere now. Thousands of horsepower were used by him at that time. Dr. Tesla explained that he frequently stood upon one pole of his mastodonic coils while the full current was on. Of course, he had to stand upon a metallic plate, but he had to be careful so that no sparks jumped from his body to other objects or to the ceiling. This would have meant instant electrocution. Dr. Tesla pointed out that as the human body has a certain capacity, it radiated a good deal of energy into the surrounding air. Due to the tremendous current the sensation was anything but comfortable. The current heating the blood vessels raised the bodily temperature, and the experiment for this reason alone could not be extended for any great length of time. Dr. Tesla explained that during the experiment sparks and long spark-streams would envelop his entire body. At the extremities, elbows, knees, hip bones, nose, ears, etc., the spark display was most pronounced. Streams five to ten feet long would shoot out from the extremities with a crackling noise. Due to the exceedingly high frequencies used, however, the sparks did neither sting nor burn the flesh. Mr. Nikola Tesla's own words, his body, indeed, was enveloped in "cold fire." Dr. Tesla also explained that during the experiments his hair would rise on end, producing the same effect as if a large static machine had been used, with the well-known result, on the hair.

The other day we endeavored to repeat Dr. Tesla's experiments, and the illustrations shown here are the result. We called upon the Electrical Testing Laboratories of New York, who have one of the most powerful high frequency machines in the country. Altho but a pigmy alongside of Dr. Tesla's Colorado thunderers, the machine gives 500,000 volts and uses 20 kilowatts. The transformer is sunk into oil, and when the full load is on throws streams six to seven feet long. The noise of the tremendous sparks can be heard for blocks.

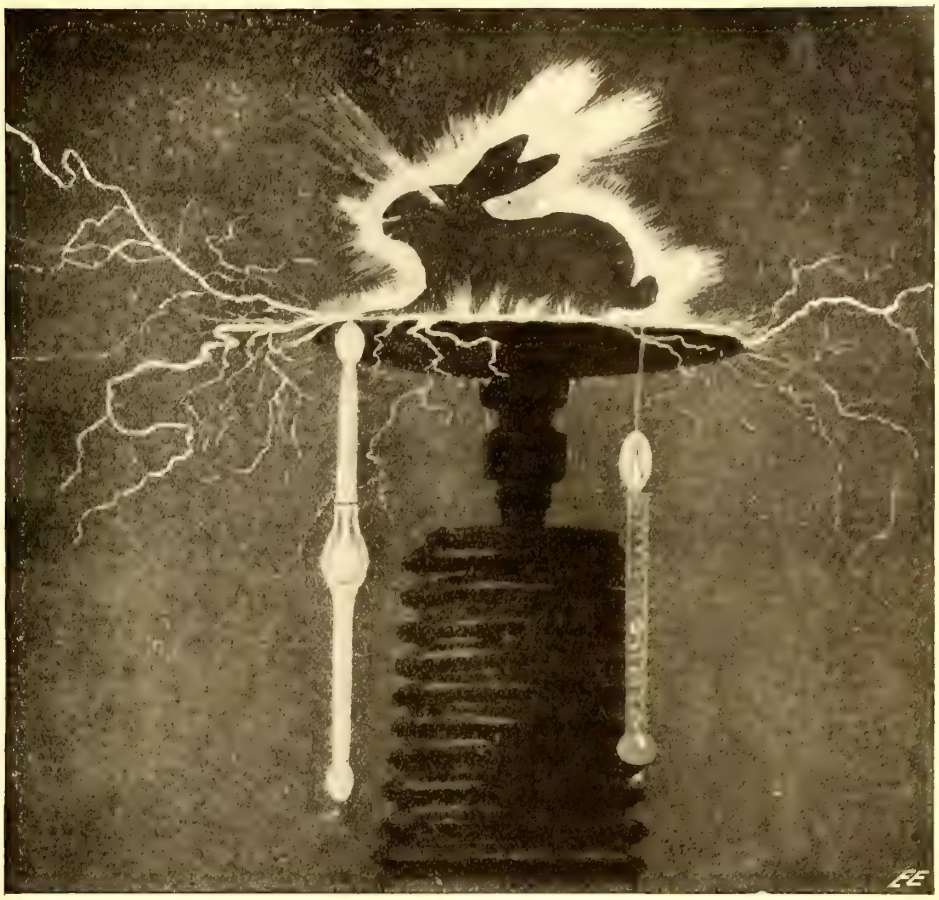


Fig. 1. A dry bath with "cold fire." Altho millions of volts are used in the process, this form of bath is quite pleasant. The currents throw off all dead skin, scale and dirt clinging to the skin. Besides the treatment is distinctly invigorating, leaving the skin rosy and all a-tingling. Every home will soon be equipt with a huge Tesla coil.

We first took a rabbit and placed him upon the metal plate of the "high" terminal of the transformer. At first he was much frightened and jumped off the plate at about 5 kilowatts. Long sparks had shot out from his nose and above his eyes and at the end of the ears. So the writer wetted the platform with water, because he thought that sparks might be jumping into the rabbit's belly and legs which insulated the fur part of his body, giving rise to stinging sparks. An improvement was seen immediately. The rabbit now held perfectly still for about 20 seconds, taking the full charge of 20 kilowatts at 500,000 volts. Long spark streamers, four or five feet long, shot from brer' rabbit's nose, ears and back, and, curious to note, immediately above the eyes. Here the sparks were so hot that they singed the hair. So the writer wetted the spots above the eyes, and after that the rabbit took the full charge, never moving once for twenty seconds at a time. See Fig. 2. Altho long streamers came principally from the nose, the photograph does not show it. After awhile the rabbit seemed to enjoy the performance, and right after his séance

he was as lively as ever, eating a big carrot at once. He is still well and about now.

We next wished to try a human being instead of the rabbit, but the management of the laboratory, due to possible danger, would not grant permission. It was explained that the frequency of the big machine was too low for the experiment, which had never been tried before on a human being, so we desisted. The photograph shown in Fig. 1 was made with a regulation Tesla coil of a very high frequency, but of comparatively low power. Only 1 K.W. was used. The subject, Mr. Joseph Kraus, field editor of this publication, experienced hardly any sensation worth mentioning. Only at the extremities, such as the ears and the nose, a slight prickling sensation, not at all uncomfortable, was felt. The feet were wetted with salt water to insure perfect contact.



Bre'r Rabbit taking a trifling 500,000 volts at 20 kilowatts, and liking it well, thank you! He held still for 20 seconds, only blinking once in awhile. He was not chained nor held down otherwise. "Movie" operators were at hand and filmed him, too. He is still alive, so Sis needn't worry that we killed him.
Fig. 2.

And the value of these experiments? As Dr. Tesla points out, if these machines come into daily use, and duly invade our homes, it will be possible for us to have a dry bath, more sanitary and infinitely better than our present water baths. If the current conditions are right, the body will throw off scale, dead skin, dust and dirt particles, hurling them far from the body. For it should not be forgotten that Tesla currents travel mostly over the skin, ridding it of all impurities. But that is not all. The unquestioned therapeutical effects to the human body are of great value, not only to the muscles but to the entire nervous system. Tesla currents, by softening the arteries, make the old feel younger, and the young, younger and more aggressive. Women, particularly, should derive great benefits from their future high frequency dry baths.

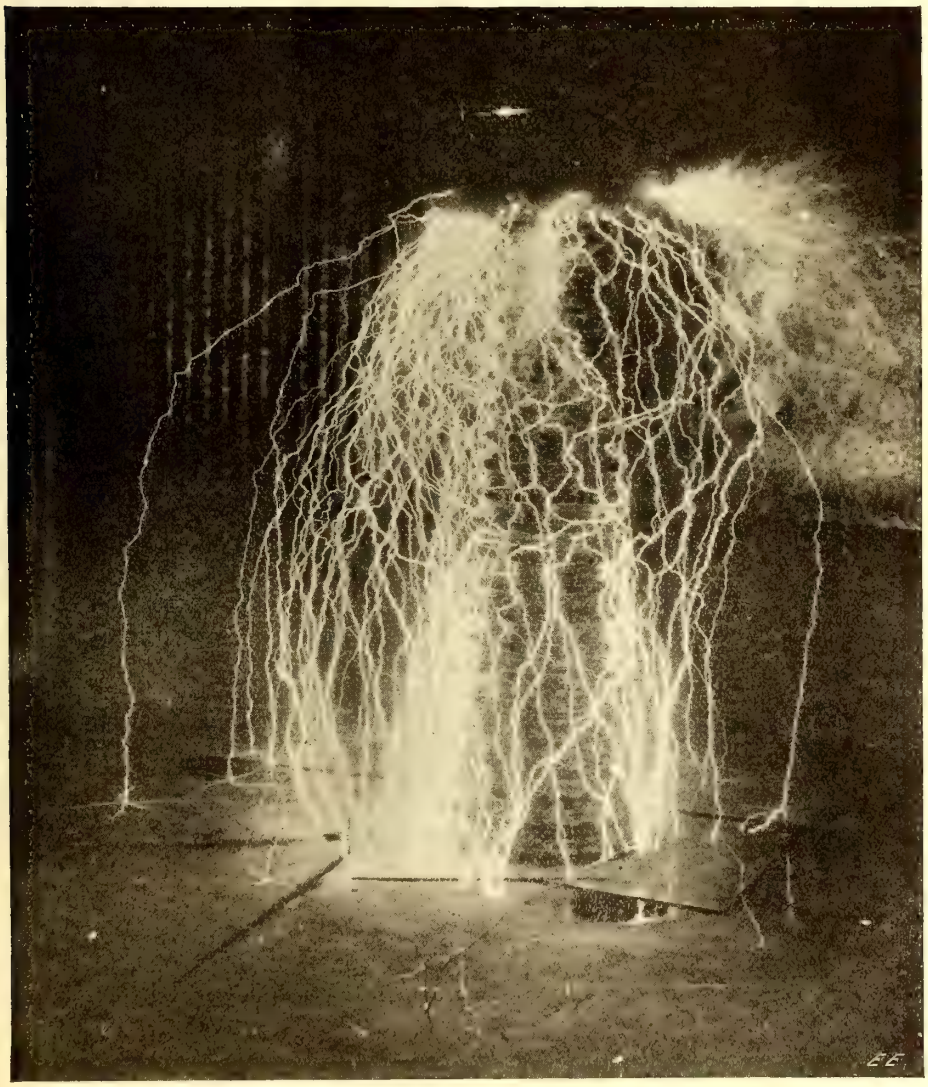


Fig. 3. This shows a wonderful corona and flash-over on a 37-inch porcelain pedestal insulator. This corona is occurring at a potential of 234,000 volts and 51,000 cycles per second.

Largest High Frequency Laboratory of the World.

The insulating of apparatus for voltages of from 100,000 to 150,000 at sustained frequencies varying from 15,000 to 500,000 cycles per second, such as used in radio telegraphy, is a far more difficult problem than that of insulating for the same voltages at "commercial" frequencies, such as 60 cycles per second.

To study this problem, the Federal Telegraph Company built at its plant at Palo Alto, California, a high voltage laboratory, in which it is possible to duplicate the high voltage and high frequency phenomena which have to be met with in operating a high power radio station.

The laboratory is unique in that it is capable of generating a potential *to earth* of a half a million volts, which is about as high as is obtainable in any of the 60-cycle high voltage laboratories of the country, and at the same time this voltage is generated at a sustained frequency of 50,000 to 100,000 cycles per second. Thus, this laboratory is the largest of its kind in the United States, and, as far as is known, the largest in the world.

Photograph No. 3 shows a corona and flash-over on a 37" porcelain pedestal

(Continued on page 709)

"ODD PHOTOS"

A MOVIE PHOTO THAT "RAN."

We have often heard of the "run" of motion pictures, but the brilliant phantasy gracing the top center of this group of "Odd Photos" is a motion photo that "ran" on one hot summer day in the Pathé film studios. It originally represented a scene from the "Isle of Jewels," a photo play of note, but this plate of a "still" view was overcome with the heat and so distorted the faces and forms of Stuart Holmes and Frances Mann that they now look most grotesque. The effect was produced by accident, of course, the emulsion on the plate having become distorted, due to trying to force rapid drying by artificial heat, before the photographer caught it, "freezing" the graceful forms of the actors in the poses here portrayed.

This is liable to happen to those who indulge in an overdose of 2.75 Bock. This is what the editors would call an "Ideal" type of "Odd Photo." So all those interested in our "Odd Photo" contest take notice, that what we desire is novelty, snap and something different!

IS SHE TRIPLETS?

Triplets? No! Just one girl having her picture taken three times on the same plate. The black background turns the trick.

Contributed by A. J. VIKEN.

A REAL GHOST PHOTO?

The accompanying *ghost plate* was produced to convince a steadfast believer in spiritualism that photos of ghosts were not genuine, but only fakes, easily produced by making double exposure using a black background.

The lady in the picture by posing as both ghost and a living person in the same photo succeeded in convincing a lady friend that photos of ghosts are not always what they seem!

Contributed by A. J. VIKEN

TORPEDO TUBE IN FRONT OF MUSEUM.

This clever superimposed or double exposure photo shows two of Uncle Sam's blue-jackets mounting a full-size, honest-to-goodness torpedo tube, and right in front of the New York Museum of Art—the naughty boys. Old "Pop Knickerbocker" sure will be sore when he finds it out.

Contributed by F. E. ZIESSE.

PAUL BRAS IS "2" ELECTRICIANS, ALREADY YET.

Herewith is a photo for your "Odd Photo" contest. Although it has nothing to do directly with electricity, it is odd. This is a photo of an electrician, or rather two of him, in front of a switchboard. It is a double exposure, of course.

Contributed by PAUL BRAS.

A NOVEL "LIGHTNING" PHOTO.

I am sending you herewith a photo for your "Odd Photo" contest. It shows a great forked "ribbon" lightning discharge which was a very pretty sight. It seemed to start in the lower right-hand corner of the picture and streamed upward, splitting into three very brilliant and several less brilliant "ribbons."

Contributed by A. J. VIKEN.

STANDING ON THE "3RD RAIL."

The picture, as you will see, shows two boys standing on a "live" third rail, which proves that as long as a person stands on the rail with both feet at the *same* time they cannot be harmed unless they place one foot on the ground and the other on the rail, which causes a circuit, thus killing or severely shocking the person.

Contributed by EDWARD HINES.

THE "ELECTRIC TOP" AT NIGHT.

I herewith submit an "Odd Photo." I took this photo while out at Riverview in Chicago. It is a picture of "The Top" at night. It was a time exposure. It is the same "Top" that you described in one of your back numbers of the ELECTRICAL EXPERIMENTER.

Contributed by ROBT. H. FREEMAN.

Cheesit! Willie! The Electric Spanker

It's kind of rough on Willie to tip off his dad this way, but news is news and it's got to be printed.

Next time Willie smashes the neighbor's kid on the nose, or sticks a surreptitious finger in father's wallet, or chucks the cat in sister's bath, he's in for it. He can't go out and brag to the gang.

"Shucks," says Willie, "I don't care. The old man will take me to the woodshed and massage me with his palm, and then he'll get tired and let me go."

The "old man" will give Willie the walloping of his young life, but he won't have a streak of red on an overexerted palm when the woodshed dialogue is done. For dad will merely thumb a button on the wall, tie Willie in a chair or on the table, apply this new "Electric Spanker," and sit by smoking a pipe or playing solitaire while Willie's heels kick in the air and Willies vocal cords contract and expand.

There was exhibited at the New York Electrical Show a mechanism that Willie will vote nefarious and his dad will proclaim a blessing. It is the Electrical Spanker!

A small motor, which retrieves with passionate vigor what it lacks in size, is the substitute for irate dads biceps. It is connected by a four-inch rod to a broad applicator that performs the painful function of liason between spanker and spankee. It is about the breadth and length of the parental palm, but packs a more violent wallop.

It has the advantage or disadvantage, according to the point of view, of deadly accuracy. Dad's palm, when fatigued, sometimes misses a few spanks. The applicator lands "smack!" every jolt. It is to be considered, too, that whereas at about the twenty-second onslaught fathers hand becomes weary, the electrical device can continue delivering a regular, rhythmic and impressive chastisement so long as the "juice" holds out.

Indeed, by tying Willie to the chair or table, father can go out for a beer, or go to the office and saunter home, to find the applicator still applicating.

Now, father's adamant determination to wallop Willie may undergo an emotional softening and regret, stimulated by Willie's tears and wails, and may cause him to quit spanking Willie with his palm. The machine, on the other hand, is relentless. Willie can howl until the moon melts and the device will keep on earning its keep until father shuts off the current or mother sneaks into the woodshed to help sonny out of his predicament.

There is only one advantage accruing to Willie. He can say with truth hereafter, "That's a lot of bunk," when dad pulls the old bromide that "this hurts me worse," and so forth.



Photo Copyrighted by Underwood & Underwood.

An Electric Spanker, the Latest Contribution to Science. Yes, But Never Before Has a Scientific Development Met with as Much Disapproval Among the Younger Set. And Why Not? Jimmie's and Johnny's Naughtiness Will Now Be Answered by a Nice and Shiny Electric Spanker Replacing the Cat-o'-Nine-Tail. So Far the Only Danger in the Use of the Spanker Is That the Spankee Will Be Tickled to Death by It.

ODD PHOTOS



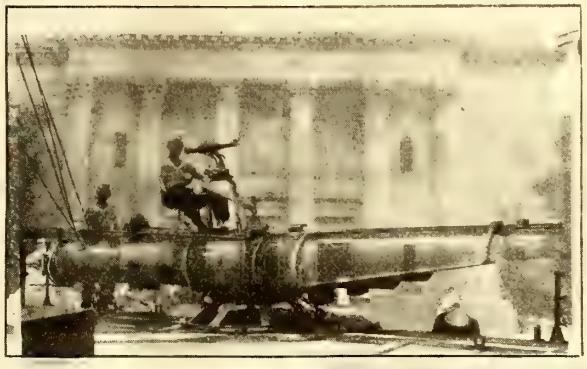
These Three Triplets—Excuse Us Please. They Are All the Same Girl. Fine Sample of Triple Exposure.



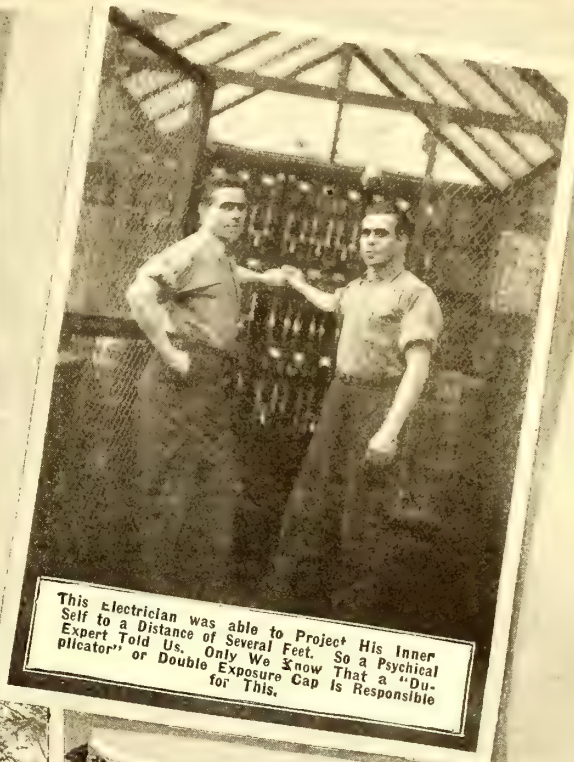
A "Real" Odd Photo—A Pathe Photo of a Photoplay Still, Which, Due to the Unexpected Creeping of the Emulsion Caused by the Forced Drying of the Negative by Heat, Resulted in the Grotesque Effect Here Portrayed.



Looks Like a Sure-Enough Ghost—But Its Not. Just an Example of Double Exposure on the Same Negative.



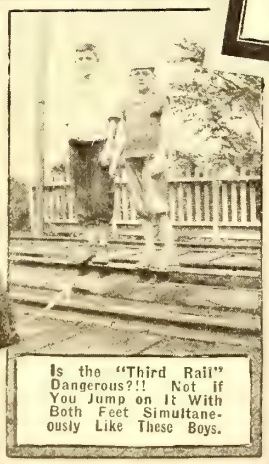
Ever See This Torpedo Tube in Front of the New York Museum of Art? Neither Did We. Two Exposures on the Same Plate Explains It.



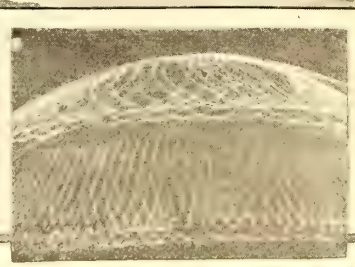
This Electrician was able to Project His Inner Self to a Distance of Several Feet. So a Psychical Expert Told Us. Only We Know That a "Duplicator" or Double Exposure Cap Is Responsible for This.



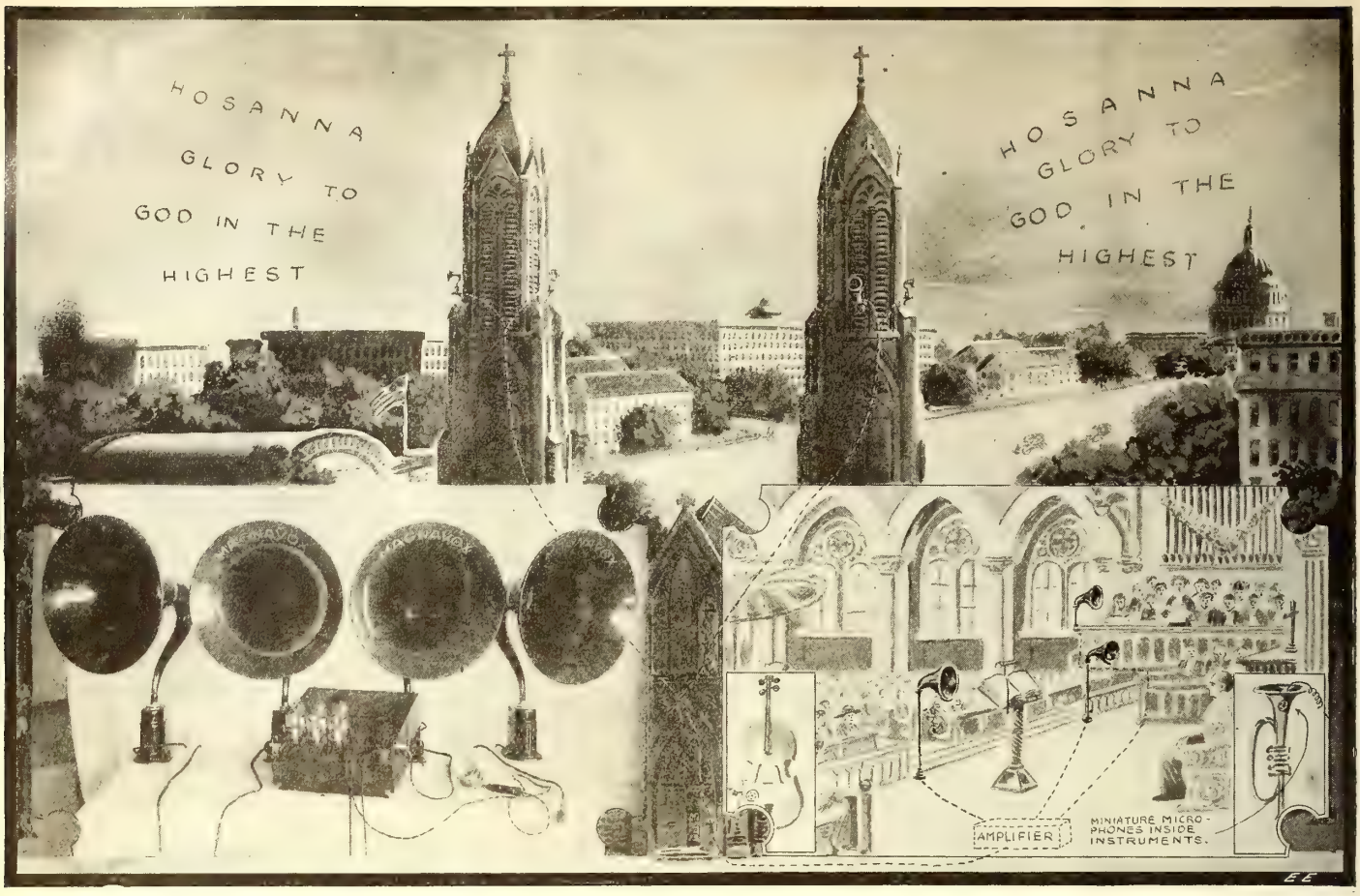
An Extra Fine Photo of Ribbon Lightning. It Takes Patience to Obtain a Picture of the Bolts of Thor as Good as This One.



Is the "Third Rail" Dangerous?!! Not if You Jump on It With Both Feet Simultaneously Like These Boys.



A Night Photo of—Guess! Yes, Its "The Top," Snapt While Spinning, at Chicago.



Recently, in the City of Washington, D. C., a Minister Had the Satisfaction of Broadcasting His Voice Over an Area One Mile in Diameter. His Sermon, Also the Choir and Organ Music, was Thus Heard One-half Mile Away from the Church, Thanks to the Magnavox, the Wonderful Sound Amplifier. People Eight Miles Away Heard the Voice, and it Wafted One and One-half Miles Heavenward to an Airplane Flying Overhead.

Church Sermon Heard Over One-Half Mile

HAVE you ever been in the country on a quiet Sabbath morning and endeavored to note how far away from a church you could hear the minister's voice,—or for that matter, the choir singing, or the organ? Not very far you will say, if you have ever tried it. But in Washington, D. C., recently, a minister had the satisfaction of speaking to more people than any other minister, possibly, in church history. His voice, as well as the singing of the choir and the organ music, were amplified to such a tremendous volume, thanks to the newest electro-mechanical amplifier, known as the Magnavox—that the sermon was clearly audible over a circle whose diameter measured one mile, or over an area having a radius of about one-half mile. The Magnavox amplifier, which has been described several times in recent numbers of this journal in connection with public speaking events, was used on the present occasion in connection with a vacuum tube or audion amplifier, which is connected to the microphones and horns; these gathered the sounds of the minister's voice and the choir singing, in the manner here illustrated. The microphones, or sound detectors with the horns, were mounted as inconspicuously as possible about the pulpit and choral gallery, and concealed wires led to the large vacuum tube amplifier, shown in the accompanying illustration at the left. This was in turn connected up with wires and a suitable source of current, which led up to the belfries atop the two church spires, where there were placed on the outside of each belfry two of the Magnavox special amplifiers, fitted with large horns of the type shown at the left of the photograph just mentioned,

The minister spoke in an ordinary tone of voice, and in fact it was somewhat uncanny to be walking down a shady Washington street, when suddenly out of the very air above you, there came the command—"Thou shalt not steal!" in stentorian tones. Verily it sounded as if the prophets had come down to earth, and that the Day of Judgment had surely arrived. While it perhaps, would not prove beneficial in a strictly ecclesiastical or religious sense to think of conducting our church services in such a broadcast manner as this, it would not seem a bad idea if in forthcoming years, our churches looked carefully into such matters, and considered the practice of broadcasting their pastors' sermons, organ and choral music by means of telephonic amplifiers, which it would seem, would surely have a beneficial effect and would do no harm, that is certain. Talking on the lighter side, there will probably be but one regret, and that will be on the part of the board of trustees of the church, which let us say has installed at some expense one of these amplifying outfits. Mr. Stay-at-Home who is enjoying the sermon may make his remittance to the collection basket when His Reverence pronounces the all important words—"The usual Sunday offering will now be received," by contributing a weekly or annual amount for maintaining the equipment and its operating expense! If he *heard* the sermon.

General Layout of Amplifiers.

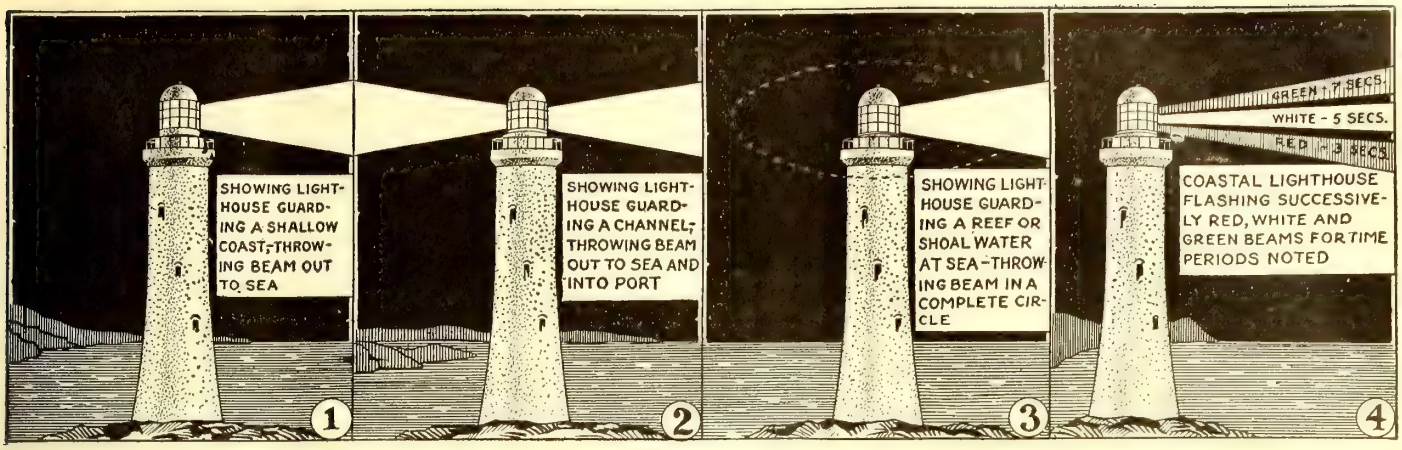
Two Magnavox loud-speakers are installed on the belfry of each tower of Trinity Church, corner "D" and Third Streets, Washington, D. C. A special three-step amplifier using a special combined audio and radio frequency circuit, is employed, so arranged that the output is 250 watts of voice modulated current. The input current can be any ordinary telephone current, radio, or the voice, spoken into special transmitters which are attached to the instrument.

Six volts are used on the filaments, and 300 to 600 volts are used on the plate circuits, depending on the volume of sound required. A special set of attachments are furnished, such as a minute transmitter utilizing a silk cord, which can be placed inside of a violin, cello, banjo, or other string musical instrument; also a small transmitter button can be attached to horned or other instruments. Any of these attachments *will magnify the original instrument one hundred times' by actual measurement.*

In the church are installed special transmitters, one along each side of the pulpit, also one for each section of the pipe organ. These transmitters are equipt with papier-maché horns, 18 inches long and 14 inches at the opening of the bell. They will pick up a speaker's voice three to four feet away from the horn and reproduce it faithfully.

Preliminary tests were made with an Ingersoll watch touching one of the transmitters, and with the three-step amplifier, the *ticking of this watch was heard two blocks away* thru normal street traffic. Pipe organ music, choir singing and special solo pieces

(Continued on page 684)



Lighthouses--How They Signal

By A. H. Whedon
Ex-Radio Electrician, U. S. Navy

EVERYBODY knows what a lighthouse is, and what its duties are supposed to be. But how many know how they work?

To begin with, lighthouses are not always on the coast, many times they are a number of miles at sea and entirely out of sight of land. And the keeper is very rarely an old retired sea captain with a beautiful daughter. More often he is an energetic young man who is not afraid of good, hard work, or the possibility of it, and in many cases also, facing the probability of being left alone for three or four months at a time.

A lighthouse on the coast line is usually in a wild and lonely spot that nobody ever comes near without a very good reason. The keeper's supplies are brought to him by land or by boat whichever is most convenient for the authorities, and are brought when it is most convenient for them.

It is of course, imperative that the keeper know all about gasoline engines and electricity. For the motor whereby the light is rotated is usually run by a gasoline engine supplemented by hand gear in case the engine breaks down. In some houses the light is an electric one, instead of gas.

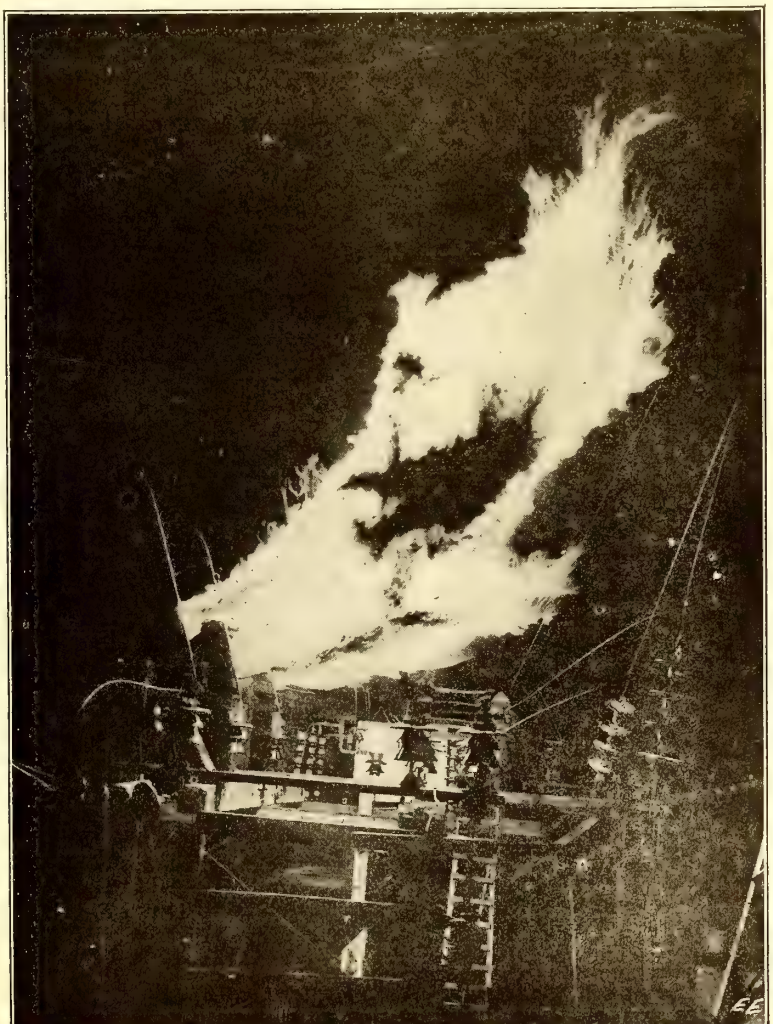
There are in general three types of lights—*steady, flashing and occulting.* The "steady" light is easy enough to understand. The lighthouse simply burns a steady red, white or green light, according to how it is marked on the navigator's chart.

The *steady light* may be fixt so that its light may be seen from all points of the compass, or its beam may be trained to any point or to several different points, if desirable. For instance, a lighthouse guarding a reef at sea would throw her beam to all points, so as to warn ships to keep off. But a lighthouse guarding a sandy beach would only throw her beam seaward, for there would be no advantage in throwing it on land.

The *flashing light* requires a little more care, for the light is mounted on a platform and rotated slowly, so that a ship at sea would see a flash every few seconds, depending upon the length of time it took for the light to make one complete revolution. This light also may be flashed in white, red and green, using a combination of two colors, or perhaps just one. For instance, it may be flashed as follows: "red, red, green," "red, white, green, white, red," —and so on. By varying these combinations and by varying the time of flash, it may be seen that endless combinations may be obtained. Thus it is made possible for each lighthouse to have its own particular flash and code designation, so as to be instantly recognized by the skipper.

Now we come to the last of the three general classes—the *occulting light.* Instead of rotating and having its beam sweep the whole horizon, it is simply lit for a few seconds and then extinguished for a time. It is seen only from certain angles, according to the position of the dangerous object it is guarding. If the object lies in a channel running North and South, then the beam will show only North and South.

And here, as before, the light may flash "red, green, red, green," or any other of a thousand possible combinations. Each combination together with the length of time of the flashes, is placed on the navigator's chart, and is also listed in all nautical tables, so that the navigator can, by timing the flashes and observing the color, lock it up and at once obtain his exact position.

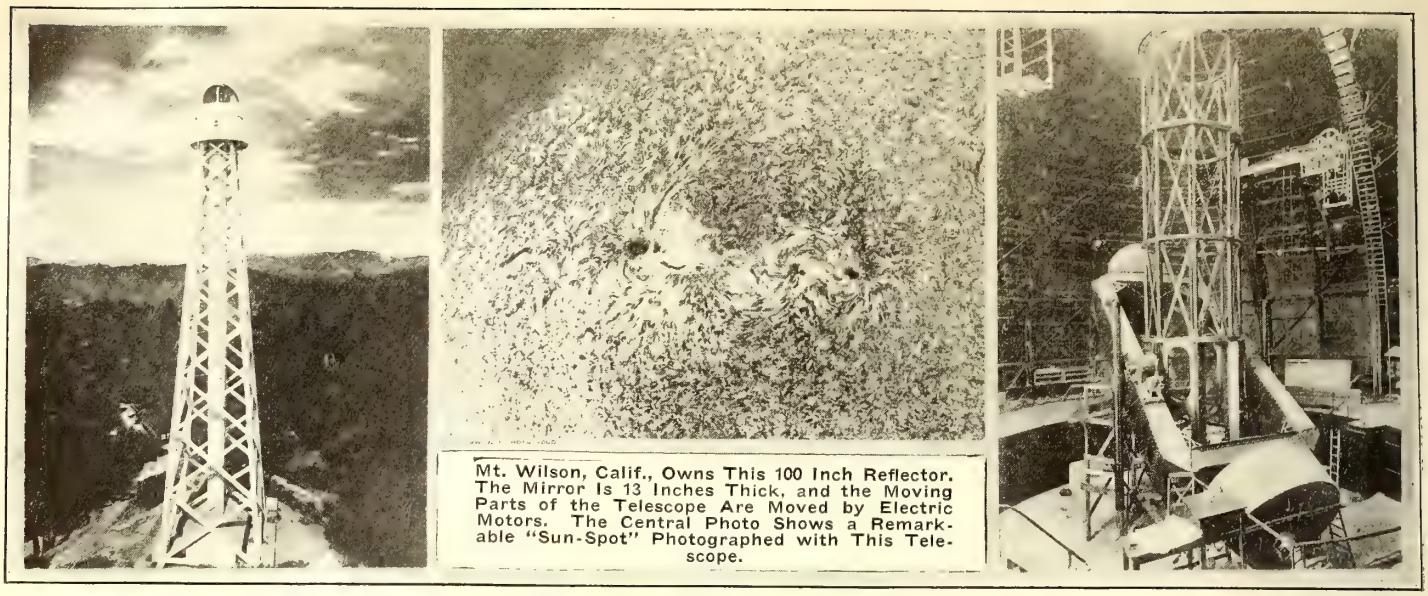


Looks Like Lightning, Doesn't It? It Is—Man-Made Lightning. This Gigantic Sheet of Flame Occurred When a High Tension Feed Wire Switch Was Suddenly Opened. It Lasted But a Few Seconds.

18-FOOT ELECTRIC ARC

The size and power of an electric arc was recently shown in an unusual photograph taken by the Superintendent of a power-house at Tallulah, Georgia, at night, when the switches were opened on a 110,000 volt transmission line that carried no load at the time. The arc, as shown in the accompanying picture, jumped 18 feet and appeared as a huge flame. It disappeared almost instantly and caused no damage. Contrary to expectation, however, these flaming arcs are very dangerous as they evolve considerable heat and will burn any person or combustible material in their path. These giant switches are controlled from the ground or other position by long handled levers, as the operator could not of course stand anywhere near it when opening a circuit carrying a hundred thousand volts or so—veritable man-made lightning. Contributed by

STANLEY W. TODD.



Mt. Wilson, Calif., Owns This 100 Inch Reflector. The Mirror Is 13 Inches Thick, and the Moving Parts of the Telescope Are Moved by Electric Motors. The Central Photo Shows a Remarkable "Sun-Spot" Photographed with This Telescope.

Mt. Wilson 100 inch Telescope

By ISABEL M. LEWIS

OF THE U. S. NAVAL OBSERVATORY

THE one-hundred-inch reflector of the Mt. Wilson Observatory on Mt. Wilson, Cal., is the largest telescope in the world. The mirror, which is one hundred inches in diameter and thirteen inches in thickness, weighs four and one-half tons, and the moving parts of the telescope, which are electrically controlled, about one hundred tons.

The glass for the mirror was manufactured at the St. Gobain glass works in France after many attempts covering an interval of three years, as it was difficult to find a piece of glass large enough and sufficiently free from imperfections for the purpose. It was then shipped to the optical shops of the observatory in Pasadena, Cal., where it underwent a long grinding and polishing process for seven years. All of this work was done by Prof. George Ritchey, a member of the staff of the observatory. As the work progressed the mirror was subjected to frequent and rigorous test, and finally, on July 1, 1917, the completed mirror, which had been pronounced practically perfect in form, was packed in an octagonal-shaped box lined with paraffin, placed on an automobile truck geared to a maximum speed of two miles an hour and taken up the steep and winding mountain road to the summit of Mt. Wilson at an elevation of nearly 6,000 feet.

The huge sections of the iron castings for the telescope were made at the Fore River Shipyard at Quincy, Mass., and shipped around Cape Horn, as they were refused shipment by the railroads on account of their great size.

All smaller parts of the great telescope and those that required special care were designed and constructed in the instrument shops of the Mt. Wilson Observatory in Pasadena.

The huge reflector is now housed in a steel building designed for that purpose with a 100-foot dome that weighs five hundred tons and is quickly and easily moved by electricity.

The 100-inch mirror lies at the base of the telescope tube and simply acts as a support for the silver coating that is placed on its upper concaved surface. The rays of light from the stars do not enter the mirror, and therefore it was not necessary that the glass be entirely free from imperfections. It is the form of the upper surface of the mirror that is of chief importance, and this must be practically perfect.

World's Largest Telescope

Reflector Resilvered Every Six Months.

Every six months it becomes necessary to resilver the mirror. This is done very quickly and easily by means of an electric elevator which lowers the great mirror from its position at the base of the telescope to the resilvering room below and returns it after the process is completed.

The parallel rays of light from the stars pass down the telescope tube and fall upon the silvered surface of the great mirror and are reflected back in the direction of the upper end of the tube, coming to a focus on a secondary mirror near the top of the tube, which reflects them to the photographic plate or observer stationed at one side of the tube.

Preliminary tests of the instrument in the fall of 1917 revealed a slight flare of the star image, due partly to temperature effects and partly to lack of rigidity in the support of one of the secondary mirrors. The latter difficulty was overcome by adding a compression ring to the tube carrying this mirror, and the temperature effect was also looked into and overcome.

Shows Extraordinary Details of Moon's Surface.

These necessary changes were greatly delayed by the fact that the staff of the observatory was largely occupied with war work of an urgent nature and the instrument shops were needed for the same purpose.

The great instrument is now fully prepared to enter upon its observing career, however. Test observations of the moon, Saturn and other celestial objects have shown the wonderful light-gathering power of the huge reflector and revealed an extraordinary amount of detail on the moon.

Its work will be largely photographic and spectroscopic and comparatively few direct visual observations will be made. It is expected that it will soon be storing away on photographic plates light from stars and nebulae that lie far beyond the reach of all other telecopes in existence and that as a result of these observations our knowledge of the form and extent and nature of the universe will be materially increased.

QUESTIONS AND ANSWERS.

Q. 1. Will you explain what astronomers mean by "the cepheids"?

A. 1. From the context of your letter I should judge that you refer to the cepheid variables, tho the cepheids is also an expression for a swarm of meteors whose radiant point lies in the constellation Cepheus.

The cepheid variables constitute a very important class of variable stars. They receive their name from Delta Sephei, a well-known star of this class.

The light of a cepheid variable fluctuates periodically in a most peculiar manner. There is a sudden rise to maximum brightness that occupies about one-third of the entire period, followed by a much slower decline of brightness which usually has a more or less pronounced pause. These light changes are performed with the greatest regularity and have been likened in effect to a revolving light in a lighthouse in which there is the same sudden increase to maximum brightness, followed by a slow and gradual decline repeated over and over with absolute regularity.

The periods of light changes of the cepheids range from less than a day to forty-five days and there is a close connection existing between the *period* of the *light variation* and the *actual size or luminosity* of the star.

The discovery of this fact has led to some very far-reaching results and made this class of stars of the highest importance in determining the distance of the globular star clusters.

Dr. Shapley's revolutionizing discoveries concerning the distances of these objects are founded upon the simple relationship found existing between the periods and luminosities of the variable stars in these clusters, which are simply short period cepheid variables.

It has been found that cepheids whose periods are less than a day are giant stars whose absolute magnitude is constant at one hundred times the light-giving power

(*Continued on page 721.*)

New Electrical Gyro Compass

UNTIL recently the *magnetic compass* has been relied upon as a means of indicating direction to mariners at sea. In doing so it utilizes the directive forces of the earth's magnetic North Pole. In indicating direction the magnetic compass is subject to a great number of errors and influences which make its indications unreliable. When used on board a ship, especially a steel ship, many devices and precautions must be taken to obtain a compass indication which is anywhere near accurate.

It is well known that the direction of magnetic fields upon which the compass relies vary in different localities of the earth. Magnetic mountains will distract the needle—magnetic and electric storms also influence it.

INACCURACIES OF THE "MAGNETIC COMPASS."

On board a steel ship the change in character or displacement of a cargo seriously influences the magnetic compass. Even a slight change in wind will cause the smokestack to change its magnetic characteristics by changing its temperature. The magnetic compass will show deflection—it is caused when the ship rolls. The compass needle is caused to oscillate as the mass of the ship is displaced to either side of the compass needle.

An altogether different force is now used to indicate direction. This force is as old as the earth itself—the earth's rotation. The earth's rotation is made to indicate direction by utilizing the new Sperry gyroscopic compass. The Gyro Compass is nothing more than a small electrically driven wheel rotating at a high speed.

Scientists have discovered that any small wheel rotating about its own axis and freely suspended to move in any plane when placed upon a larger wheel, will place its axis in the same direction as the axis of the larger wheel. This principle has been demonstrated, proven, and in practical use for years. The Gyro Compass forms the smaller wheel referred to, while the earth forms the larger wheel. As the earth rotates it combines forces with the small rotating gyro wheel and causes the axis of the compass to point *true north.*

The captain or navigator of a ship in using the Gyro Compass does not have to take into consideration any variation or deviation. He does not have to compensate his compass. He does not have to check the compensation of his compass.

Instead of encountering the disadvantages outlined, he is free to steer a true course and to keep his ship on the straight line course.

Perhaps the greatest feature of the use of the Gyro Compass is the safety factor. Many ships have been wrecked due to inaccuracies of navigation resulting from the use of the magnetic compass. The Gyro Compass insures against such contingencies, thereby insuring the ship, passengers, crew and cargo.

HOW THE GYRO COMPASS WORKS.

When used on land one wheel, or element, is sufficient to show the *true North* Pole. When used on board ship, however, the roll, pitch and yaw of the ship introduces forces which would tend to throw the wheel from off its indication. In the

(Continued on page 700)

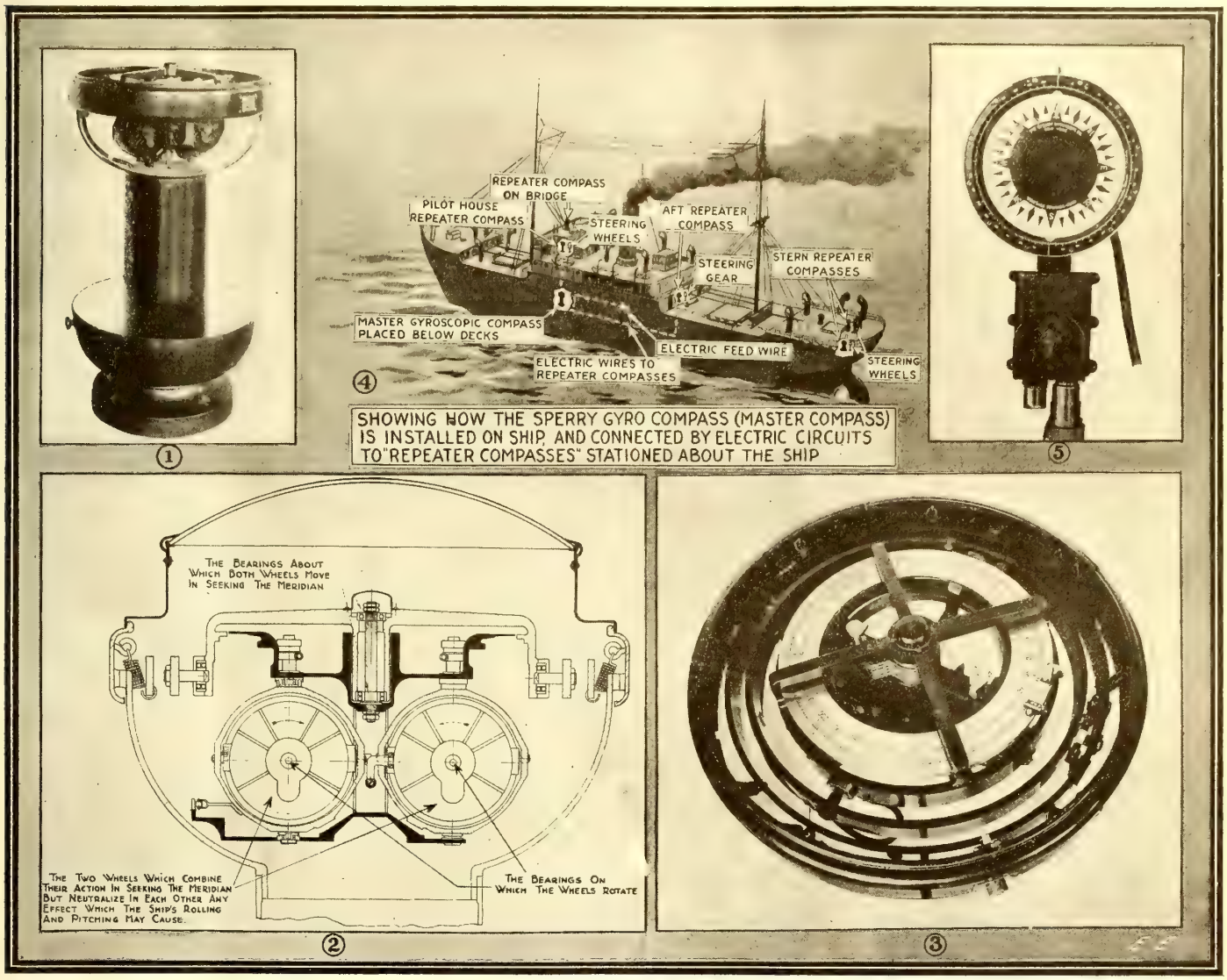
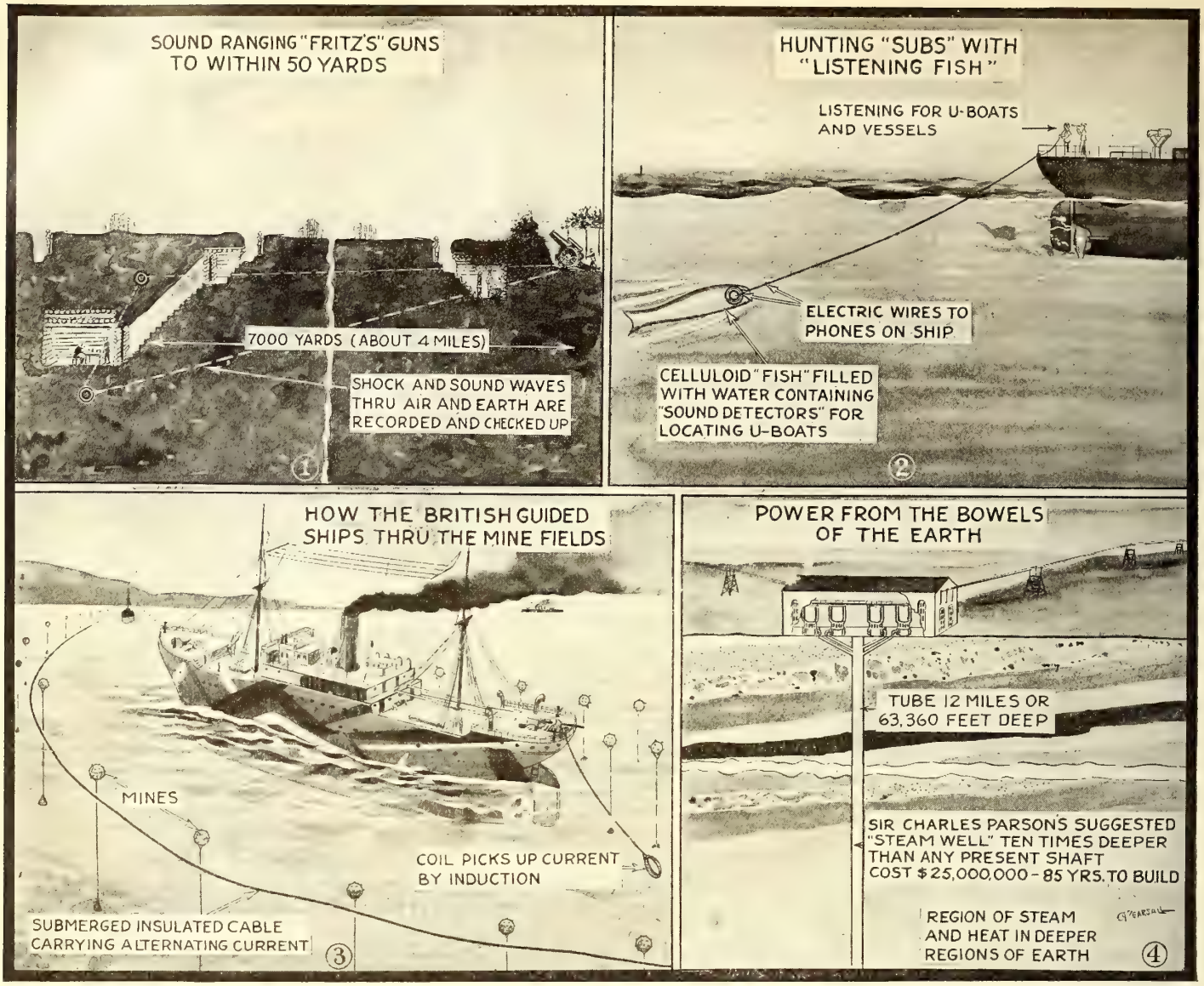


Fig. 1. The "Master" Gyroscopic Compass, Which Does Not Depend Upon Magnets for Its Operation, and Which Is Placed Below Decks on the Ship as Shown in Fig. 4, While "Repeater" Compasses Are Stationed at Various Points About the Ship, Such as Steering Wheels, Etc. Fig. 2 Is a Sectional View Thru the Gyro Compass, Showing the Revolving Wheels. Fig. 3, Top View of Master Compass, Showing New Navy Type of Dial, Graduated in Degrees, Instead of Points of the Compass. Fig. 4. This View Shows the Location of the "Repeater" Compasses About the Vessel. Fig. 5. The "Repeater" Compass, Operated by Electric Currents Transmitted from the Master Compass.



Four Important Wartime Developments Described by the Eminent Scientist and Inventor of the Parsons Steam Turbine—Sir Charles Parsons—before the "British Association for the Advancement of Science."

Sir Charles Parsons on War Inventions

THE work of scientists in the war occupied the greater part of the Presidential address delivered before the *British Association for the Advancement of Science* at its meeting at Bournemouth by Sir Charles A. Parsons, inventor of the marine turbine engine.

British scientists, he said, "worked in close collaboratiou with the men of science of the allied nations and eventually produced better war material, chemicals and apparatus of all kinds for vanquishing the enemy and the saving of our men than had been devised by the enemy during many years of preparation, planned on a basis of total discregard of treaties and the conventions of war.

As illustrating the immense difference between the recent and all preceding wars, Sir Charles gave some interesting figures. At Waterloo 9,044 artillery rounds, with a weight of 37.3 tons, were fired, whereas in the last offensive in France on the British front alone 943,837 artillery rounds, weighing 18,080 tons, were fired. Again, in the entire South African war 273,000 artillery rounds, weighing 2,800 tons, were fired, while on the British front in France during the entire war over 17,000,000 rounds were fired!

SOUND RANGING AND LISTENING DEVICES.

Many of the new war devices Sir Charles left to be discus' in the meetings of the sections, but he dwelt on *sound-ranging* and *telephonic listening* methods. By the end of 1916, he said, the whole front in France was covered by devices which enabled the British to locate the position of the enemy's batteries merely by sound. In 1918 more batteries were thus detected than by any other means, and a single good set of observations could give the position of an enemy gun at 7,000 yards range to within about fifty yards. Listening devices were also largely used at sea, but it was found that the motion of the vessel carrying them when the sea was rough, and also the noises caused by dragging the devices themselves thru the water made them useless.

HOW THE WHALE HELPED PERFECT SUBMARINE DETECTORS.

"So," Sir Charles went on, "the assistance of eminent biologists was of invaluable help at this juncture. Experiments were made with sea lions by Sir Richard Paget, who found that they have directional hearing under water up to speeds of six knots. Also Professor Keith explained the construction of the hearing organs of the whale, the ear proper being a capillary tube too small to be capable of performing any useful function in transmitting sound to the relatively large aural organs, which are deep-seated in the head. The whale, therefore, hears by means of sound waves transmitted thru the substance of the head. It was further seen that the organs of hearing of the whale, to some extent, resembled a hydrophone.

"The course now became clear. Hollow towing bodies in the form of a fish or porpoise were made of celluloid, varnished canvas, or very thin metal, and a hydrophone suitably fixt in the centre of the head. The body is filled with water, and the cable towing the 'fish' contains insulated leads to an observer aboard the vessel. When towed at some distance behind the chasing ship the disturbing noises are small, and enemy noises can be heard up to speeds of 14 knots and at considerable distances."

Other listening devices made use of the echo, and were developed until they could pick up a submarine a mile away. Sound-ranging stations were established ashore, and from them ships steaming in a fog were informed of their positions accurately for ranges up to 50 miles.

SHIPS PILOTED THRU MINES BY CHARGED CABLES.

Another device, used first by the Ger-

(Continued on page 720)

Interplanetary Communication

By Dr. C. S. BRAININ, Ph.D.
Of the Columbia University Observatory

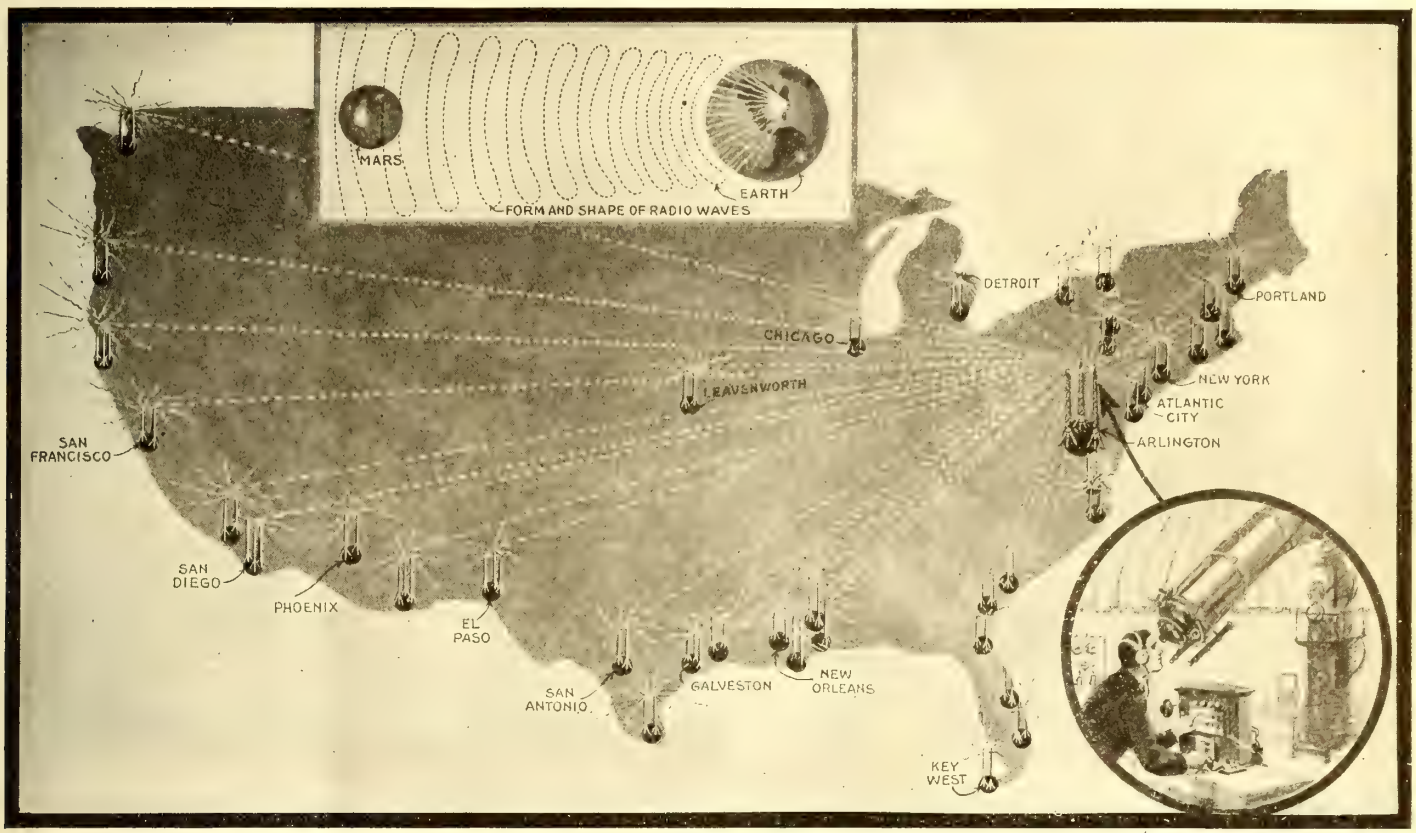
THE tremendous advances made by wireless telegraphy and telephony during the last decade and particularly in connection with the activities of the great war have given renewed impetus to the already considerable speculation as to the possibilities of pushing this method of communication beyond the limits of man's earth and using it for the purpose of "speaking" with other inhabitants of the universe with which the popular imagination has peopled cosmic bodies. The subject falls naturally into two divisions: Are there in space or within the confines of the solar system other inhabited spheres, and secondly, is radio a suitable means for interplanetary communication? And in the discussion we must distinguish clearly between that which is science—knowledge—and that which is merely speculation based upon science.

The first division of our subject presents the bigger IF. Astronomy is not as yet so far advanced as to be able to speak with finality. Much has been learned about the physical and surface conditions of the earth's fellow members in the solar system, but not enough to decide the question. Should we wish to extend our field to outside space, instead of limiting ourselves to the planets of our own system, we may speculate with safety. Every star in the heavens is a sun, more or less like our own sun, and multitudes of them must possess planetary systems. No doubt upon many of these planets conditions have been such as to be favorable for the development of some kind of life. But the question of life in other systems can be left here; it need hardly be considered further in connection with the problem of communication for the distances are too great. In the first place, too much of the original energy of the emitted signal would be squandered unless it were possible to make the transmission truly undirectional, and secondly, the time between the emission and the receipt of the signal at the other end would be too long. Even the *nearest* star is so far away that it would take the electric waves about *four and a third years* to reach it: and only a very small number of stars are within even a hundred years by wireless from us.

There has, of course, not as yet been found any direct, unimpeachable evidence of the existence of inhabitants upon the other planets, and we are limited, therefore, to a consideration of the planets' physical conditions and to a discussion as to whether these are favorable for the development and maintenance of life. We ourselves are the products of the terrestrial conditions of temperature, atmosphere, humidity, etc.; a different combination of these factors would no doubt have produced an entirely different form of life. We cannot, however, discard a planet as uninhabitable because its condition differs somewhat from the earth's, but we are safe in discarding the major planets, Jupiter, Saturn, Uranus and Neptune. It is certain that conditions upon these are unfavorable. The temperature seems to be far too high and the surfaces of these planets have not yet reached the state of solidity attained by the surfaces of Mars and earth. Undoubtedly, the temperature is far too high, also, for the existence of the very complicated organic chemical compounds necessary for any imaginable form of life, different tho it be from ours. Of Mercury we know very little, indeed; it is so close to the sun that observation is extremely difficult and unsatisfactory. Venus and Mars remain.

Mars has been the favorite playground. Since the first announcement of the "canali" by Schiaparelli and the subsequent observations and speculations of W. H. Pickering and Percival Lowell, much has been written and said on both sides of the question. We may briefly sum up the affirmative: The surface of Mars is declared to be crost by a network of straight lines, some of them double; the poles of the planet show at their respective winters, broad sheets of white, very like the terrestrial ice-caps, which decrease rapidly in area with the coming of the summer, and at the same time the "canals" broaden, "germinate," as they say. Evidently, then, Mars is an arid planet with very little water and these "canals" have been constructed by the Martian engineers to carry the water from the melting polar caps to different parts of the Martian surface. Therefore, Mars is inhabited, and by advanced beings, too, for their engineering feats are of the greatest difficulty. But the observations upon which all this rests are not accepted by the astronomic world at large. The great majority of observers, among whom are the most skilled and experienced in the whole world, have declared themselves entirely unable to see this complicated network of straight lines. Streaks and patches are seen by all but nothing like Lowell's maps; nor do published photographs reveal them, and we are reluctantly forced to decide in the negative. There is

(Continued on page 692)



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Mr. H. Gernsback's Radio Scheme Publisht in May, 1909. The Underlying Idea Is to Operate All the Powerful Radio Stations in the United States and Canada Simultaneously by Means of Long Distance Radio Control. A Radio Operator Seated at Arlington (Washington) by Pressing His Key Would Operate All the Radio Stations Over the United States as if All These Stations Were But One Huge Powerful Station. Theoretically, This Would Give Us Enough Energy to Bridge the 35 Million Miles Separating Us from Mars. The Insert Shows How the Radio Waves Are Propagated. It Is Understood, However, That the Waves Go in All Directions, Not Only Towards Mars. Thus if Venus Were to the Right, She Also Would Receive the Messages.

MR. TESLA'S ARTICLE

announced in our October issue was unavoidably delayed due to important research work of the great inventor. We hope to present it in an early issue.

—Editor.

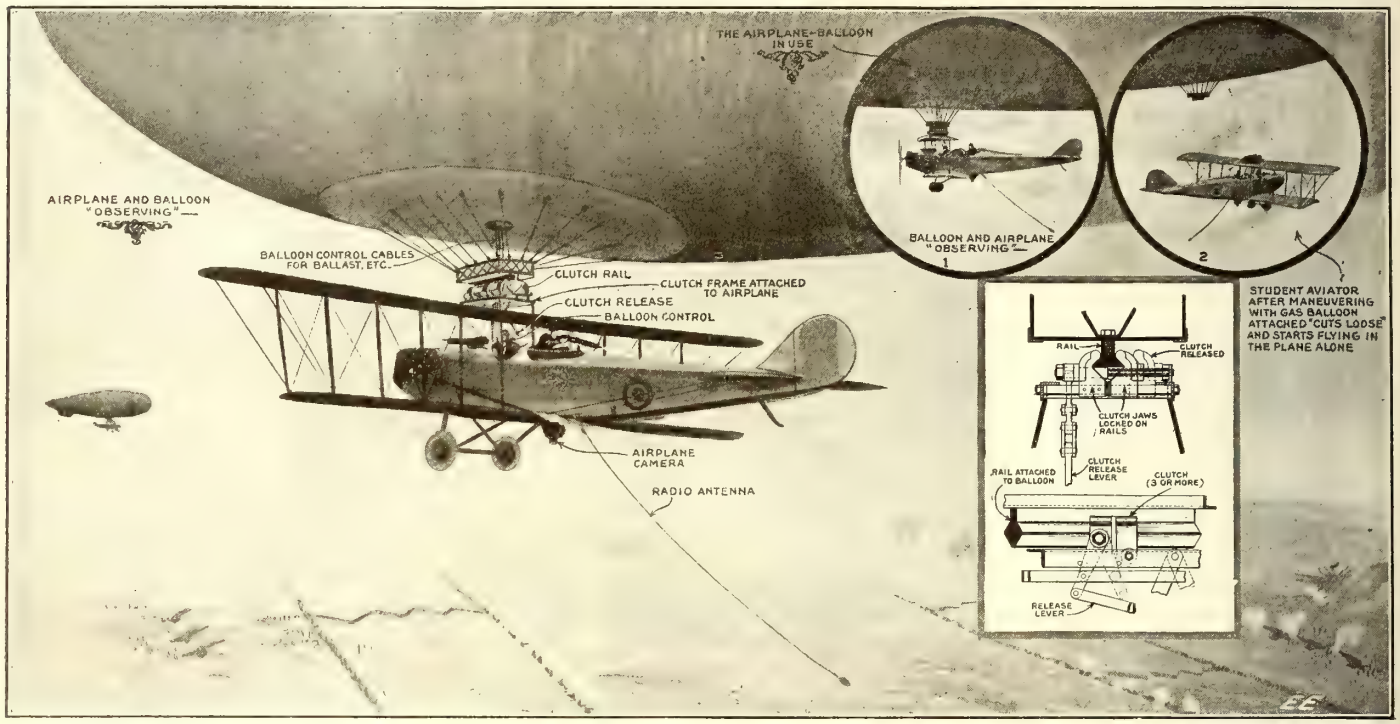
Combination Airplane and Blimp

THIS clever invention, combining some of the characteristics and qualities of the airplane with the blimp or gas-filled balloon, is due to Mr. James N. Lewis, of Detroit, who has recently taken out a patent on it. There are many military as well as other features, which seem to give great promise in this combination of the lighter-than-air flying machine or balloon, with the heavier-than-air craft or airplane.

For one thing, the airplane is attached to the blimp or gas-filled balloon by means of a special and powerful design of quick-acting clutch; by simply throwing a lever attached to this clutch, the aviator, seated in the airplane, may at any time release the clutch and sail off, having, of course, started his engine going before doing so, altho he can in emergency and if necessary, cut loose from the balloon and volplane to earth without the engine running. This would seem to be one of the principal features of Mr. Lewis' invention, particularly where aircraft are used for artillery observation, etc., over the battlefields, where balloons were frequently set afire by incendiary shells or balloons, or else attacked by enemy aircraft. Under such a condition, the observer, if he were seated in an airplane carried by the balloon could cut the plane loose and descend to earth safely, much more safely, we believe, than is the case where the observer has to depend upon a parachute, for in some cases the parachute fails to open and the observer is killed.

Another purpose of the invention, as pointed out by Mr. Lewis, is the feasibility of using the airplane with the attached gas-bag to provide auxiliary buoyancy, the airplane being operated or propelled in the regular manner by its usual engine and propeller. Naturally, of course, the speed of the airplane in this case would not be as great as if it were flying without the attached balloon, owing to the great bulk of the gas-bag, which would have to be propelled thru the air. At this juncture we perceive another very fine point of interchangeability and adaptability, which would seem very useful and commendable for war-time requirements, and which is here made evident in our estimation, for it would not be necessary to build expensively equipt blimps or balloons of the dirigible type if this idea be put in practice. For example, by providing these special clutches on simple forms of balloons with no gondola gear, or other attachments, then by simply attaching the balloon onto the airplane we would have a dirigible which could be driven at 30 to 40 miles an hour and maneuvered in all the regular ways in which dirigibles are steered. Suitable control ropes or cables may lead down so as to be readily accessible to the airplane pilot, so that so long as he is flying attached to the blimp, he may have control of the relief valves for the gas compartments, air valves, et cetera.

Another very important feature of this invention lies in the fact that it should prove one of the greatest advances yet brought out in safely training aviation pilots for the army and navy service. As is well known, it is very risky to send aloft a young pilot or aviation student who is not very familiar with the idiosyncrasies of the machine he is trying to fly, and this was very forcibly brought out at the army training fields during the war. The seaplane pilot has much more chance to save himself in such an emergency than the land plane pilot or student, for with the seaplane he can always land on the water, and, with the present design of this aircraft, the machine will safely volplane down from any height with the engine dead. Landplanes may also volplane down in most cases, even if the engine should go dead. But with the seaplane the landing area is not restricted as long as it is over water. With the land plane, the angle at which the volplane occurs is dependent upon the height at which the plane starts, and, before he knows it, the student may find himself headed directly for a group of trees or several high, piercing church spires with a few dozen brick chimneys and iron fences thrown in for good measure. All of what we have just said is intended in its application to the embryo aviator, while he is learning the graces of ordinary or trick flying. Ever imagine what a difference there is when his buoyancy is not dependent upon the exact movement of his hands and feet, when a slight misjudgment may spell death to him. Now, with this invention he simply throws on the clutch, so as to secure the plane to the gas-bag, and at the command, "Let go!" he is hauled skyward by the buoyancy of the balloon.



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No Need to Fall Any More While Learning to Fly an Airplane, if You Are Equipt with This New Balloon Release Clutch. You Can Enjoy the Safety Afforded by the Superior Buoyancy of the Gas-Filled Balloon. When Sufficient Skill Has Been Attained by the Student Aviator, He Can Cut Loose from the Balloon and Fly in the Plane Alone. The Combination Forms an Ideal Observation Unit for Military Work, In That the Balloon Is Under Control of the Pilot. In Case of Attack the Observer Can Also Cut Loose and Descend Safely to Earth in the Airplane, Which for This Work Need Not Have a Very Powerful Engine.

THOMAS A. EDISON

will talk to you in our December issue. This important as well as unusual feature should not be mist by any reader of the Electrical Experimenter. Mr. H. Gernsback, who interviewed the famous inventor, asked Mr. Edison a multitude of important and timely questions, which, with the inventor's answers, will be presented to the world for the first time next month.

We have also secured many new and unique photographs about Mr. Edison and his work, all of which will be publisht for the first time in our December issue.

There being no oil-painting in existence of Mr. Edison—altho several attempts were made by great painters, but their paintings having been rejected and destroyed by the great inventor—a well-known artist was selected by us to execute Mr. Edison's portrait. Upon completion of the work, Mr. Edison was highly elated over the painting and exprest himself as well pleased with the excellent likeness.

The cover of our December issue is an artistic reproduction of this historic painting and should not be mist by any reader.

The next issue being heavily advertised thruout the country, regular newsstand readers should order at once from their newsdealer to be sure of their copy.

—THE PUBLISHERS.

A Hair-Raising Razor

Users of faradic electric coils, such as used for medicinal purposes and shocks, may have thought that the day of the faradic coil had about reached its zenith. But such is not the case, for behold in the present illustration we have the very latest in tonsorial arts and sciences—the *faradic electric razor,* invented by Frank White of St. Louis, Mo., which not only shocks the little hairs into a vertical position so that they can be cut off painlessly, but also the application of the mild electric current to the patient's physiognomy produces the effect of an excellent massage, and not only do these two wonderful phenomena take place, but thirdly, the inventor makes another strong claim in his recent patented invention on the faradic razor—wherein he states that the current flowing from the razor to the face has the effect of aligning the metal fibers on the keen edge; in other words, the faradic current flowing thru the razor acts on the steel fibers, particularly at the edge, with the same effect as when the razor is stropt.

The apparatus required with the faradic razor outfit here shown, is quite simple and comprises a dry battery or other source of electric current, and an induction coil provided with primary and secondary windings. One terminal from the secondary or faradic current circuit is connected to a metal part of the razor, which may be a safety razor; while the second terminal from the faradic coil leads to a suitable electrode or contact plate, strapt to the wrist of the shaver. Sweet dreams of Ossining's electric chair!

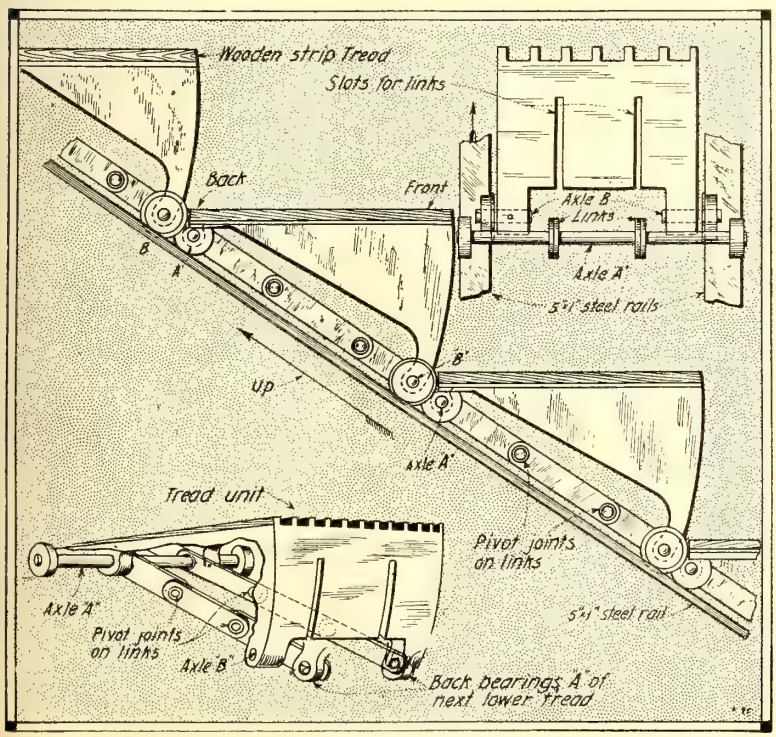
The accompanying illustrations show precisely the effect "before and after" the application of the faradic current to the lathered skin—before a current is applied, the hairs lie down—Fido-like—and a little while after the current is turned on and the razor applied, the hairs stand in line just like a platoon of soldiers, so that when the razor blade waltzes along over the skin the hairs are *guillotined* at the roots, not lynched, as with the present-day un-faradized—or should we say un-paradized—razor! Watson—the needle!!



Eureka! We Have Found It!! After a Long Many Years of Searching Thru Patent Gazettes from All Over the World, We Had to Dust Off Our Glasses Carefully to Make Certain That We Had Not Been Foozled: For What Did Our Eyes Behold!!! Sure Enough, the Electro-Faradic Razor That Makes Papa's Little Whiskers Stand up on End as Here Shown, so That the Keen Edge of the Razor Can Zip Them off without Mangling Them, Heretofore Causing Papa to Ejaculate Profanely.

More About New York's Subway Escalator

In the May issue of the ELECTRICAL EXPERIMENTER there appeared a feature article with special illustrations on page 20, showing the four motor-driven escalators being installed at the Park Place station of the New York subway system, which is one of the most elaborate and highest lift escalators anywhere in the world.

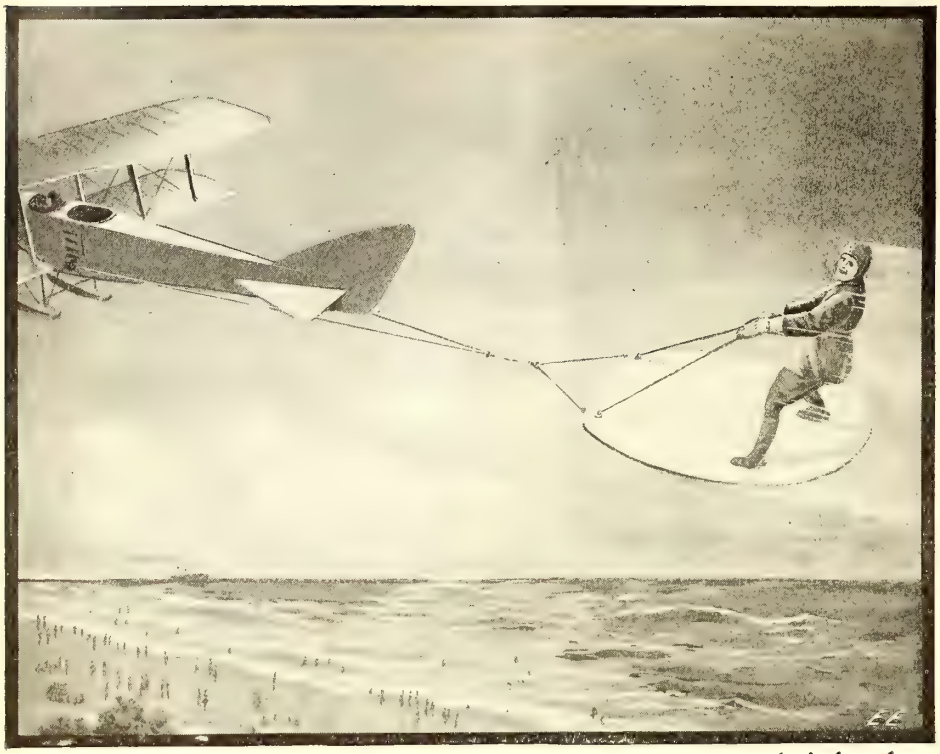


In the May issue of this Magazine there was publisht a sectional illustration and description of the new duplex escalators, installed at the Park Place subway station in New York City. This new escalator presents several novel features, and the accompanying detail illustration shows the ingenious design of the treads or steps. Each step is made in the form of a casting, and it travels up the inclined rails on four wheels. The steps are linked together by a series of link belts, which give sufficient flexibility for the series of steps to round the curved return-bends of the escalator at top and bottom, in order that the returning steps may follow in their reversed position on the underside of the escalator. These escalators are elecrically operated, and mark the very latest advance in the design of moving stairways.

The details of the steps used on these escalators, which are four in number, are very interesting, and the accompanying illustration shows how the steel plate steps, which are fitted with wooden tread strips, are linked together by an endless chain, so as to be carried by the escalator upward and over the toothed-end drums in the usual manner.

The steps are independent units. This is due to the novel arrangement of the small iron wheels on which they they are carried up the escalator tracks. These tracks are flat steel members measuring about 5 inches by 1 inch. The rear wheels are flanged and travel on the inner edges of the tracks, while the front wheels of each step unit are plain flat wheels without flanges. The step units are held rigidly in line owing to the link belt or chain construction followed in connecting up one step with another, as the illustration shows clearly. The links are made of light steel about 3 inches by ½ inch in section, which gives great solidity and ruggedness to the construction, while at the same time preserving the necessary degree of flexibility, so that the step units will properly intermesh in passing over the cogged drums at the top and bottom of the escalator. Each of the four escalators is driven by means of a powerful electric motor mounted at the top of the structure and properly geared to the cogged drum at the top, over which the moving stairway belt passes. The steps return to the base of the structure under the rising treads, within the enclosed stairway provided for it as shown in the illustration in the May issue.

Surfplaning in Mid-air



Sensations! That's What We All Crave These Days. And Here's One That Will Make You Stare for Some Time. Surfplaning in Mid-air, from the Tail of an Airplane. As the Magician Said—"It's a Good Trick If I Do It—and it's a Good Trick If I Don't Do It." We'll Say So.

Imagine yourself standing upright on a piece of plank in mid-air, and skimming thru space at a speed of 100 miles an hour, while the green fields, rivers and houses flit along beneath you with dizzying speed. "How did I get out there?" you will say, "on that skimming board in mid-air? I have seen the natives at Wakakee beach ride the surf boards—'Surfplaning' they call it in that part of the world—but this stunt has sure got me." Well, it all happened this way. The planing board was secured to the high-powered airplane by a small, strong wire cable secured to a quick-acting reel. This board was held close up under the fuselage or body, with release clips, so that when the pilot pushed a button, the board swung loose, and you proceeded to scramble on it and hold fast for dear life. The next minute the pilot unlocked the cable reel, and before you got your second breath, you found yourself standing up vertically in mid-air on the planing board and being hurtled thru space at a terrifying velocity, with the wind whipping by you with an exhilarating, yet awe-inspiring velocity.

Planing thru the sky in this fashion promises to become one of our newest hair-raising "air circus" stunts. The inventor, Frank H. Ellison, of New York City, guarantees to bring out all the people in any town or city, including his own home town, wherever this death defying air trick is performed. We said it!!—*"Wherever" it is performed,* with the accent on the whole four words.

In describing his invention, Mr. Ellison, goes on to say: "A skilful rider can manipulate a planing board in the air as many ways and even more than on the surface of the water, balancing himself with his feet placed in the toe-clips on the top of the board, and using the ropes and ring as a rein. In carrying out this astounding feat, the observer releases the board from the side of the airship, holding it edgewise to the wind as he climbs on board, holding on to it with one end and grasping the hand support on the fuselage of the airplane with the other. The pilot lowers the prospective steeple-jack of the air by means of an automatic reel, a sufficient distance to clear the ship. By this time the wind has caught the board, turning it flat in the air, after which time the airplane pilot opens up his engine and proceeds to drive his machine at such a speed as to hold the rider in a vertical position on the planing board. Yes, boys, its some sport,—take it from us land lubbers.

Catching Worms by Electricity

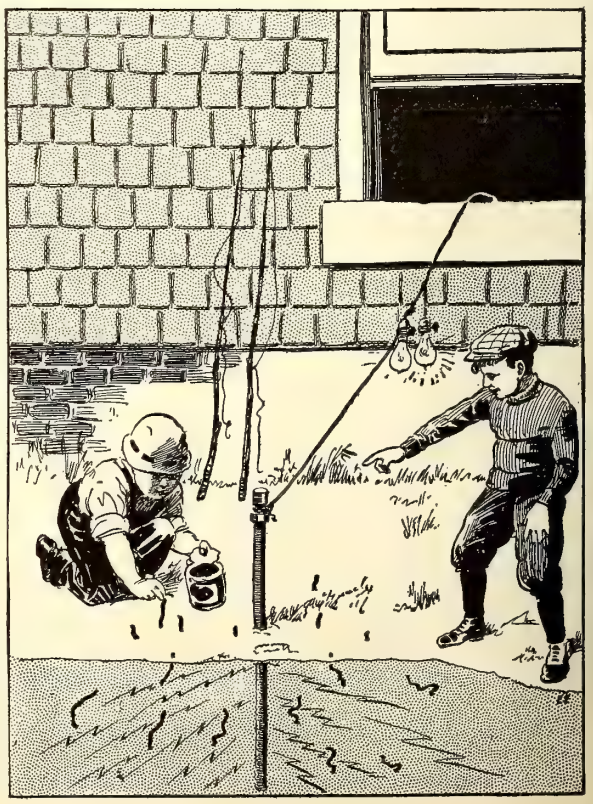
Ever want to go fishing and couldn't catch enough worms? "Many's the time," says you. Well, right here we have something new and original in fish worm enticers. I have recently found that by driving a piece of iron pipe down in the ground a few feet (and, by the way, it should be good, damp ground), and then connecting a wire to the house electric light circuit (with a 110 volt lamp or two in series), the current passing over this wire to the earth and spreading thru the soil about the pipe, will tickle Mr. Worm and his fellow reptiles so that they will come out of the ground helter skelter and post haste,—not by ones and twos, but by the dozens!

The worms are so glad to get out of the ground, that they fairly jump out of their holes into your hand. Don't believe me, I suppose, but go ahead and try it. But before you start, be sure and get a sufficient number of large 40 quart milk cans, in which to put the worms. With this remarkable electric worm catcher, you can safely invite the whole neighborhood to go fishing, for there will be plenty of worms to go around. There is only one bad thing about it, and that is when the office boy finds out how beautiful it works, he will be out fishing five days a week, and will be in on Saturday to spend those immortal three hours between nine and twelve o'clock with us.

One more word of caution before you try out this stunt. You may find that in order to have a current pass thru the lamps and down thru the pipe to earth, that you will have to reverse the wire where you connect it, owing to the arrangement of the electric light circuit, one side of which only is *grounded,* while the other is not. It is to the *ungrounded* side that you will have to connect the wire, and you can immediately tell when you have the right side of the circuit hooked up, as the lamp or lamps will immediately light up as soon as the connection is made.

Do You Have Trouble In Catching Fish Worms? Of Course, You Do. Well, Here's a Trick Taught the Editors Recently by a Youthful Electrical Experimenter. Quoth He—Ever Try Sticking a Charged Electric Light Wire in the Wet Earth, and See the Worms Come Wiggling Out; Oodles of them? No, Said We. Well Try It. And We Hereby Confer on the Esteemed Inventor, the Croix de Angleworm, Pour la Merit.

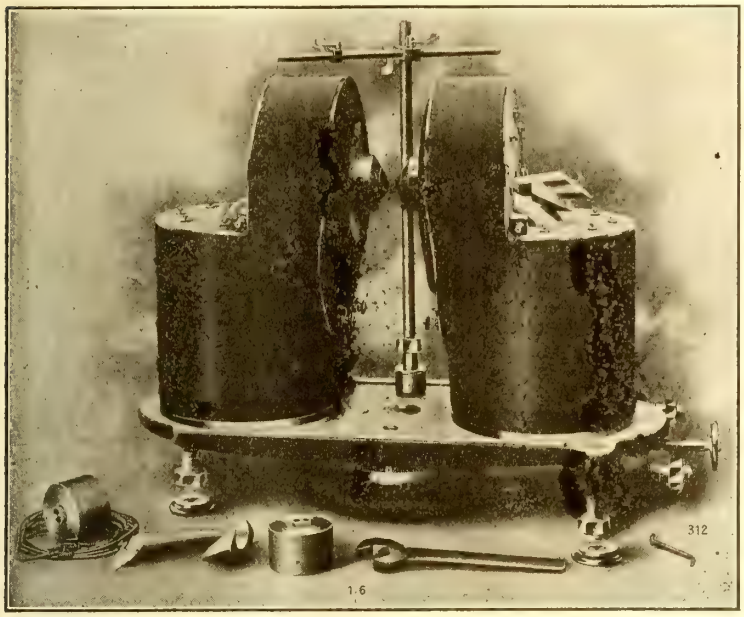
Contributed by
TOWNSEND BROWN.



New Laboratory Electro Magnet

Frank C. Perkins

The accompanying illustration and drawing show a new laboratory electro-magnet designed by Dr. Du Bois for making various physical tests. With these coils a half ring core is provided besides various shapes of pole-pieces. It is possible to produce an extremely powerful magnetic effect and one of the strongest fields ever obtained. Provision is made for a very narrow air gap when desired and swivel poles in cylindrical sockets may be used so as to turn about at any angle. This magnet may thus be utilized to great advantage for effects of light beam and magneto-optical investigations upon different substances put in the air gap.



For Laboratory Researches an Electro-magnet Must Possess Many Unusual Features. The One Here Shown, Designed by Du Bois, Permits Experiments in Magneto-optics as Well as Those at Very High and Very Cold Temperatures.

It is possible to send the light thru the poles by means of axial holes or crosswise in the air gap. Interesting experiments can be made at different temperatures and provision is made for using liquid air contained in leather bellows mounted on the magnet or by surrounding the poles by a porcelain heating vessel.

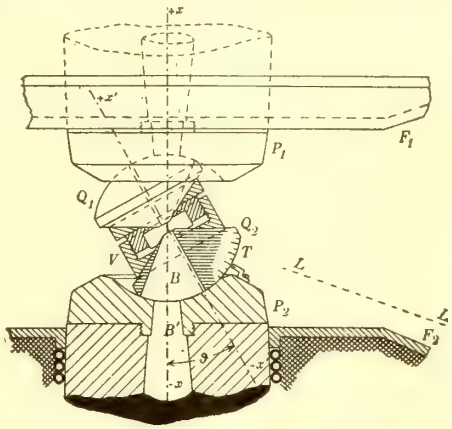
It is possible to work between temperatures of 200 degrees Centigrade and 1300 degrees in a very strong magnetic field. This powerful magnet allows of observations of all kinds of effects in a very strong magnetic field and a widely different degree of heat, and microscopic apparatus may be utilized to great advantage with the attachments provided.

NEW RADIATOR TYPE, SELF-COOLED X-RAY TUBE.

A new self-cooled, radiator type X-ray tube is described by Dr. W. D. Coolidge, in the *General Electric Review*: The type of tube described in this article was developed specifically for military use in the portable Roentgen-ray outfits at the Front. Its characteristics are such, however, that it seems ultimately destined to supplant the earlier type of hot-cathode tube for all diagnostic work.

The earlier form of hot-cathode tube having a solid tungsten target is capable of rectifying its own current; but only for such amounts of energy as do not heat the focal spot to a temperature approximating that of the cathode spiral. As soon, however, as any part of the focal spot is heated to a sufficiently high temperature, it emits electrons copiously, and, therefore, when supplied from a source of alternating potential, it permits so-called "inverse" current to pass. The "inverse" cathode-ray stream comes out from the focal spot in a direction perpendicular to the face of the target and proceeds, in the form of a narrow pencil, straight to the glass wall of the bulb close to and slightly behind the cathode. The glass at this spot fluoresces vigorously, becomes locally heated, and usually cracks. As air enters the bulb, a spark discharge passes thru the opening and it is then easy, for one who has not studied the phenomenon, to conclude that the tube failed by *puncturing* under electrostatic strain.

The essential condition to be fulfilled was that heat should be more rapidly withdrawn from the focal spot. This could have been accomplished by water-cooling, but this method clearly involved undesirable complications for portable work. Experiment showed that the most effective simple method consisted in providing a target having a large heat capacity and high heat conductivity, and then in arranging to effectively cool this mass of metal during the interval between radiographic exposures. The importance of having the target cold at the start is shown by the following experience with a tube having a 3.2 mm. focal spot and a solid tungsten target: With the maximum allowable energy input, it was possible when beginning with the target at room temperature to run four times as long before "inverse" current appeared as when the experiment was started with the target at dull red heat.



Detail of Swiveling Pole-pieces on New Laboratory Magnet Shown Above. They Are Calibrated and Can Be Swung to Any Angle Desired—a Very Important Feature.

The considerations which are described finally led to the *anode* design shown. The anode stem consists of a solid bar of copper 5/8 inch in diameter which is brought out thru the glass of the anode arm to a multiple wing *copper radiator*. The head of the anode consists of a mass of specially purified copper which is first cast in vacuum onto a tungsten button and is then electrically welded to the stem. The tungsten button, which is destined to receive the cathode ray bombardment is 2.5 mm. (0.1 in.) thick and 9.5 mm. (3/8 in.) in diameter.

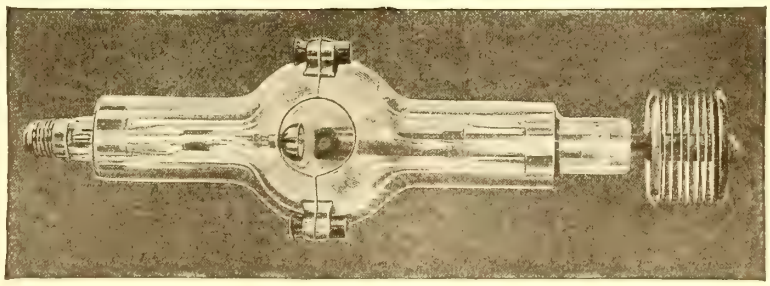
The complete target, with radiator, weighs 860 gm. and has a heat capacity of 81 calories per degree Centigrade; while the present standard solid tungsten target, complete with molybdenum stem and iron supporting tube, has a heat capacity of less than 10 calories. Because of its greater heat capacity, it takes much longer to heat the radiator type of target to a given temperature than it does the solid tungsten target. What is much more important, however, is the fact that between radiographic exposures the target in the new tube cools comparatively rapidly owing to the large copper stem and the radiator.

In the standard hot-cathode tube with the solid tungsten target, the target gets very hot and radiates thru the glass walls of the tube the greater part of the energy it receives. As a result, the glass becomes strongly heated. In the new *radiator type* of tube, by far the greatest part of the energy imparted to the target is conducted to the radiator. It, therefore, becomes possible to make the glass bulb *very small*. For portable work, a diameter of 9.5 cm. (3¾ in.) has been standardized.

For some applications it has been found best to enclose the X-ray tube in a lead glass shield. Glass of good quality and containing sufficient lead is satisfactory material from which to make such a shield. The ordinary X-ray protective glass with which the author is familiar does not have as high a lead content as seems desirable. However, the author was finally able to obtain glass containing enough lead that, for the same protective effect, the glass layer has to be but four times as thick as sheet lead.

As seen from the photograph, the lead glass shield has a round opening thru which the Roentgen-rays can pass. The two halves of the shield are bolted together.

Two portable Roentgen-ray generating units have already been built around the first model of this tube. These are the "U. S. Army Portable Unit" and the "U. S Army Bedside Unit."



Interesting Form of Improved X-ray Tube Fitted with Radiator Flanges so as to Be Self-cooling. It is Encased in a Lead-glass Shield, the Desired Rays Issuing Thru a Circular Opening at the Center.

"Old Phonograph Record" Contest

OUR old phonograph record contest as announced in our *August* issue proved to be one of the most popular contests that we have ever held. Hundreds and thousands of letters were received and many clever as well as ingenious and practical suggestions poured in upon the editors. It was no easy task for the judges to pick out the winners, and in making the first prize award the following was taken into consideration by them.

While perhaps many of the other suggestions were more ingenious, it struck the judges that a new idea tending to improve our health should receive first consideration, and this is why the first prize was awarded to Mr. F. R. Spindler. Not only were the judges prompted to award the prize on account of this feature, but also because the suggestion is not only new, but is eminently practical.

Furthermore, the bar bell as well as the dumb bells *can be made adjustable* by adding only two records at a time. Thus, as the user becomes accustomed to it, he can add more and more weight as he sees fit. This is an important consideration, as at the present time there are no bar bells or dumb bells on the market that are adjustable to such a fine degree.

On the opposite page we have endeavored to illustrate a few of the good ideas; there were of course thousands of others, but most of them were either duplications of similar ones publisht herewith, or were not very practical to the minds of the judges.

Many contributors suggested the use of phonograph records as fan blades by heating the record in hot water and then shaping the blades. This was not a bad idea. However, the danger of the blades breaking is very great and while flying thru the air might seriously injure people.

Our wireless enthusiasts, to be sure, came in with a rush and had many good ideas. There were loading coils, switch-board panels, oscillation transformers, adjustable transmitting condensers, tuning coils, bases, condensers, fixt, variable and otherwise, lead-ins, washers, scales for rotary condensers, loose coupler ends, etc.

Then we had knife sharpeners, a great number of Tesla water turbines, many formulae how to melt the records and make various compounds from them, switches, panels for wireless instruments, covers for all sorts of chemical bottles and otherwise, rheostat bases and even clock dials. One ingenious contributor even showed us how to make a mantle clock casing made entirely of phonograph records, bent and worked into shape.

One contributor from the middle west sent in an elaborate design for a colored disc apparatus to show the changing colors of rotating discs. There were of course a number of so-called omnigraphs, using the record to make the dots and dashes by cutting notches around the rim for the dots and dashes. There were a great number of electrical switches as well.

Some of the wireless ideas and several others were so good that we will run them in our other departments shortly. Particular mention should go to Victor H. Tegge, of Haddonfield, N. J., who succeeded in making a synchronous telegraph which he calls a codeless telegraph. A very good idea, which will be publisht later.

Mr. W. L. Lyndon, of Lyndon P. O., Alta., Can., showed us how to make a large switchboard panel in four layers by shellacking together a great number of records.

Frank J. Pastern, of Chicago, takes the cake by submitting an idea how to bend a record in the form of a horn so it can be used as a bicycle or automobile horn, using a buzzer in the back to make the noise.

FIRST PRIZE.

ADJUSTABLE BAR BELL AND DUMB BELLS.

By F. R. SPINDLER,
83 Saranac Street, Rochester, N. Y.

Every Experimenter needs physical as well as mechanical or electrical training, therefore he can make a real muscle builder from cast-off or worn-out phonograph records.

A steel bar about ¾" diameter and approximately 4 ft. long, threaded 12" from each end, will serve as the support for the records.

Variable diameter records are used to give it a fairly spherical appearance. The amount can be varied to suit the user. Steel washers are placed on each side of the series of records, which are held in place by the hexagon nuts. The weight can be made adjustable by simply increasing or decreasing the number of records. A bar bell too heavy is not practical as it tires the user. About 50 lbs. is a good maximum weight for the average athlete.

The second illustration shows how dumb bells are made by using a short steel bar, threaded at ends, and a number of 10c or else 7" records.

Prize Winners

First Prize—$25.00. F. R. Spindler, 83 Saranac St., Rochester, N. Y.

Second Prize—$15.00. Jackson H. Sterrett, 1001 Walnut St., Erie, Pa.

Third Prize—$10.00. E. M. Williams, 301 Main St., Salisbury, Md.

SECOND PRIZE.

CHEMIST'S TEST TUBE RACK.

Herein is shown a revolving test tube rack which the writer has constructed and considers a very practical and useful application for phonograph records which have outworn their welcome.

Several points about its practicability are:

1. It is very easy to construct.

2. It will hold a great number of tubes, especially if large discs are used.

3. Being made of the phonograph discs, it is quite impervious to most chemicals.

No dimensions are given, as the individual will invariably desire to construct it according to his own requirements. Single face records with the blank faces up, will look best; otherwise the name plates may be enameled black.

All small holes were drilled with a twist-drill, and those in the lower disc were reamed out to accommodate the bottoms of the tubes nicely. Having no twist-drill large enough for the holes in the upper disc, a hole just large enough to pass the threaded part of a bit was first drilled with a twist-drill; then the bit was carefully applied from both sides, until the piece could be pushed out.

The Experimenter who possesses a lathe can make many improvements over the very simple construction here suggested.

Contributed by Jackson H. Sterrett, 1001 Walnut Street, Erie, Pa.

THIRD PRIZE.

RADIO SET MOUNTED ON RECORD.

The accompanying photograph shows my idea of one use old phonograph records can be put to. This is in the form of a combination Radio Receiving and Practice Set, fastened on an old phonograph record with a tuning coil on the back. Very accurate tuning can be accomplished by moving knobs up or down which extend out at each side. Arms which contain knobs extend to the center of record on back, and by means of a flexible wire are connected to each slider, so that the set can be tuned to any desired pitch.

Contributed by E. M. Williams, 301 Main Street, Salisbury, Md.

FIRST HONORABLE MENTION.

Novel Lamp Shade.

I submit herewith a description for using old phonograph records in constructing a beautiful electric lamp shade. The bracket supports were made out of ⅛" galvanized iron wire in the following manner:

First measure the radius of a record to be used, double this length, then find the distance wanted between opposite records at the top. Add these dimensions together and add 1" for making loops at ends of wire.

Now cut two wires, each being the total length just measured, and bend as shown in diagram. When this is completed they are then placed to cross each other at centers and fastened with thin wire so as always to remain at right angles to each other. Now obtain four small store bolts about ⅛" x ½" and bolt on phonograph records, one to each of the four loops on the wire supports. Then get a shade support which can be placed over the electric bulb, fasten it centrally on the bracket and the shade is completed.

Contributed by Jacob Keener, 3145 West 54th Street, Chicago, Ill.

SECOND HONORABLE MENTION.

Tool or Bricabrac Stand.

The photo herewith shows how to build a useful tool or bric-a-brac stand, of service in every shop or parlor, respectively.

To make this stand you should collect (it sounds much better than swipe) a number of records, seven spools 3" long, one spool 1½" long, two pieces of wood 10½ x 1¼" x ½", and one long rod that is to pass thru the holes in the spools and records with a nut on top to tighten them. Then take the two pieces of wood and cut out a piece ½" from the side and about 1" from the ends. In the center of one of these pieces cut a piece ⅜" deep. Cut out a piece ⅜" deep from the bottom in the other piece. Then put these pieces together. Drill a hole ¼" in diameter thru these pieces so the rod can pass thru. The next thing to do is to take the rod, pass it thru the base, put on the small spool, then a record, then a spool, etc., until they have reached the top of the rod. Put the nut on and tighten it. Many variations of this design will suggest themselves. The stand may, for instance, be composed of gradually decreasing sizes of records. Then again, it is well to drill holes in the records to fit some of the tools, especially those that tend to roll off easily. This makes a nice stand for small articles.

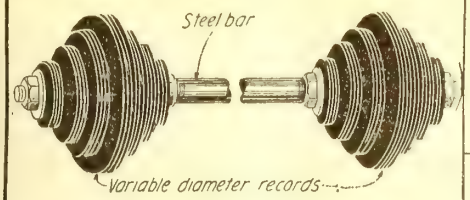
Contributed by George Kostka, 2347 S. Ridgeway Avenue, Chicago, Ill.

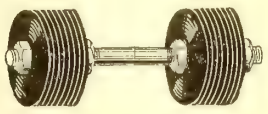
THIRD HONORABLE MENTION.

Tesla Turbine.

Below is my idea for the "Old Phonograph Record" Competition. This Tesla

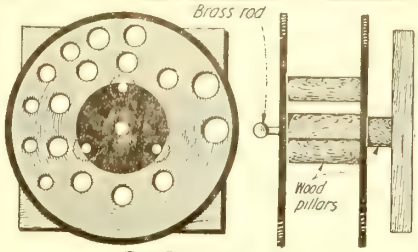
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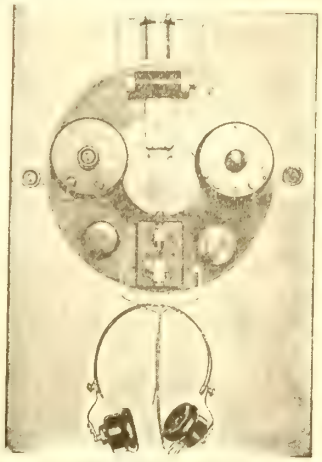
1ST PRIZE





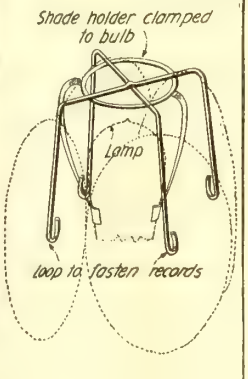
2D PRIZE

3rd Prize

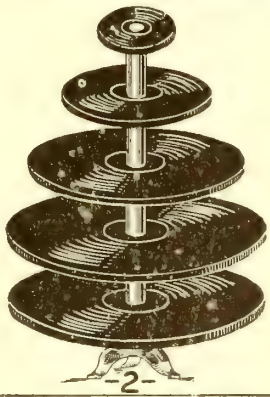


HONORABLE MENTION

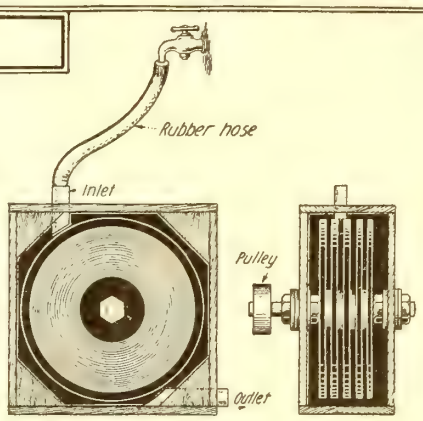




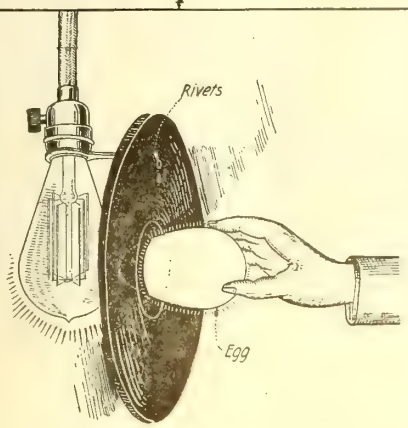
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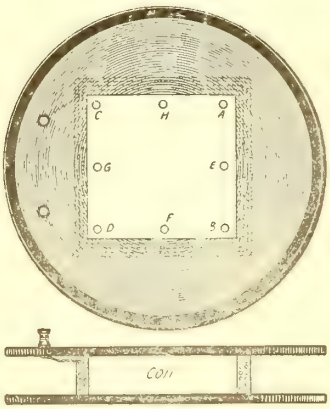
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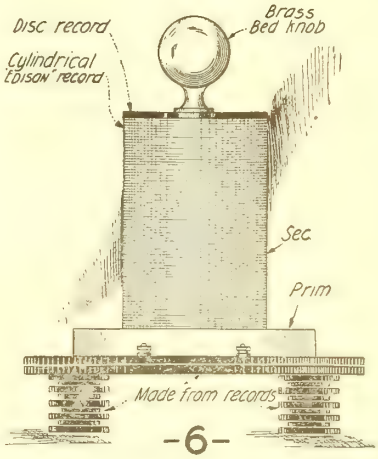
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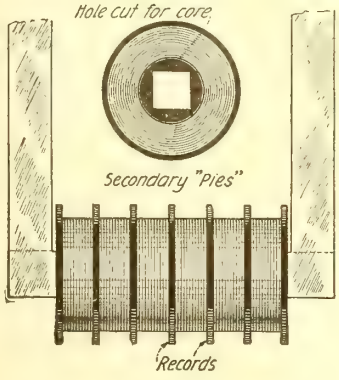
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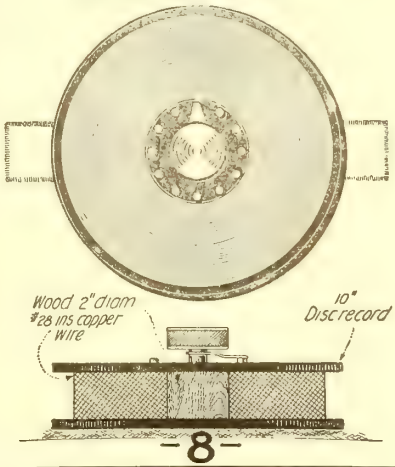
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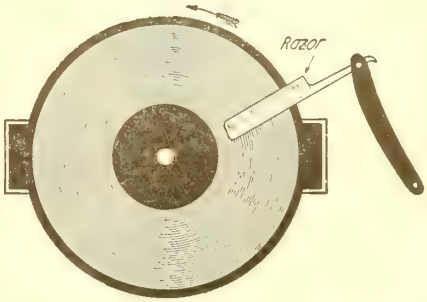
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DRAWN BY M.P.

"PLAN-T"

By JOHN WHITE

"LARNELLE! and have all on fifth and taken here s. Bordinage."

The clipping scissors ran swiftly up the margin of the daily newspaper and neatly cut the foregoing from its personal column. With a little murmur of satisfaction, such as a naturalist might give upon the capture of a new and interesting specimen, Paul Stevenson viewed the latest addition to his collection. Paul Stevenson was a hobbyist. Owing to former experience in the U. S. Secret Service, he was more or less adept in the solution of codes, and gathered material for this pastime from the personal advertisements in newspapers. These deciphered excerpts formed a collection of human and unique interest. His other hobby, possibly more practical, was that of Radio telegraphy, and in this he had profitably turned to the benefit of the government when his fine six-foot physique gained him easy admittance to the navy as a Radio-man. During the war he had been injured in U-boat patrol, and, tho not slightly, he had been forced to abandon his work with the navy. Upon complete recuperation he hoped to continue in his former capacity as detective for the nation.

As he fingered the "personal" it appeared to offer no formidable obstacle to decodation. Opening an album, which he had removed from the polished oak shelf over his desk, he disclosed any number of personals ranged alphabetically, in regard to the recipient, while on the opposite page under corresponding names were their deciphering.

Stevenson's careful perusal assured him that he was the possessor of no other advertisement directed to a "Larnelle" by which to be guided in his solution of the present excerpt.

Replacing the volume he applied various methods to the solving of the cipher. He attempted the solution by the assumption that each word was an individual letter, then rearranging the order of the words and the letters themselves. As a last resort he applied the dictionary, hoping to discern its actual meaning by a definite number of words above or below those of the code, or in possible alternation. Having vainly endeavored to do this with several universal editions of dictionaries, he finally considered the possibility of the message—for such he assumed it to be—being void of code and understandable only to one cognizant of its reference. However, he decided that its very lack of unity and coherence proclaimed that this was not the case, and that the message was really conveyed in a very subtle code at present impervious to his attempts to decipher.

That evening, after another futile endeavor at solution, he diverted to his other hobby in despair. At one extremity of his study his instruments were arranged in panel formation, the majority of them hidden within a highly veneered oak cabinet. On a desk, adjoining the instrument table, reposed magazines relating to radio work, many containing articles of his own, dealing comprehensibly with the subject.

The night was damp and the ether seething with the invisible pulsations. Orders and conversation raced back and forth between the battleships in the lower Hudson. One of the men-o'-war was experimenting with wireless telephony and the *Marseillaise* chimed with bell-like clearness in his telephone headset. The Brooklyn Navy Yard roared in with a running jargon, and Stevenson, in attempting to copy it, realized that it was code. Disgusted with code, he tuned them out instantly.

He noted the time—nine-forty-five—and threw on more meterage with the intention of receiving the *time signals* within the next quarter hour.

Suddenly the clear, quenched note of a high-powered station other than Arlington reached his ear. Stevenson's face depicted his astonishment as the air screeched out the uncommon name of "Larnelle." He quickly and with increasing surprise, penciled down the remainder of the message:

".....and have all on fifth and taken here s. Bordinage."

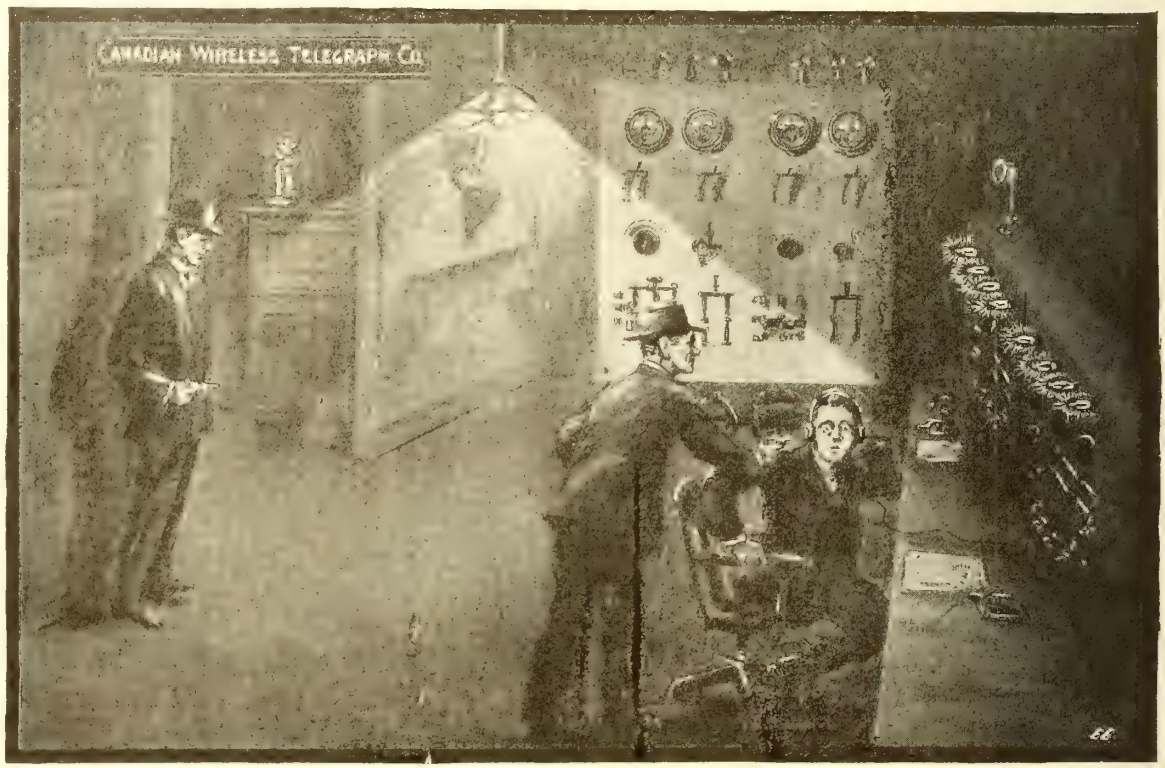
It was identical with that of the "personal."

As he was puzzling over this startling coincidence, the possible answer, calling "Bordinage" broke in upon him.

"Damn fool," it read, "that's the same thing. Wait now."

There was silence, then Arlington dashed out the time and Stevenson threw down his headset in the midst of the weather report.

The first was the sending of an expert, and from the sound he judged it to be that of a professional station, while the reply was more slow and amateurish and possest the coarseness of other than a quenched gap



"Then Back Crashed the 'O. K.' in the High-Pitched Tone of the Q— Station. The Operator at Q— and Bordinage Were the Same! The Light from the Powerful Nitrogen Bulbs Flooded the Transatlantic Radio Station at Q—. One of the Secret Service Men in the Outer Office Replaced the Long Distance 'Phone. The Radio Operator Moved Nervously, as for the Fifth Time He Had Tried to Call the Unresponsive 'Larnelle.' Feeling a Hand on His Shoulder, He Whirled About, and Faced — a Representative of the Canadian Secret Service."

Replacing the receivers he listened on the same wave length for a possible solution to the enigma. However, the ether was still as the grave in regard to the call of "Larnelle" or "Bordinage." Again scanning the response, it dawned on him that the wrong communication had apparently been transmitted, and that the first operator was to wait, probably until the morrow, before rectifying his mistake and sending, as Stevenson thought, the correct key to the cipher.

The next evening with little excitement the ex-secret service man adjusted his instruments to two-thousand, five-hundred meters, the Arlington wave length. It was not until the evening was well over and the hour was close at hand for the *time signals*, that his vigilance was rewarded. The high-powered station screeched in his ears:

"-.-- .- .-. -. . .-.. .-.. . . Larnelle Larnelle, Bordinage."

Stevenson listened with unnecessary tenseness for the signals rushed in with the tone and loudness which marks only the professional of great range:

"...watkins short delivery send four the danger directions up s."

(Continued on page 712)

Will These Perpetual Motion Schemes Work?

By JOHN D. ADAMS

IT usually requires but the most elementary knowledge of physics to detect the fatally weak point in most "perpetual motion" devices. In the three schemes illustrated in the accompanying illustrations, however, the inherent defects are rather hidden, and the writer has known not a few practical mechanics and electricians who have been led astray by them. As the youthful and enthusiastic inventor will find it instructive to uncover the underlying errors, we will not expose them here, but will confine our remarks to a brief description and incidentally point out why they "ought" to operate.

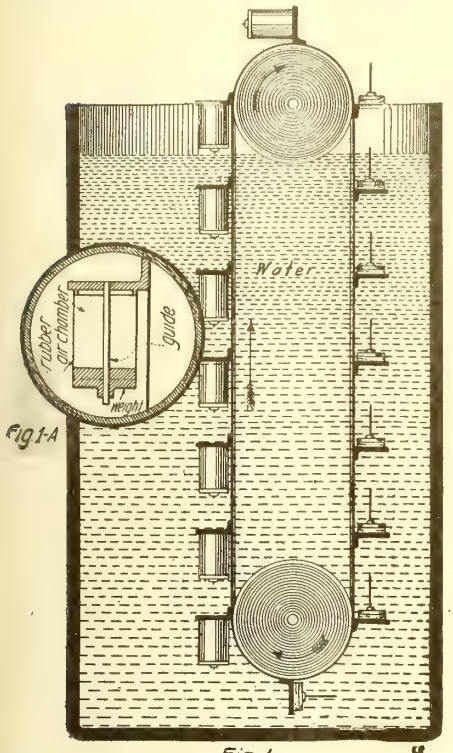


Fig. 1

A Proposed Hydrostatic Perpetual Motion Machine Which Would Appear to Offer Several Advantages Over Simpler Types. The Expansive Rubber Chambers Have Weights Fitted to Them, Which Weights Cause These Chambers to Collapse as They Descend Down Through the Water on One Side of the Belt; While as They Start to Ascend on the up Side of the Belt, the Chambers Open up and Present a Considerable Amount of Buoyancy. Imagine What a Tremendous Amount of Buoyancy a Series of These Air Chambers Will Give! It Looks Like Free Power, Sure Enough!!—But Will It Work? Think It Over!

SCHEME I.

In the first one, Fig. 1, a large pulley is placed at the top and another at the bottom of a deep vertical tank of water. On these pullies a belt is placed, and at regular intervals along this belt brackets are attached. To each bracket a guide rod is secured, and along this rod a heavy circular weight is arranged to slide. The weight and the bracket are connected by a suitable length of soft rubb r tube of large diameter. The bracket, weight and tube, when all assembled constitute an airtight pocket or cylinder, as illustrated in the detail sketch, Fig. 1-A.

It will now be evident that the weight will tend to distend the pockets on the left-hand half of the belt and to compress them on the right-hand half, as the weights in the latter position are on top. Imagine, then, the enormous buovant effect of all the submerged air pockets on the left side, and it will readily be seen that this side of the belt will have a very strong upward pull. As each pocket comes up out of the water and starts to descend on the right side, it will collapse, and the whole series of collapsed pockets on that side will present just so much dead weight, which will accordingly add to the turning effect on the pullies. Most perpetual motion machines depend on one force being stronger than another, but the fundamental principle here employed has the distinct advantage of having all the forces involved act in the same direction.

SCHEME II.

In scheme number 2, Fig. 2, the water is contained in a vertical stand-pipe, and, by providing one several hundred feet high and attaching it to the back of a skyscraper, it will be apparent that enormous power may be generated as long as the force of gravity remains on the job.

At the top and bottom of the stand-pipe are two large sprocket wheels, and around these is operated a continuous belt composed of light, hollow copper balls connected with suitable links. These balls enter the stand-pipe thru a tube placed in the bottom, the accuracy of fitting being such that no appreciable leakage will occur If the reader will now suppose our illustration extended in a vertical direction several feet, and will form a mental picture of the string of several hundred submerged air pockets, the tremendous upward pull will be appreciated. For every ball that passes out of the water at the top, another will take its place at the bottom, so that the motion will necessarily go on perpetually. If one should feel alarmed lest the motion become *too rapid and violent* at light load, there would be no objection to providing a *governor!*

$10.00 CASH PRIZE FOR THE BEST ANSWER.

What is your opinion as to why the three proposed "perpetual motion" machine schemes here described and illustrated will not work? Here are the rules by which to write your answer to this problem:

Typewritten replies preferred, or else hand-written letters in ink, but not in pencil. Try to make your reply as short as possible—about 150 to 200 words should cover it easily. As thousands of replies will be received, this will greatly expedite the work of examining all the answers which come to hand. No mathematics are required or desired in explaining the fallacy of the machines here illustrated. The answers received will be past upon by a board of experts, including the following:

Mr. John J. Furia, A.B., M.A.; Mr. H. Gernsback, editor, and Mr. H. W. Secor, associate editor. This contest will close January 15.

Address all letters to "Perpetual Motion Contest."

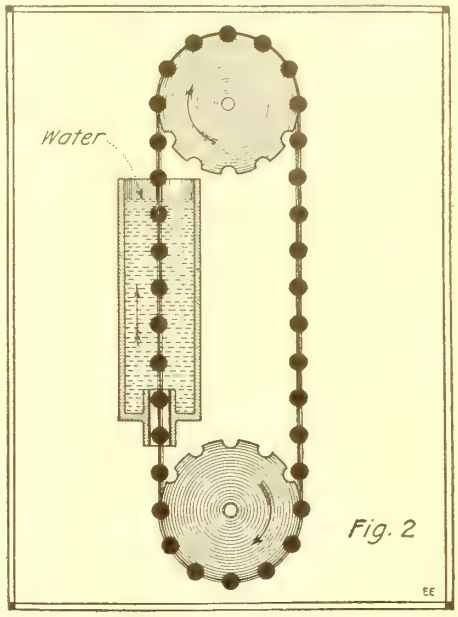


Fig. 2

Another Water Power Perpetual Motion Idea Which Is Out of the Ordinary Class. This Promising Design of "Everlasting Motion" Machine Utilizes a Series of Hollow Balls Mounted on a Continuous Belt. Gravity Helps the Downward Motion of the Balls on the Right Side, While as Soon as They Enter the Water Chamber at the Left, There Is Realized a Considerable Amount of Buoyancy Created by the Long Series of Hollow Balls Which Are Pushed Upward by the Water. Again We Say, "Think It Over." You May Win a TEN DOLLAR Prize!

SCHEME III.

In scheme number three, shown at Fig. 3, permanent magnets are employed in a horizontal position in the manner illustrated. A long slender bar magnet is suspended from above on a swivel in such a way that the lower end—the North pole—can move freely about in the same plane as the three horseshoe magnets. A triangular groove is provided so that the free North pole can only move along its three sides.

First, consider only the upper left-hand of the three magnets, and start with the free North pole at the point "a." It will be evident now that the North pole will tend to move in the direction indicated by the arrow, because there is no point along that side of the triangle which is not nearer to the North pole of the horseshoe magnet than to its South pole, in consequence of which repulsion will prevail over attraction. When the point "c" is reached (still forgetting the two other magnets) the motion will tend to continue in the direction of the arrow because motion in that direction tends to move the free North pole further from the North pole of the horseshoe magnet and slightly nearer to its South pole. True enough, there will not

(Continued on page 712)

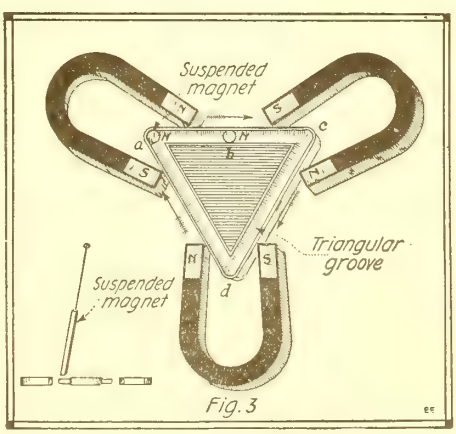


Fig. 3

A Magnetic Pendulum Arranged in the Manner Shown, so That a Suspended Magnet Reacts in a Field Created by Three Horseshoe Magnets. The Lower End of the Suspended Magnet Runs in a Triangular Groove, as Shown. Apparently, the Pendulum Magnet Should Keep on Rotating Around the Groove, and in the Direction of the Arrows Perpetually! Is It So?

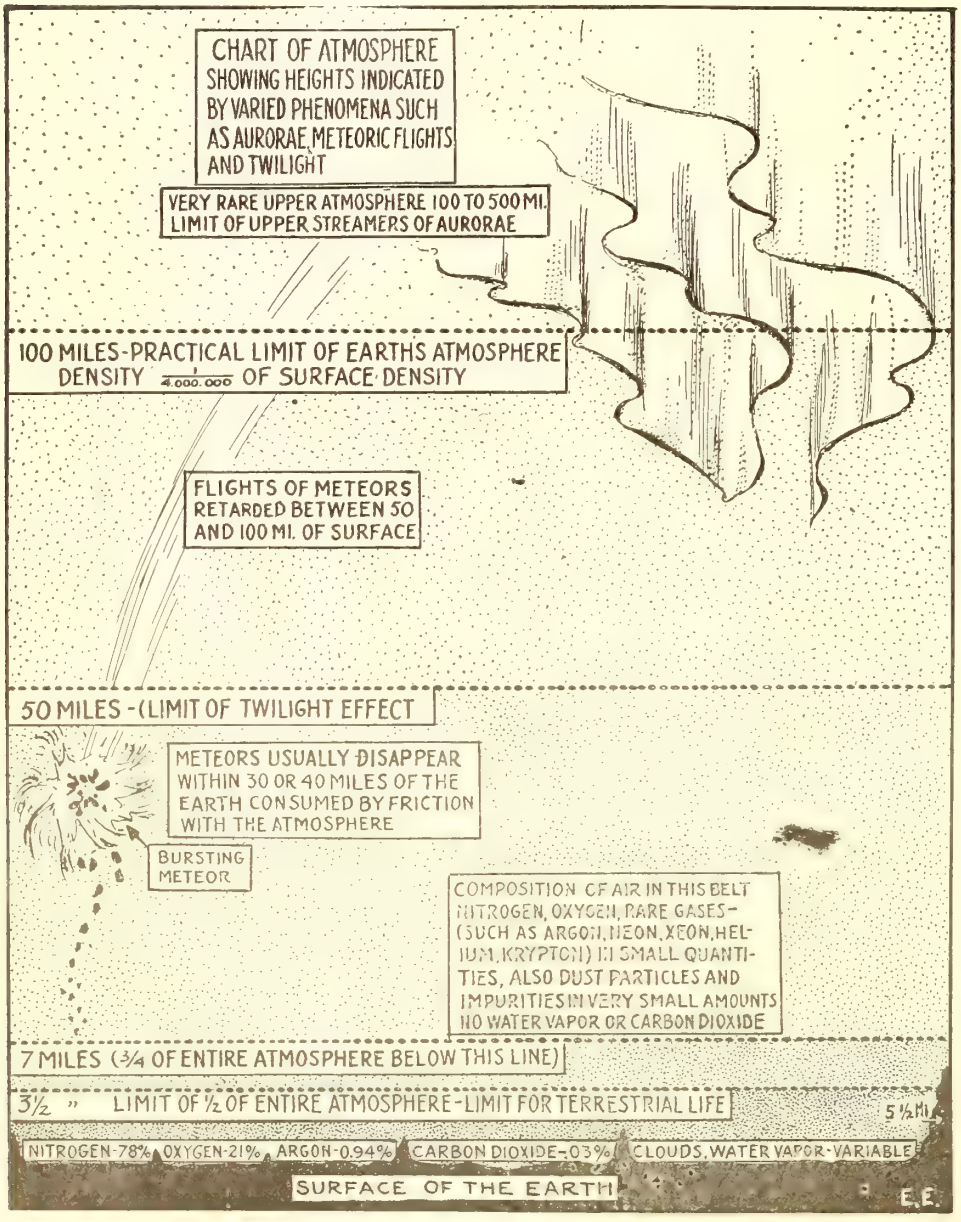
Popular Astronomy

By ISABEL M. LEWIS
Of the U. S. Naval Observatory

The Earth's Atmosphere

IT is a fact, well known to all of us, that no form of life could exist upon our planet earth for the briefest interval of time if the light and heat-giving rays of the sun were suddenly withdrawn.

Yet an equally vital factor in the maintenance of terrestrial life is the earth's atmosphere. Were the thin veil of gases that envelopes our planet to drift away into interplanetary space, all life upon earth would cease as suddenly and as effectively as if the rays of the sun were to fail us.



This Illustration Vividly Depicts How Thin Our Earth's Atmosphere Really Is. Note That Three-Quarters of the Entire Atmosphere Is Only 7 Miles Above the Earth. Even at This Moderate Height It Is Impossible for Man to Live, Unless He Brings His Own Air with Him.

If we should take for a model of the earth a ball, two feet in diameter, the highest mountain on the earth (Mt. Everest, 5½ miles high) would be no more than a grain of sand on its surface, since on this scale one-fiftieth of an inch represents six and two-thirds miles.

The extent of the earth's atmosphere on the same scale would be represented by an outer shell about one-third of an inch wide, assuming that the limits of the atmosphere are practically reached at one hundred miles above sea level.

As we rise above the surface of the earth, the density and pressure of the atmosphere decrease with great rapidity. At sea level, the pressure of the earth's atmosphere is about fifteen pounds upon every square inch of the surface. At an elevation of only three miles it has decreased to such an extent that the average human being would find it impossible to live and breathe at this heighth for any length of time, soon becoming violently ill from "mountain sickness" as a result of the reduced pressure to which the human system cannot suddenly adapt itself.

Aviators who fly high above the surface of the earth are also apt to be overcome by the effects of this reduced atmospheric pressure. So earth-bound is man even in his aerial flights that very moderate atmospheric heights are as inaccessible to him as the moon and the summit of Mt Everest, represented by a grain of sand on our two-foot model of the earth, lies beyond the reach of man and could not be capped by him in his flights thru the air

It can be shown, in accord with the law that governs the decrease in density of the air with altitude, that *one-half of the earth' atmosphere lies within three and one-half miles of the surface,* one-half of the remaining atmosphere within the next three and one-half miles, and so on until the atmosphere becomes so rare that this law no longer applies.

Three-fourths of all the earth's atmosphere, therefore, lies within seven miles of its surface.

It is an interesting result of this rapidly decreasing density that celestial objects shine most brightly when they are overhead for their rays then strike the earth's surface more vertically, and, therefore, have a much shorter path to travel thru the lower densest layers of the atmosphere than when the object lies close to the horizon. (See Fig. 1.) We are all aware of the fact that there are always more stars visible overhead than at low altitudes, the light of the fainter stars being blotted out by the densest lower strata lying close to the horizon.

No reliable observations of the heavenly bodies are ever made within ten or fifteen degrees of the horizon, and whenever star positions of great accuracy are desired the object is observed at the highest altitude possible. This is owing to the fact that the path of a ray of light is changed by refraction as soon as it enters the atmosphere and bent more and more toward the vertical as it penetrates the denser layers. Rays from objects directly overhead or in the zenith suffer no refraction, for they strike the earth vertically, but the nearer the object lies to the horizon the more are its rays refracted by the atmosphere and the more is it thrown out of its true position. (See Fig. 1.)

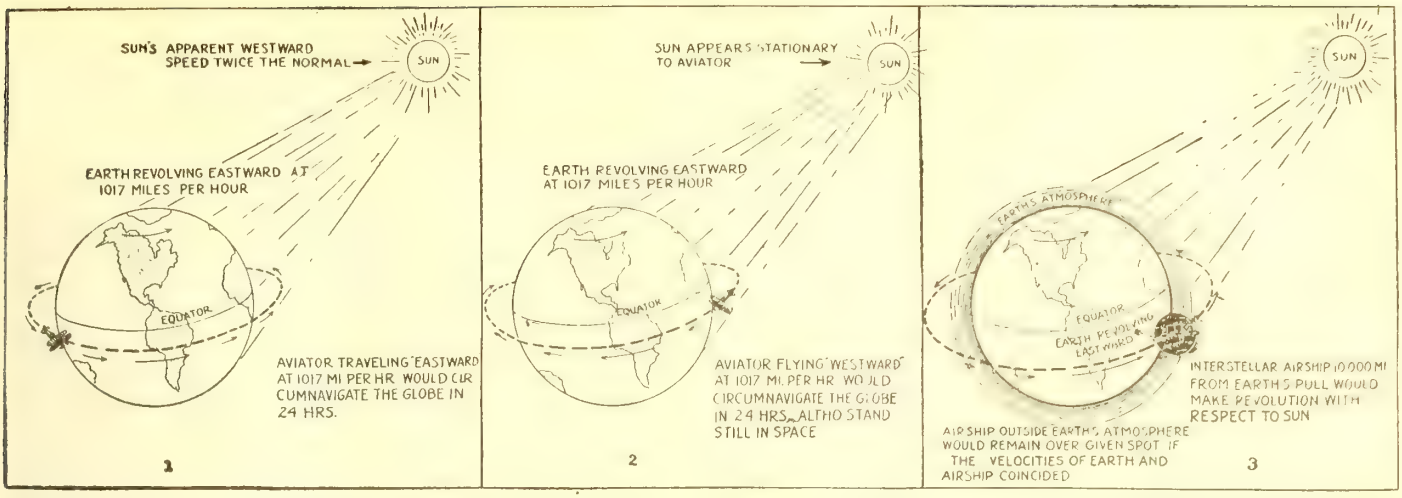
Refraction at the horizon amounts to more than one-half a degree, varying with the changing temperature and density of the air, and decreasing very rapidly with altitude above the horizon.

Since the diameter of both sun and moon about equals the amount of refraction at the horizon, it follows that these bodies appear to be just *above* the horizon when in reality they are just *below.*

The oval shape of the sun or moon so noticeable at the time of rising or setting is an atmospheric effect that is due entirely to the fact that the amount of refraction increases so rapidly in the immediate vicinity of the horizon. As a result the lower limb of the sun or moon is raised more than the upper limb and the vertical diameter is shortened while the horizontal diameter is unaffected and the disk, therefore, appears oval.

The apparently greatly increased size of the sun or moon at rising or setting is not generally considered an atmospheric effect, but due to the fact that we then unconsciously compare them with nearby terrestrial objects, such as houses and trees; but this explanation seems hardly satisfactory.

At the earth's surface the atmosphere, measured by volume, contains 78 per cent



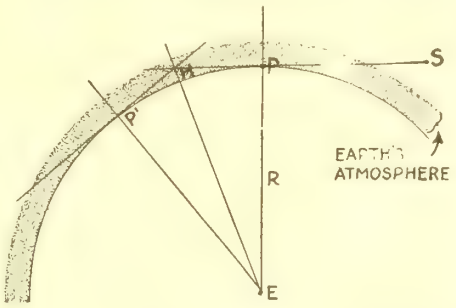
nitrogen and 21 per cent oxygen, with less than 1 per cent argon and minute quantities of helium, krypton, xeon, neon and other rare gases, as well as such impurities as soot, ammonia, etc. It contains, in addition, water vapor and carbon dioxide. These two constituents of the atmosphere represent scarcely 3 per cent of its weight, but they are absolutely essential to all living organisms upon our planet.

Fig. 2. To Show How the Height of the Earth's Atmosphere Is Found from the Duration of Twilight. An Observer at P for Whom the Sun is Just Setting at S Is Carried by the Earth's Rotation to P^1, the Last Point from Which He Can See the Twilight Effect Produced by the Sun's Rays Shining on the Earth's Upper Atmosphere After the Sun Itself Has Disappeared Below the Horizon. It Has Been Found as a Result of Many Observations That the Angle PEP^1, Thru Which the Observer Passes from Sunset to the End of Twilight, Is About 18 Degrees and Therefore the Angle PEH, Which Is Half of This Angle, Is 9 Degrees. Knowing the Value of the Earth's Radius R in Miles, It is Now an Easy Matter to Find H, the Height of the Atmosphere That Produces the Twilight Effect. This Comes Out Almost Exactly Fifty Miles. Therefore the Earth's Atmosphere Exists to a Height of Fifty Miles in Quantities Sufficient to Produce Twilight. The Duration of Twilight Depends on the Angle at Which the Ecliptic or Path of the Sun Cuts the Horizon and Upon the Altitude of the Observer Above Sea Level as Well as Upon the Height of the Atmosphere; Therefore It Varies with the Time of Year and with the Latitude of the Obesrver. It Is Shortest at the Equator, Where the Ecliptic Rises Most Sharply from the Horizon, and at High Elevations Where the Quantity of Air Above the Observer Is Less in Quantity and Charged with Fewer Impurities.

It is the tempering effect of these two compounds in the atmosphere that protects us from the great extremes of heat and cold that would otherwise exist on the day and night side of our planet.

About 40 per cent of the sun's rays are reflected away into space by the earth's atmosphere. Of the remaining 60 per cent, one-fifth is absorbed by water vapor suspended in the atmosphere between sea level and an elevation of five miles, while two-fifths are absorbed by clouds lying one or two miles above the surface. *As a result, only 20 per cent of the rays that enter the atmosphere actually arrive at the surface of the earth.* These estimates are the results of measurements of the solar radiation made at sea level and on mountain heights.

The heat-rays that are radiated from the earth's surface also suffer powerful absorption by the water vapor and carbon dioxide in the atmosphere. According to estimates made, fully half the radiations from the earth's surface are absorbed by clouds and three-fourths of the remainder by water vapor and carbon dioxide in the atmosphere, so that barely *10 per cent* of the earth's radiations escape directly into space, tho by continual radiations from one place to another within the atmosphere the heat gradually seeks higher levels and tends to escape.



Were it not for this blanketing effect due almost entirely to the water vapor and carbon dioxide in the atmosphere, preventing too rapid radiation into space, as well as the effect of the atmospheric currents which are a most powerful factor in equalizing the extremes of temperature all over the globe, it is very doubtful whether either animal or vegetable life would be found to any extent upon our planet. It is well known that there are much greater extremes of heat and cold between day and night on the mountain peaks than in the valleys, owing to the greater rarity of the atmosphere and the comparatively small amounts of water vapor and carbon dioxide.

It is also well known that early frosts will not occur when there is much water vapor in the air or when clouds are plentiful.

(Continued on page 691)

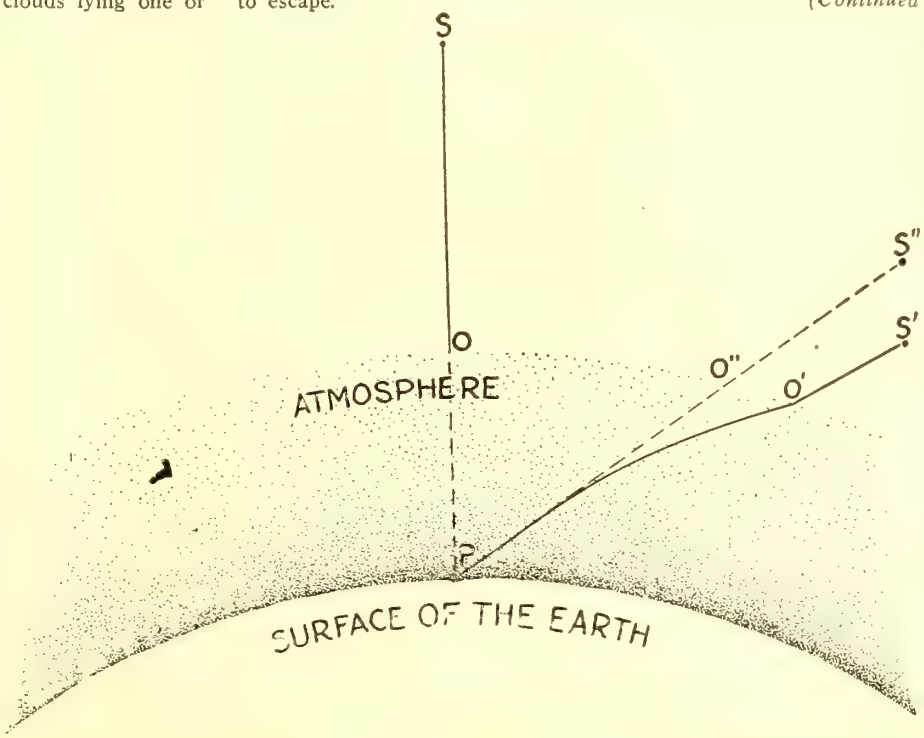


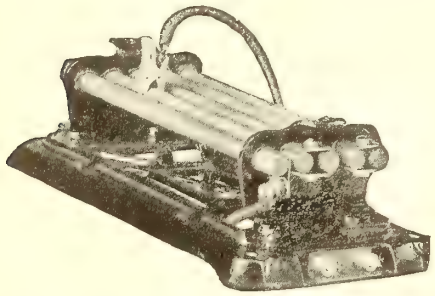
Fig. 1. When Rays of Light Pass from a Rarer to a Denser Medium, as from Interplanetary Space Into the Earth's Atmosphere, They Suffer Refraction, That is, They Are Bent Out of Their Course in the Direction of the Vertical. Since the Atmosphere Increases in Density Toward the Earth's Surface, the Rays Are Bent More and More from Their Course the Further They Penetrate Into the Atmosphere. The Light from a Star S in the Zenith Suffers No Refraction Because Its Rays Strike the Atmosphere Vertically at O, But the Light from a Star S' Striking the Atmosphere Obliquely at O' Is Bent More and More from Its Course as It Passes on Thru the Atmosphere. The Observer at P Sees the Star S' Not in Its True Direction PO'S', But in the Direction of the Rays at the Time They Enter His Eye, That Is, in the Direction PO"S". The Effect of Refraction Is to Displace the Star from Its True Position and to Increase Its Altitude Above the Horizon. Refraction Is Greatest for Stars at the Horizon, for the Length of the Path Thru the Atmosphere Increases Toward the Horizon. The Line O"P Is Longer Than OP and It Passes for a Greater Distance Thru the Dense Lower Layers of the Atmosphere, Where It is Most Bent from Its Course. Also Stars Shine Most Brightly When They Are Overhead. The Path of Their Rays Thru the Atmosphere Is Then Shortest and They Are Scattered and Absorbed Less by the Atmosphere. The Twinkling of Stars Which Is Due to the Unsteadiness and Changing Density of the Atmosphere Is Also Greatest Near the Horizon.

. . . AUTOMOBILE NEWS . . .

VARIABLE CARBON RESISTANCE FOR BATTERY CHARGING.

It is often desirable and necessary to give a long low rate reforming charge to ignition and other storage batteries.

Small batteries for motorcycles, mine lanterns, time clocks, etc., require a low ampere charging rate because of their low



A New Variable Resistance for Battery Charging Composed of High Resistance Carbon Rods Connected in Series. The resistance Is Adjusted by Moving a Slider Along the Carbon Rods.

ampere-hour capacity. In the laboratory where there are a great variety of uses for a variable current in experimental and research work this form of variable resistance proves very useful, and, in fact, indispensable.

When connected in the charging circuit between the rectifier and the storage battery, this rheostat will give any ampere charging rate between a very low rate and the maximum current output of the rectifier by simply moving the spring clip along the carbon rods.

This resistance is non-corrosive and infusible; cannot melt, disintegrate or break from overload or continuous service, claim the makers.

It is constructed of special high resistance carbon rods. It weighs about 5 pounds.

A TOOL FOR REGROOVING PISTONS.

Fitting of piston rings properly requires that the grooves into which they fit be true. The new regrooving tool here illustrated makes possible the easy truing of the grooves. The device is wired to the piston and turned around so that the cutter removes the high spots.

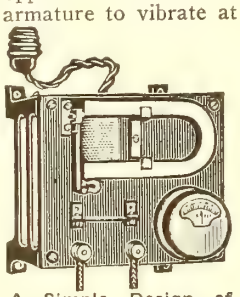


Ever Have to Regroove Your Piston When Fitting New Piston Rings? A Mean Job, Isn't it? Well, Here's a New Tool that Does the Work in a Jiffy. It Cleans Out and Trues Up the Piston Grooves Accurately.

A NEW BATTERY CHARGING RECTIFIER.

Since the demand of low voltage storage batteries for lighting and starting has become so universal there is an ever growing need for a device to keep these batteries fully charged, and especially a low-priced, efficient A.C. and D.C. rectifier. The rectifier here illustrated is very simple as well as inexpensive. They are practically automatic, requiring little or no attention whatever since they operate from 110-volt alternating current, which makes them very convenient to use, as they are portable and can be operated from any convenient lamp socket, each machine being equipt with a cord and screw plug, which can be readily attached to any lamp socket.

A transformer is assembled to each and every machine which steps down the 110 volts to a proper low voltage. This is done by means of two separate windings on the transformer, each winding being well insulated, making it entirely safe and independent of the other. A permanent magnet of the high-grade magnet steel is fastened to the slate base opposite the armature, which causes the armature to vibrate at the same frequency as that of the alternating or line current. To one end of the armature is attached a platinum point, which makes contact with another point of the same material, mounted on an adjustable contact screw. It is automatic in its action, being self-starting. When the current starts up again the rectifier starts up.



A Simple Design of Battery Charging Rectifier.

NEW PLIER-WRENCHES OF CLEVER DESIGN.

A Chicago inventor brings out two new ideas in Plier-Wrenches that will fill the long-felt want in any mechanic's tool kit. These wrenches are quick-acting, self-adjusting, always taking a firm grip on any object that may be clamped in the jaws.

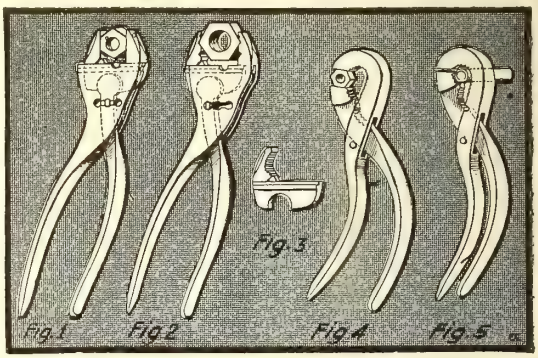
The main features that Mr. Allan, their inventor, claims for these wrenches are: that they are self-adjusting, and that the jaws are always parallel when clamping objects of various sizes, or when the jaws are closed or wide open.

It does not matter whether the jaws are closed or wide open or clamping nuts, pipes or objects of various sizes, the *grip* of the handle is always the same.

Referring to the above cuts, in Fig. 1 the jaws are shown clamping on a medium size nut, while in Fig. 2 the jaws are seen clamping on a large size nut, and the jaws nearly open. If you will carefully notice, you will observe that the handles are in about the same position, irrespective of the jaw opening.

Fig. 3 shows a pipe jaw that is interchangeable with the regular jaw used for nuts, which comes in handy for loosening nuts that have had the corners all rounded off. It also shows that this can be used as a pipe wrench.

Referring to Fig. 4 you will observe this form of a plier gripping a medium size nut. Note that the jaws are parallel, and that the position of the handles do not lose their grip. This plier-wrench has no adjustments. It is absolutely automatic and self-adjusting to any size object, such as nuts or pipes that may be wished to be clamped in the jaw. All that has to be done to operate it is to open the jaws, place the hook jaw on a nut or pipe or any other object wishing to be clamped in the jaws, then simply grip the handle, which will cause the jaws to adjust themselves rapidly to objects of various sizes.



New Plier-Wrenches for Autoists. Fits Round, Square and Hexagon Shapes.

Referring to Fig. 5, the jaws are shown nearly closed and gripping a small size pipe. Note that the jaws are parallel the same as they are in Fig. 4, gripping a medium size nut. On this style of a plier, length 8 inches, it will take in as large as a three-quarter-inch pipe and has a parallel jaw opening that will take in any flat object such as a nut; the flat parallel opening being three-quarters of an inch.

IMPROVED STORAGE BATTERY HYDROMETER.

You can easily test your battery and know that it is receiving proper care by using this improved hydrometer, which contains the following special features:

The rubber collars at each end of hydrometer protect it from striking and breaking, if accidentally dropt. The square collar at bottom prevents rolling off.

The float is always in plain view. There is no plug in bottom to drop out, spilling the acid and breaking the float. All rubber fittings are made of special high-grade stock. The graduations on scale are guaranteed accurate.

This hydrometer consists of the standard hydrometer described above fitted in a glass jar. This jar is to be filled with distilled water or pure rain water, making a safe and handy receptacle for both the water and hydrometer. The large rubber collar on hydrometer fits the top of jar, making it dust and evaporation proof. After testing the battery the hydrometer is placed back in the water and acid is rinsed off.

Instructions for testing the battery and for its proper care during both winter and summer are printed on the label.

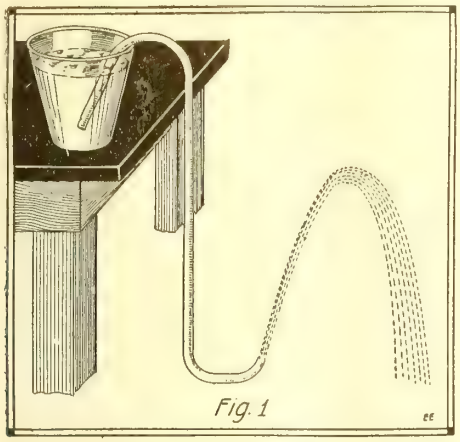


An Improved Storage Battery Hydrometer for Testing Ignition Cells.

Experiments in Physics

By JOHN J. FURIA, A. M.
DEPARTMENT OF PHYSICS, N. Y. UNIVERSITY

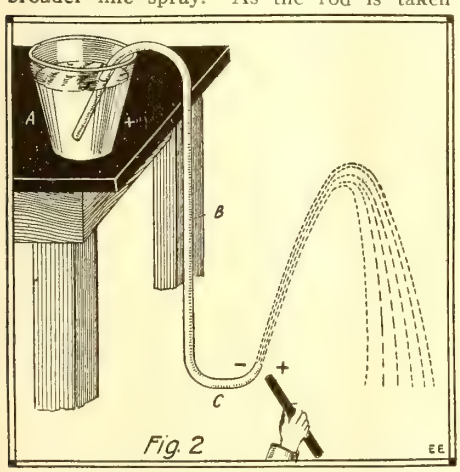
4--Water Jets and Air Jets.



An Ordinary Water Jet Such as Produced When Siphoning Out Water from a Receptacle at a Higher Level. Not Electrified.

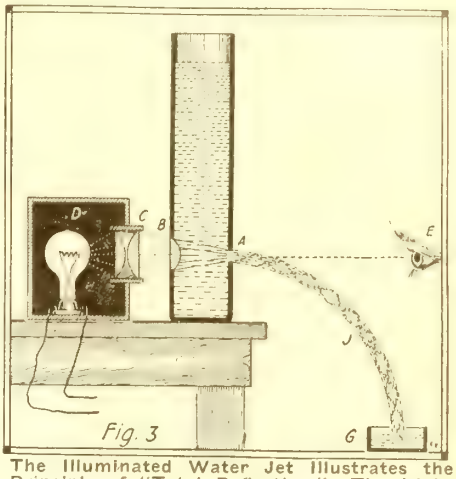
SEVERAL very interesting experiments can be performed with the ordinary water jet. Among the best known are the electrified water jet, the illuminated water jet, and the Bernoulli air jet, each demonstrating a fundamental principle in physics.

The electrified water jet illustrates the principle of *electrostatic induction* (see figure 1). A is a pail of water; B, rubber tubing, and C, a small nozzle. On creating suction at C, we siphon out the water from A in the form of a jet. The jet is inclined at a small angle from the vertical as in the figure, and we find that the stream breaks up into drops a small distance above the nozzle C. Electrify a rod (ebonite rubbed with cat's fur, sealing wax rubbed with flannel or glass rubbed with silk), and bring it near the nozzle as in figure 2. As the rod approaches nearer and nearer to the nozzle, the jet breaks up into a broader and broader fine spray. As the rod is taken away again the stream becomes compact again as in figure 1. The rod, when held near the jet, causes the water to be electrified with the opposite charge just as it breaks up into drops. The drops, since they all have the same charge, repel each other, forming a broad spray. The system from the pail to the jet is electrically neutral when the rod is not near. As the rod approaches the jet, the charge similar to that of the rod is repelled to the pail and the opposite charge is attracted to the jet. This is induction. (The jet becoming charged without coming in contact with the rod.) When the rod is removed, the pail-jet system becomes neutral again (the positive and negative charges distributing themselves uniformly thruout the system). By allowing the spray to fall against an insulated metal plate and then bringing the plate into contact with the electroscope we may test the nature of the charge on the spray. The nature of the charge of the water in the pail can be tested by connecting the water to the electroscope thru a conductor (copper wire).

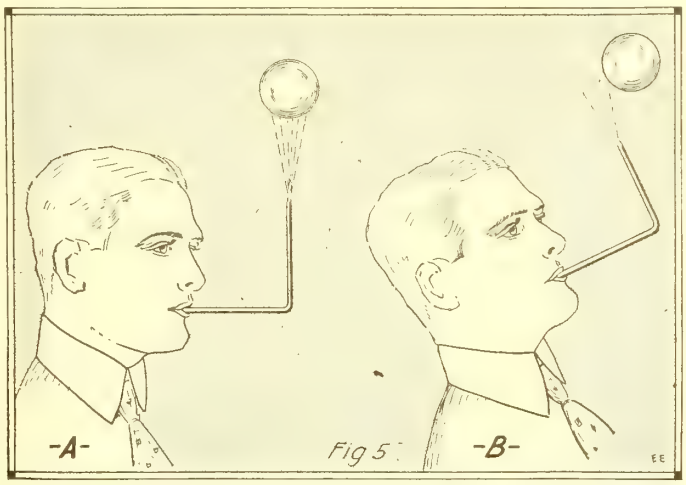


When a Charged Electrode, Such as a Fountain Pen Barrel Rubbed with Cat's Fur, Is Approached to the Water Jet, the Stream Breaks up Into a Broader and Broader Fine Spray, as Here Illustrated. The Water Becomes Electrified.

The illuminated water jet illustrates the principle of *total reflection*. A vessel about 3 feet high, having a circular opening A, about ½ inch in diameter, and a lens B, opposite to it that concentrates upon A the light coming from the condensing lens C, is filled with water. The room is darkened and the stopper removed from A. The water is heard striking the floor but nothing is seen while the lamp D is switched off. When lamp D, enclosed in a light-proof box, is turned on, we see the jet J illuminated, the rest of the space around it remaining dark. Even if the eye is placed at E, directly in line with the lamp lenses and opening, no light is seen. However, if a piece of glass G is placed anywhere in the path of the jet and the eye behind it, a brilliant spot is seen. It is evident, then, that the light from the lamp *travels only in the path of the jet.* The rays of light coming from D are concentrated (on opening A) thru the lenses C and B and strike the jet on the inner surface at an angle greater than the *critical angle,* so that they are totally reflected and none of the rays emerge into the surrounding space. When light strikes a surface so that the angle it makes with the surface is greater than the critical angle, it is all reflected just at is is from a mirror; and just as no light passes thru the mirror, so no light passes thru the jet surface into the surroundnig space.



The Illuminated Water Jet Illustrates the Principle of "Total Reflection." The Light Beam Is Reflected Down the Jet.

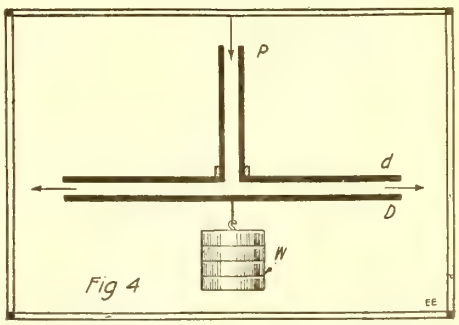


A Similar Phenomenon to That Illustrated by Experiment Shown in Fig. 4 Is That Here Shown. The Rubber Ball Is Held Suspended in Mid-Air by the Air Blast from the Blowpipe.

The Bernoulli jet illustrates the *Bernoulli principle,* which is sometimes stated as follows: In any fluid (liquid or gas) the pressure is least where the velocity is greatest. Figure 4 shows a cross-section of a pipe P, connected to a disk D, thru which a jet of air is being blown under high pressure. D is another disk to which a weight W, is attached. The greater the velocity of the air between the disks, the less the pressure between them and the more they are forced together, and hence, the greater the weight W, which can be supported. On a small scale, a spool may be substituted for pipe P, and disk D, and a small card may be substituted for D and W, the air jet being formed by blowing thru the spool.

The same principle is illustrated in figure 5. At "A" we see a vertical jet supporting a light ping-pong ball up in the air. If, now, the jet is gradually inclined almost to the horizontal, we still find that the jet keeps the ball in the air in spite of the attraction of gravity. The velocity of the air at P_1 is greater than at P_2, and, therefore, the pressure on the ball at P_1 (downward) is less than the pressure at P_2 (upward); hence, the ball remains suspended.

(To Be Continued)



In Any Liquid the Pressure is Least Where the Velocity Is Greatest. This Device Proves It. If Air, at High Velocity, Is Blown Down Thru the Pipe P, the Two Discs d and D Are Held Together, Supporting the Weight W.

THE CONSTRUCTOR

A Model Electric Theater

By EDWARD K. JEWETT

FEW boys indeed realize the fun and entertainment furnished by building and operating a model theatre. The purpose of this article is to describe the construction of a miniature playhouse and the method of electric illumination used in such a model to produce the wonderful effects seen in modern life-size theatres.

The first step in building the theatre is to procure a strong wooden box, measuring about 1 foot high, 20 inches long and from 10 to 12 inches in depth. A common soap box is just the thing, and in using such an article one has the frame of his theatre ready made and does not have the trouble of making one. The box should stand on its side on the table. The entire bottom is removed, and the back half of the upper side, as shown in Fig. A. A small table-like structure is next built by joining the removed half of the upturned side with a small piece of wood 20 inches long, 2 inches wide and ¼ inch in thickness.

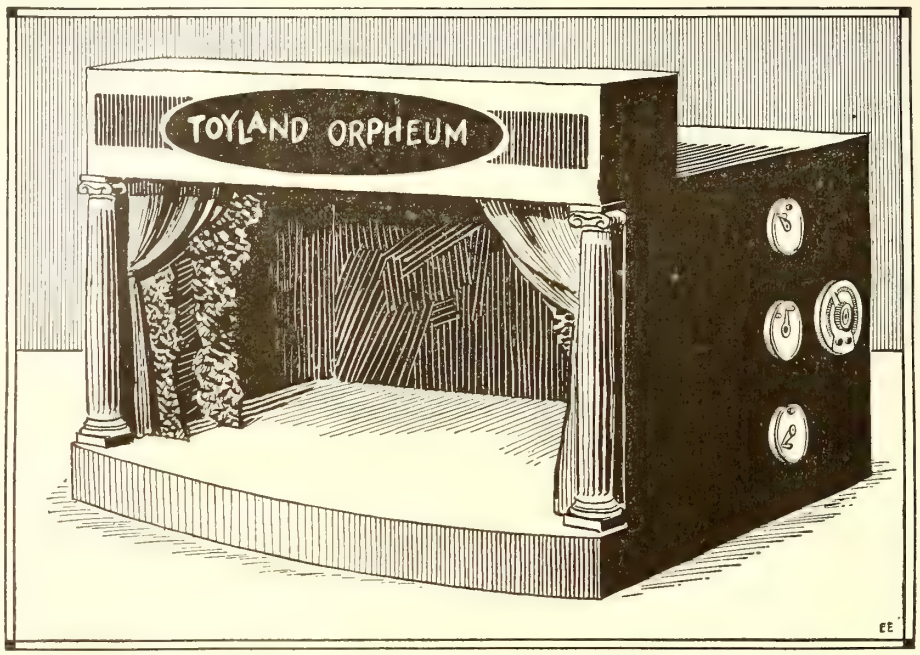


Fig. 1C. A miniature Theater Provides Lots of Amusement and Instruction During the Winter Evenings. Some Experimenters Give Quite an Elaborate Show with One of These Theatres. By Means of Electro-Magnets Under the Floor of the Stage, "Soldiers" Can Be Made to March; Cannons and Tanks Operated by Motors, Etc. The Curtains Can Be Raised and Lowered by Motor and Orchestra Music Supplied Via a Phonograph.

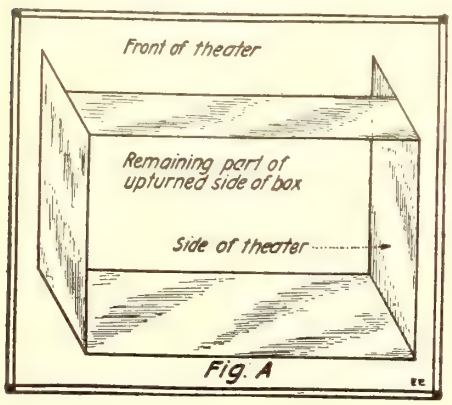
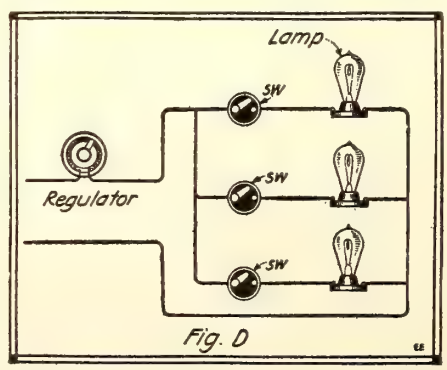


Fig. 1-A. Forming the Frame-Work of the "Home" Theatre. A Good Sized Soap Box Makes a Nucleus for the "Stage."

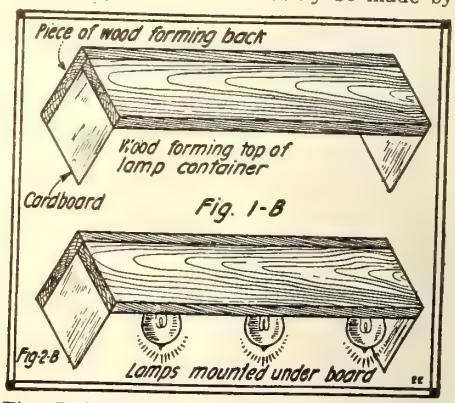
Next, go to a store dealing in electrical goods and buy three small colored incandescent "Christmas tree lamps" and miniature sockets to fit them. The bulbs come in many colors, but the best to choose for the theatre are red, blue and green. Having procured these miniature lamps, screw the sockets on the under side of the upper board forming the top of the table-like structure mentioned above, as shown in No. 2, Fig. B. The next step is to paint the inner walls and floor of the box with some very black substance, such as lampblack, etc. This is done to prevent any reflection of light from the walls and floor when the lamps are turned on. This paint being thoroly dried, begin to wire the instruments and lamps as shown in the lighting diagram D, shown elsewhere. The most convenient location for the instrument is on the remaining half of the upturned half of the box. The instruments are, respectively, one small rheostat or current regulator, and three one-point wood-base switches; by means of these separate switches any single one or any combination of the different lamps may be turned on, and by means of the regulator any degree of brilliancy may be obtained at will.

Having tested the three colored lamps, and having found that they operate satisfactorily and are easily controlled by their respective switches, start building the stage scenery. Let me say here that it is practically impossible to state just what scenes to make; the builder must decide that.

One of the most beautiful types of scenes is the "forest." This may be constructed very easily. For a background, go to some wallpaper dealer or paper hanger and ask him to sell you a yard or two of "forestry" wallpaper. This paper is usually printed with a representation of a forest or jungle on it, and makes a most excellent background for the model theatre. The easiest way to hang scenes in the back of the theatre is to cut the scenery to the exact dimensions of the back of the stage, then take some small sticks of wood (preferably flat pieces) and form them into a square of the same size as the dimensions of the scene, then paste the scene across the "frame" and hang it on the back of the theatre by means of miniature hooks or brads. (Be sure that you hang the scene on the theatre with the "frame" on the *rear* of the scene and not on the *front*, as in the latter case the frame would be visible and would tend to spoil the effect of the scene). Of course, "side scenery" and "ceiling scenery" are necessary, but these can easily be made by cutting them out of the "forestry" wallpaper described above.



Wiring Diagram for the Model Theater. Each Battery (or 110 volt) Lamp Has a Switch and All Three Lamps, Red, Blue and Green, Can Be "Dimmed" by the Rheostat.



The Red, Blue and Green Lamps Can Be Mounted in a Small Box Like That Shown, and Mounted on Top the Stage Frame As in Fig. 1-C.

The side view of the complete theatre is shown in No. 1, Fig. C. The method of making the back scenery is more clearly illustrated in No. 2, Fig. C.

The main scheme in having the different colored lights and switching arrangement for them is to have different "effects" and various intensity of light to correspond with the change in the scenery. For instance, for a "forest" scene in which "dawn" is supposed to be the time, a faint blue, gradually becoming more brilliant, is suitable. For a "sunset" a combination of strong red and faint blue is necessary.

A Fan-Operated Show Window Attraction

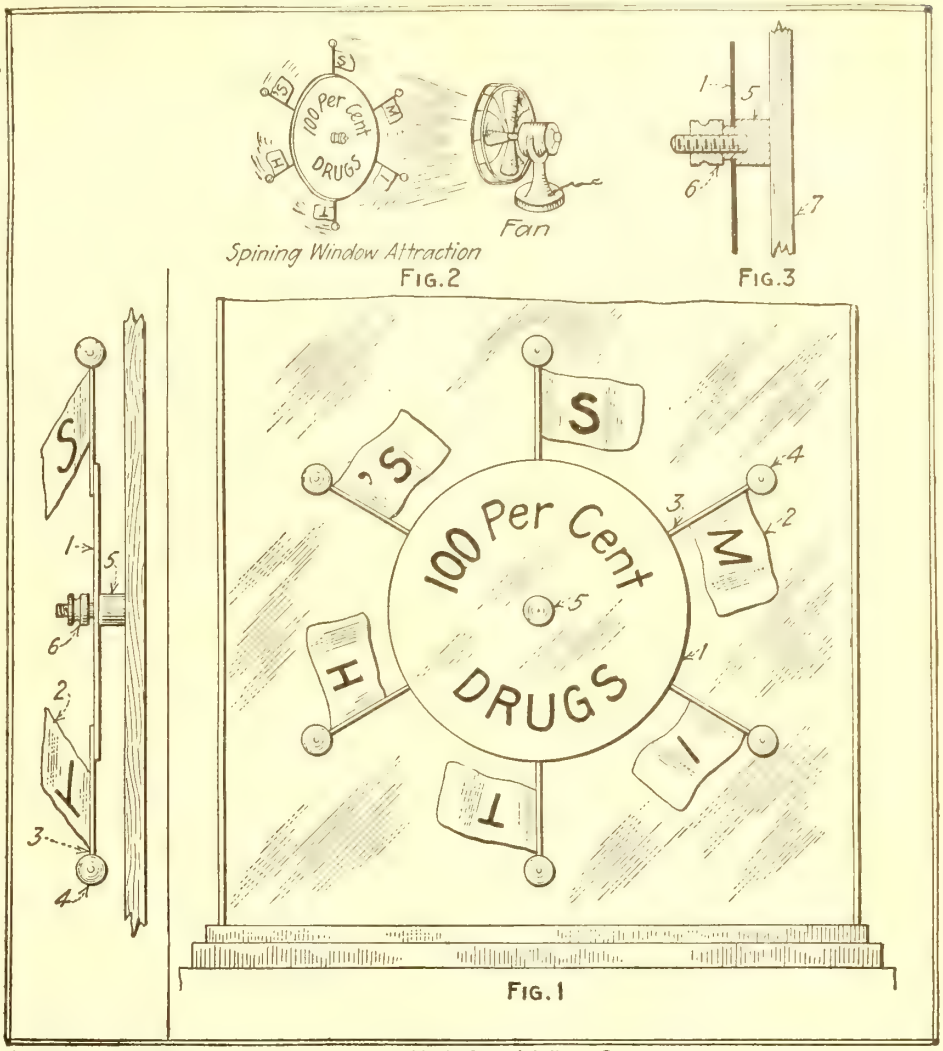
Many store-keepers use their electric fans during the winter months to keep their show windows free from frost, and no doubt an effective animated attraction that is easy to make and will utilize this breeze from the electric fan for its motive power will be of interest. Such a device is described herewith.

It consists of a sheet metal disk upon which the desired advertisement is painted. This is left to the originality of the user, but it is suggested that it should be of few words and the lettering large and arranged in the form of a circle. Bright contrasting colors will help to make it conspicuous. The disk turns on a pivot fastened to the inside surface of the window glass at such a height, that it comes in direct line with the vision of a person walking by on the sidewalk. It is revolved by the current of air against the driving vanes which can be made in any desired form, such as a flag, broad arrow, etc. The pitch of these vanes should be adjusted by trial until the disk revolves at a speed that permits the advertisement to be read easily.

Referring to the drawings Fig. 1 is a front view as the device appears from the outside of window. Fig. 2 is an end view and Fig. 3 is a detailed sectional view of bearing. 1 is a disk of light sheet metal (aluminum) about 8 inches in diameter. 2 is a driving vane in the form of a light metal (1/64" aluminum) flag. 3 is the flag staff soldered to disk. 4 is a small metal ball for a neat finish and is the means whereby the device is balanced. 5 is a binding post forming the bearing for the disk and which is glued to the inside of window glass 7. 6 is the thumb nut of binding post to allow the disk to be quickly and easily removed so that the display can be easily changed from time to time. As shown in detail in Fig. 3, the bearing for the disk is made by turning down a portion of binding post so as to form a smooth projection just long enough so that when the thumb nut is tightened against the end of it there is enough play to allow the disk to turn freely. In operation this bearing should be oiled occasionally.

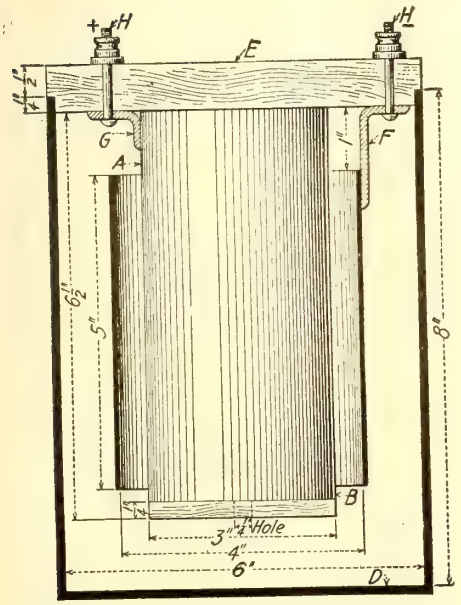
This attraction is very effective even when the source of energy is visible, but when the fan producing the breeze is concealed from view, the element of mystery adds wonderfully to its ability to attract attention.

Contributed by J. A. WEAVER.



A Window Attraction That Revolves at High Speed When Operated by the Breeze from an Electric Fan.

A Home-Made Edison Primary Battery



Home-Made Edison Primary Battery, Using Copper Oxid and Zinc Electrodes in Caustic Potash Solution.

The battery which I am about to describe will give good service and is not expensive to build.

This battery is of the Edison type and consists of a perforated copper pipe A, filled with red oxid of copper as the negative element and a zinc cylinder C as the positive element. (The positive *element* gives the negative *pole* and vice versa.) The exciting fluid is a 25 per cent solution of caustic potash in water, which means one pound of potash in three pounds of water.

The battery container is a glass jar D, which is 6 x 8 inches. E is a cover for the jar, and to this A and C are fastened by the lugs F and G. There are three lugs similar to F, and three to G. They are arranged around the top of the jar at an angle of 120 degrees with each other in the same set. To one of each set of these lugs, which are soldered to A and C, a common dry battery bolt H is fastened, as shown to the terminals.

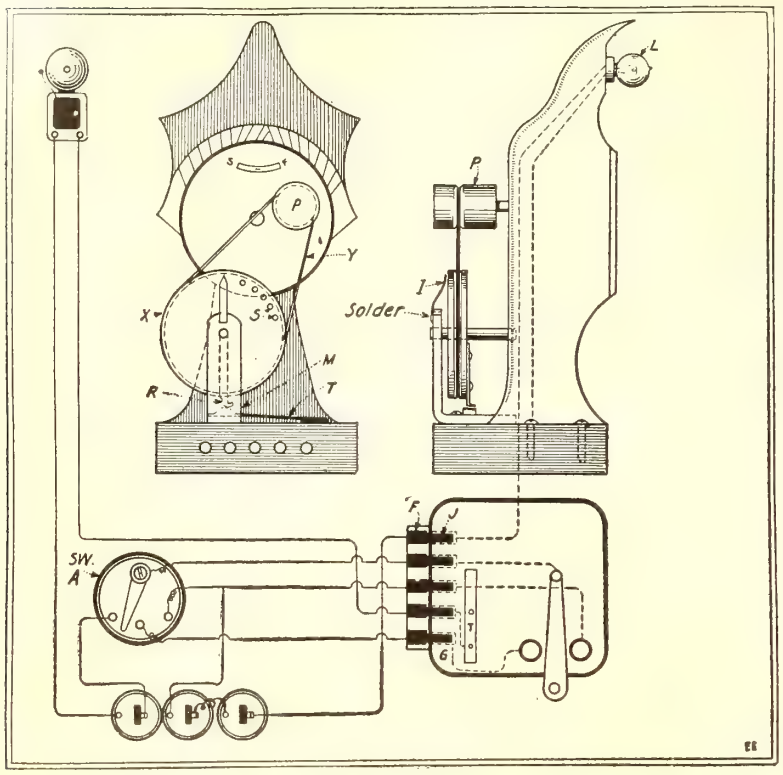
The negative element A is a copper tube 3 x 6½ inches. It is punched or drilled full of ⅛-inch holes, and the bottom is closed by a piece of wood, B, which has been boiled in paraffin fifteen minutes. This is fastened in by taking a large nail and denting in the tube A on the wood. When you have finished the cylinder solder on the copper lugs F, which can be of copper strip, strong enough to hold up A, place these lugs around the cylinder at a distance of 120 degrees.

The positive element is made of zinc sheet rolled into a tube 4 x 5 inches. This has lugs F soldered on as shown, and must be well amalgamated, which can be done by rubbing the cylinder with dilute sulfuric acid and mercury.

Make top as shown in drawing of some soft wood. Boil this in paraffin for fifteen minutes, and then assemble the battery. Make a 25 per cent solution of caustic potash (be careful, as one drop might cost you your eyesight) and fill two-thirds of the jar. Now fill the copper element with red oxid of copper or cupron, which is a higher form of the ordinary commercial copper oxid. Then place your elements in and pour a layer of paraffin oil to a depth of ½ inch on top of solution. The battery is then ready to use. The E.M.F. of this Edison-Lalande cell is approximately .7 volt and the internal resistance 0.03 ohm. A 300 ampere-hour cell requires about 2¼ lbs. cupric oxid, yielding 1/5 horsepower-hour.

Contributed by E. E. CROSS.

Converting a Dresser Clock to an Electric Alarm Type



The ELECTRICAL EXPERIMENTER is one of those interesting chaps, who is forever telling us about some new-fangled electrical do-funny, in an earnest effort to make our lives more livable, but one thing he never does forget to tell us about is how to make an electrical alarm clock. But if we do say it ourselves, Mr. Beasley, the author of the present article, has really shown us something new in an electrical alarm clock which he has devised and constructed, so as to be a suitable attachment to any ordinary dresser clock. He also shows us how to rig up a most desirable night lamp on the front of the clock, so that by means of a switch on the base, or else mounted on the wall near the bed, one can turn on the light at any time of the night, so as to note the time, —the lamp serving besides as a bed-room light. The alarm can be set for any hour desired by the simple dial device shown.

The sketch illustrates how to make an electric alarm from a small dresser clock, and circuit for lighting lamp on dial from two different locations regardless of position of other switch; it allows alarm to be turned off from bed without getting up when switch "A" is placed near enough. A small grooved wood pulley "P" attached to the winding key of clock, rotates pulley "X" with rubber band "Y." Pulley "X" is of sufficient size to rotate only once in 24 hours. Alarm can be set for any time by setting marks "S" on pulley "X" to pointer "I." Marks "S" can be numbered if desired with two numbers each, one number to determine time to be set, and another indicating time it will give the alarm. The bell ringing contacts "R" and "T" close when pulley "X" is in position shown. Contact arm "R" is soldered to shaft to insure good electrical connection. Plugs "F" are tips from telephone cords inserted into receptacles "J" made from copper line wire sleeves, allowing clock to be detached from circuit. Wire at "G" is grounded to the clock frame. The circuit is self-explanatory.

The alarm clock device as here worked out, makes a very attractive and at the same time very useful apparatus, which anyone handy with tools can make. It is not necessary to obtain an extra battery for the operation of this alarm attachment; the regular house-door bell battery may be used.

Contributed by B. F. BEASLEY.

An Experimental Motor Generator

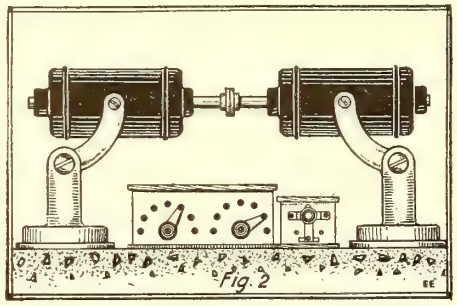
The diagram herewith shows the construction of a small motor-generator set, which may be used to generate direct or alternating current. First I will tell you the advantages of this set. Most all radio amateurs have had experience with spark coils and interrupters used on direct current. With this arrangement you put a heavy load on the 110 volt line, draw an excess amount of current which registers on the meter and increases the electric light bill considerably. Also you may notice that every time the key is prest the lights grow dim, and the larger the coil or transformer, the dimmer the lights will grow. This is very annoying to the other members of the household.

With the set here described you are getting your current from the armature of the second motor and the load on the 110 volt line is always the same. We all know that it takes more current to start a motor than to keep it going, after being started, so when your motor is started you have a constant load on the line, which is smaller than if the coil or transformer was connected in series with the line.

The articles required to build this set are a base 24" x 12" x 1½" and two discarded 110 volt fan motors, which may be bought from any electrical repair shop.

Fan motors are usually series wound. As constant speed is required, the field coils of the motor may be connected in shunt with the armature thru a rheostat. The field coils of the generator may also be connected in shunt around the armature, thus giving us the desired constant voltage.

The speed-regulating resistance found in each motor may be used as a field rheostat, or other resistances may be wound for the purpose. These may be placed in a box with two multiple switches, with desired number of contacts to act as a field rheostat for the motor, and one for the generator. The box may be placed beneath the coupling of the two armatures.



A Home-Made Motor-Generator Constructed from Two D. C. Fan Motors

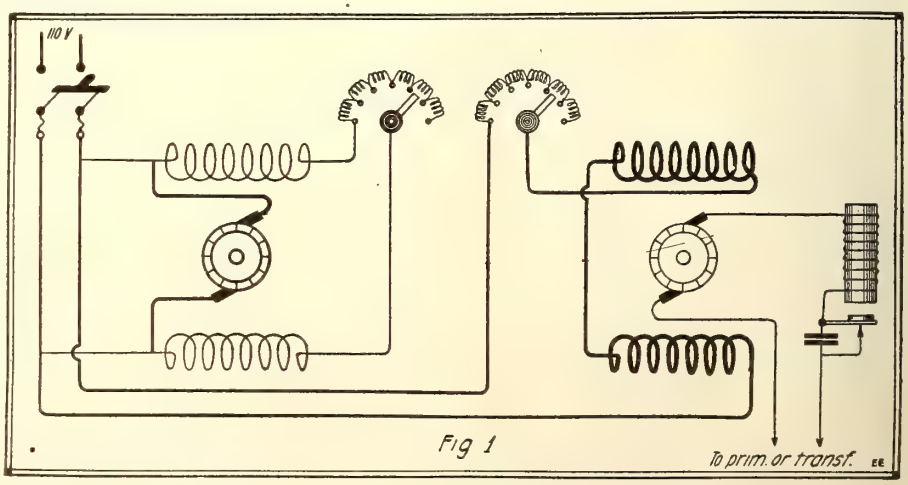
If both are direct current motors and alternating current is required, this may be done by making an interrupter and placing it in series with armature current of the generator.

An interrupter may be used to a great advantage in increasing the frequency, if properly made. A core made of soft iron wire from three-fourths of an inch to one inch in diameter, and about two inches long, with about five turns of number 14 wire, will be sufficient. If the magnet is too large it will act as a reactance or resistance, and also the self-induction will cause a large arc at the vibrator contacts.

The vibrator can be made of a piece of spring steel cut to suit the maker. To be sure of good, durable contacts a piece of silver may be soldered onto the vibrator.

If the set is used on a 110 volt direct current line, the voltage taken off of the generator will be from 65 to 80 volts. If an A. C. machine is used the frequency will be low and may be calculated.

Contributed by "ELECTRICIAN-RADIO," U.S.N.



Connections of Armature and Field Windings of Two Fan Motors Constituting Experimental Motor-Generator. Suitable for Radio, Charging Storage Batteries, Electro-Chemical and Plating Work and Many Other Things

Measuring Resistance in Direct Current Machines

By Gustav E. Jansson
Associate Member A.I.E.E.

IF the resistance of a direct current machine is to be determined, the simplest way is to connect the armature to a source of low potential D.C. Then measure the potential between two commutator segments, each segment located under brushes of opposite polarity, as indicated in Fig 1. The segments are best marked with a punch so that the resistance is always measured between the same segments. The armature should, however, be turned so as to obtain a position to give as near as possible the mean value of the resistance.

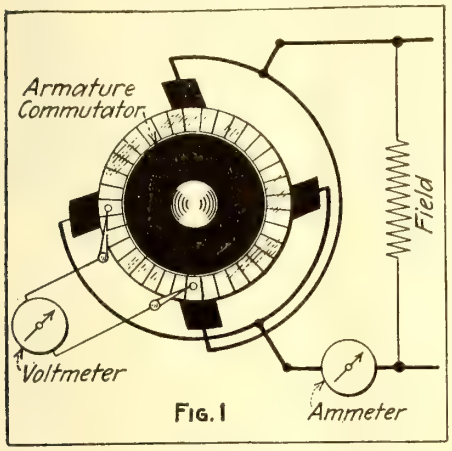


FIG. 1

To Measure the Resistance of a Direct Current Machine, the Current and Voltage May Be Determined by Means of Volt and Ammeter, in the Manner Here Indicated.

If the voltmeter indicates "E" volts and the ammeter "J" amperes, then we have:

$$R = \frac{E}{J} \text{ ohms}$$

and hence if "I" denotes the normal load current then $I^2 \times R$ denotes the copper losses in watts.

If it is not convenient to obtain a low potential source of ample capacity to measure the resistance as per above, then the resistance can easily be obtained in the following way, using a few storage batteries or ordinary dry cells as the source of energy.

Fig. 2 indicates the connection in detail. Now if,

P = Number of poles
P/2 = Number of pole pairs = p
a = Number of circuits in parallel, depending on armature connection (a = p for usual parallel connection, a = 1 for series-connected armature)
R_m = Measured resistance
R_t = Total resistance of winding
R_a = Actual resistance of armature to imprest voltage on brushes in running (Ohmic resistance only).

$$R_t = \frac{4p^2 R_m}{P - 1}$$

$$R_a = \frac{R_t}{4a^2} = \frac{p^2 R_m}{a^2 (P - 1)}$$

Now if the average temperature rise of the winding at full load is wanted it can be found as follows:

Let "R_c" be the resistance at a temperature of the surrounding air = t_c. Care being taken that the machine has been standing without load long enough to assume the same temperature as the air.

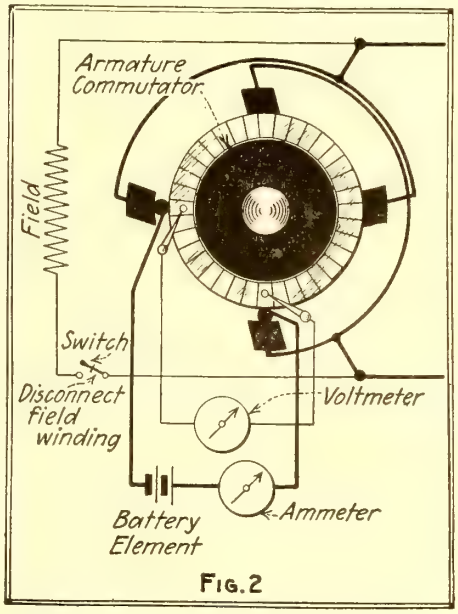


FIG. 2

Measuring the Resistance of D. C. Machinery on a Low Potential Source of Current, Such as a Battery, a Volt and Ammeter Giving the Necessary Readings.

R_h = Resistance of hot machine
t_h = Temperature of hot machine
k = Constant = Resistance increase per degree temperature increase
From equation $R_h = R_c (1 + k (t_h - t_c))$ we get

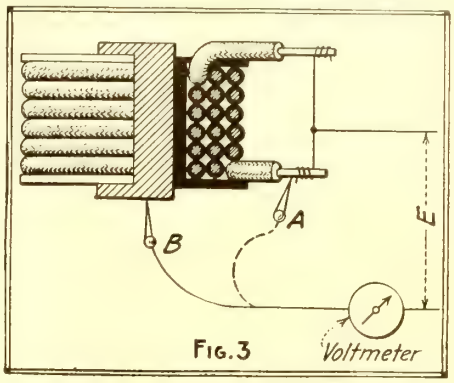


FIG. 3

The Resistance of the Coil Insulation to Iron Core Can Be Measured With An Ordinary Voltmeter of Known Inherent Resistance.

$$t_h - t_c = \frac{R_h - R_c}{k R_c} = \text{The average temperature rise of the winding above the air temperature.}$$

This gives for copper winding about 2 — 1/2 degrees Centigrade or 4 — 1/2 degrees Fahrenheit for each per cent resistance increase.

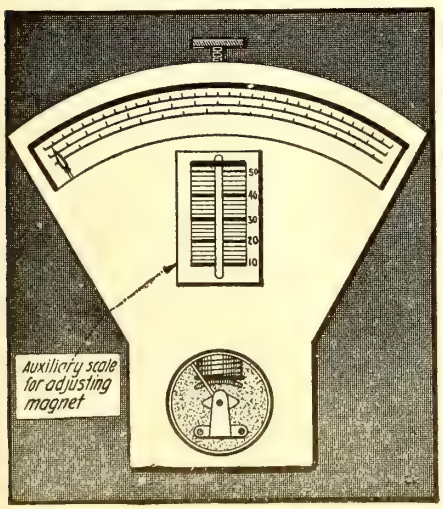
The resistance of the insulation to iron can be measured with an ordinary voltmeter of a known inherent resistance as shown in Fig. 3. Connect one pole of a suitable D.C. source to the winding as shown in figure. The other pole is connected to the voltmeter terminal. Complete the connection first to "A"; we obtain the imprest voltage "E" then connecting to "B" we get the voltage "E_2" and the resistance of the insulation is then

$$R_x = R_v \left(\frac{E - E_2}{E_2} \right) \text{ ohms, where } R_v = \text{voltmeter resistance.}$$

Care should be exercised, however, as a high potential will often arc over a much higher resistance than a supposed safe insulation resistance measured as outlined above.

A Home-Made Adjustable Ammeter

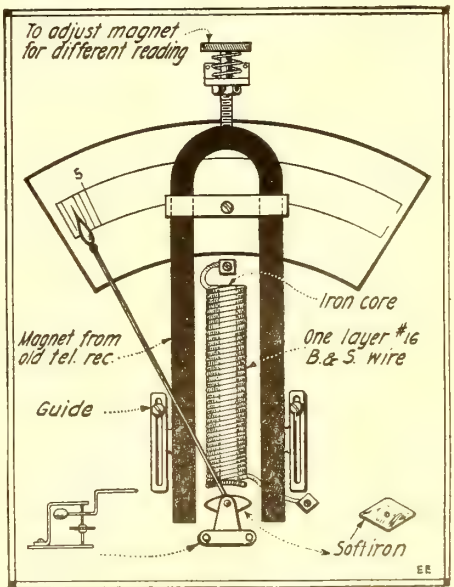
Needing an ammeter recently, I thought I would try to make one that could be adjusted to read any ordinary amperage. To adjust this instrument, all you need to do is turn the thumb nut which moves the steel magnet up or down. The further away from the magnetic vane the magnet is, the greater the sensitiveness of the meter. To graduate this instrument, I used an ordinary pocket ammeter with dry cells. First I screwed the magnet clear down, then connected the meter in circuit with the pocket ammeter which showed twenty-five amperes. This moved the other meter needle about three-sixteenths of an inch. I marked this point and divided the distance between said point and O into five parts, each part representing five amperes, and so on, until I finally had the scale calibrated for *four different readings.*



Front View of Home-Made Adjustable Ammeter.

In many cases the experimenter will find it convenient to utilize the moving element from a discarded pocket volt or ammeter for the instrument here described. With a little care and ingenuity he can thus refit this moving element into his new meter, and when this is done it is usually more satisfactory than a home-made armature and needle.

Contributed by M. G. VAN WAY.



Detail of Mounting in Adjustable Ammeter.

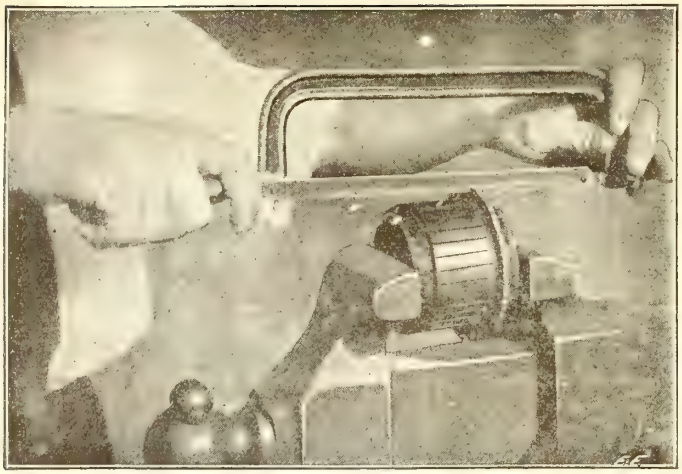


Fig. 1. Slotting the Connecting Lugs of a Commutator with a Hack Saw.

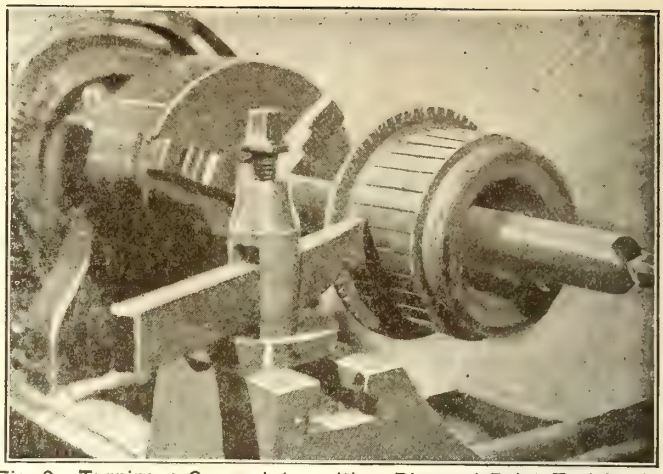


Fig. 2. Turning a Commutator with a Diamond Point Tool in the Lathe.

The Electrical Machinist

By H. WINFIELD SECOR

No. 1 Commutator Work

THE Electrical Machinist' for as such he is generally known to-day, is usually a machinist or electrician who has done a great deal of machine work, and who generally performs his work in an electrical repair shop or a machine shop, which does a certain amount of electrical repair work. One of the most delicate pieces of electrical machinery which the electrical machinist or experimenter who dabbles in mechanics encounters, is the *commutator*.

Fig. 1 shows the simple operation which has to be performed on many commutators, and a handy little wrinkle in this connection, will be mentioned. This consists of slotting the rear extensions or lugs on the copper commutator segments in which the lead wires from the armature coils are to be soldered. On small commutators of 1½ to 2 inches in diameter, a single hack-saw blade will usually give a sufficient width of slot, and this slot need be only about ⅛-inch deep, or sufficient to accommodate the two or more leads which have to be soldered in them. Where a wider slot is necessary on larger size commutators, two or more hack-saw blades are used in the frame of the saw, care being taken to see that all the teeth face away from the saw handle or in the same direction. The Star hack-saw blades which are tempered very hard, are generally used in all machine shop work, and a medium tooth pitch is desirable. If the pitch of the tooth is too fine, then the saw does not work fast enough, and a waste of time will result. If the pitch is too coarse, the teeth are easily shattered and broken out, thus wasting too many blades. The larger commutators, 4 to 5 inches in diameter, have their slots in the connecting lugs, milled out on a milling machine. An improved method for doing this in some shops is to place a milling cutter on an arbor, which is secured in the live chuck on a lathe. The commutator may be mounted on the moving carriage of the lathe, and is preferably secured by a stud and nut thru its center, so that after each slot is cut, the nut can be released and the commutator moved to bring the next segment in line with the milling cutter.

The *turning down* of commutators, illustrated at Fig. 2, is one of the commonest operations performed by the Electrical Machinist, and one which is liable to cause dismay to the embryo mechanic if he is not very careful as to how he sets about the operation. It must always be borne in mind that a considerable pressure is exerted at right angles to the direction of rotation of the commutator in the lathe while being turned, and also that commutators are not always as strong as they look. They consist of a large number of copper segments separated by mica insulating strips which are held under compression by the drum and clamping ring, which together form the commutator *shell*. If too much pressure is exerted by the tool on the commutator perifery, or if the turning

(Continued on page 717)

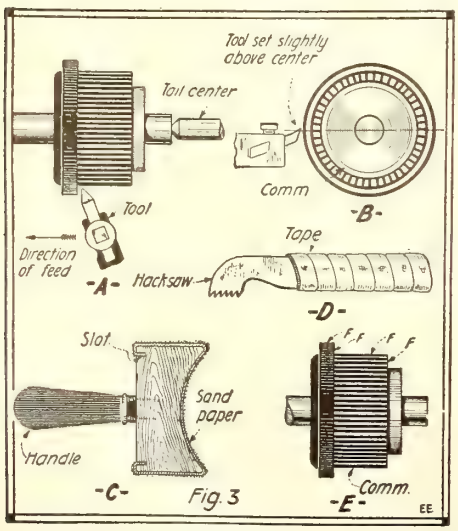


Fig. 3. Several Wrinkles of Value to the Young Electrician and Machinist Are Shown

ANNOUNCEMENT OF NEW SERIES, "THE ELECTRICAL MACHINIST."

For the past fifteen months, the publishers have been running a series of "Experimental Mechanics," which our thousands of readers everywhere who are interested in Machine Shop practice, either in an experimental or vocational way, have undoubtedly found both educational and instructive. This series of articles having now been completed, and in view of the fact that we have received many letters of commendation on our mechanical department in the Electrical Experimenter, and one that is eagerly looked forward to every month, the publishers have decided to start a new series of articles on Mechanics; especially written for the benefit of the Electrical and Radio Experimenter.

A new series of articles will appear, beginning with this issue, entitled "The Electrical Machinist," by H. Winfield Secor. Mr. Secor is an electrical and mechanical engineer of extensive experience, and his series of articles entitled "The Electrical Machinist," will undoubtedly appeal to all classes of readers, who not only are interested in a general way, but, should they intend doing any serious experimental work, MUST become interested in the mechanics of everyday shop practice. The trade of the Electrical Machinist is a recognized one everywhere today, and in the forthcoming articles Electrical and Mechanical shop wrinkles will be woven together so as to render the articles of the utmost practical value to the man who has to do the work. The readers interested in the pure mechanics of modern shop practice, will do well to procure back numbers containing the fifteen original articles entitled "Experimental Mechanics," and there are also a host of valuable books on the market available at nominal prices, which cover the orthodox details of the machinist's trade in a very thoro and complete manner. —THE PUBLISHERS.

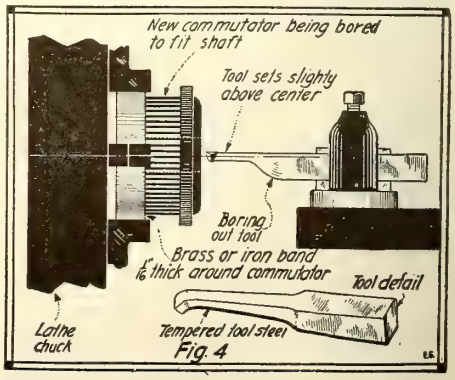


Fig. 4. Sometimes a Commutator Has to Be Bored Out to Fit a New Shaft Diameter. The Hole in the Commutator Is Bored Out with a Steel Tool of the Shape Here Illustrated.

HOW-TO-MAKE-IT

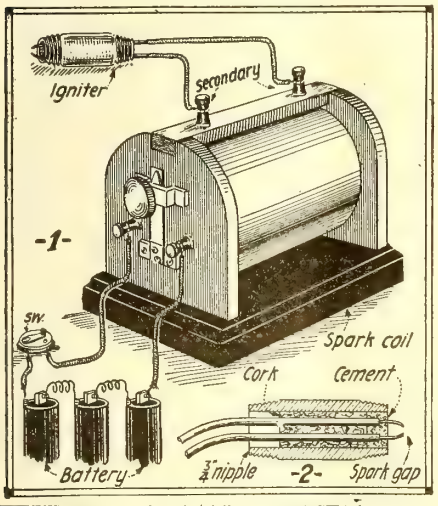
This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

AN ELECTRIC STOVE LIGHTER.

The above sketches are descriptive of a very easily constructed stove lighter, which is operated from the bedroom some distance away. All that was used were a few batteries, some double insulated wire and a small coil taken from the engine of a discarded motorboat. Fig. 1 shows a layout of the arrangement. Fig. 2 shows the igniter end. This was made out of a long cork driven into a short three-quarter inch pipe nipple. The cork was left about one-quarter of an inch from the point ends of the wire, and the space filled with an incombustible cement. The wires were pushed thru the cork, which afforded a very satisfactory insulation.

It was, of course, necessary to prepare the fire the night before, as shown by Fig.



Useful Home-Made Electric Stove Lighter.

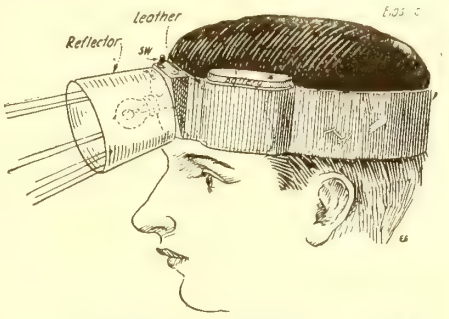
3. The grates were covered with a thin layer of oily waste, a small wisp of which was drawn thru the grate teeth near one of the damper door openings in front. Into this was laid the igniter nipple, around which some of the waste was prest. The coil never failed to generate hot enough a spark to immediately fire the waste in contact with it, which instantly spread to that on the grates above. In turn the wood and the coal were rapidly ignited.

Contributed by
FRANK W. BENTLEY, JR.

SECOND PRIZE, $2.00

MINER'S OR TROUBLE BATTERY LAMP.

This light is very handy where you are continually moving about and both hands are engaged in some kind of work, as it fits over one's head and no matter in what direction the eyes are turned, the object



A Trouble and Diagnostic Lamp.

is illuminated. Best of all, it can be made very cheaply.

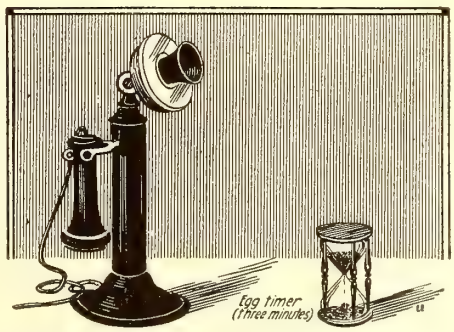
The band around the head is made of leather with a piece of elastic sewed into it, to make it fit firmly and tightly about the head. The piece of wood screwed on the band is to give the light a slanting position, so that the rays of light will shine on the proper spot before the eyes. The socket is screwed to this piece of wood. The reflector is but a piece of shiny tin rolled in the shape of a cone and fastened on as shown. It not only reflects the light, but shades the eyes from the strong light above them. The batteries can be carried in the pocket, but it is more convenient to make a pocket in the head-band which will accommodate one or more flash-light batteries. Also make a switch as shown.

Contributed by
RAYMOND WENSINGER.

USE EGG-TIMER FOR LONG-DISTANCE 'PHONE CALLS.

A very handy timer for the usual three-minute long-distance telephone calls is the common sand-glass or egg-timer. This set on a shelf near the telephone is always ready for use and saves much bother, arguments and overcharges.

Contributed by FREDA POTTS.



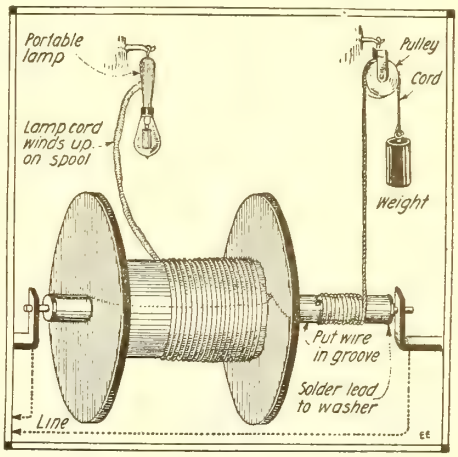
Using the Egg-Timing Sand-Glass for Timing Telephone Calls.

THIRD PRIZE, $1.00

AUTOMATIC REEL TO REWIND EXTENSION LAMP CORD.

The materials needed to make this useful device are—an empty wire reel, about ten inches in diameter, a piece of shade roller about three inches longer than the width of the reel, two shade brackets and two pins from the ends of shade rollers. Place the piece of roller in the reel to act as a shaft and drive the two pins, one into each end, with a metal washer underneath. One end of the roller is made flush, but the other end is allowed to extend. This is to form a place for the string to rewind, which has a weight attached and forms the motive power. The correct length of string can be found by experiment. Two leads are taken thru the reel, one on each side, and soldered to the washers on either end. The circuit is made thru the brackets, which act as bearings. To give this reel a finished appearance, it should be put in a box with holes cut at the proper places for the cord. The string which is used for motive power can be suspended over a pulley to take up some of its length. The diagrams will better explain the constructional details.

Contributed by W. E. CONWAY.



Making Automatic Reel to Rewind Extension Lamp Cord.

MAKING MAGNETIC CHARTS.

A permanent chart of the magnetic lines of force surrounding a magnet can readily be made as follows: A sheet of thin cardboard of suitable size is evenly coated on one side with paraffin wax, and over this is spread an even layer of fine grade iron filings. The magnet is placed against the under side of cardboard and the filings are agitated by lightly tapping the cardboard until their arrangement clearly shows the *lines of force*. Then they are "fixt" by holding over a hot stove or over a gas flame near the wax surface until it softens. When the wax is cool the magnet is removed and the filings, being imbedded in the wax, will retain their position.

Contributed by J. A. WEAVER.



DETERMINING THE MELTING POINT OF SOLIDS.

In accurately obtaining the melting point of some solids it is difficult to determine the exact instant at which the substance goes into a fluid state. This is particularly true when working with fats and crystalline masses.

A simple manner in which to make such a test is to place a small amount of the substance on the bulb of the thermometer. The thermometer is then past thru a cork and in this manner suspended in a test tube which forms an air bath. The test tube may be immersed in water or glycerol while being heated.

The material on the bulb will be clearly visible due to the refraction of the light while in a solid state but as soon as it becomes fluid the bulb will clear up.

Fats and waxes may be scraped with a knife, a few shreds put on the thermometer. Crystals should be powdered and the bulb immersed in the powder so a few grains will adhere to the bulb.

Contrib. by THOMAS BENJAMIN.

SILENT DISCHARGE OZONE APPARATUS.

First procure a Liebig's condenser. After all traces of dust have been removed from the Liebig's condenser a coating of tinfoil is placed upon the outside, two inches from each end, by means of shellac, and also another coating is placed upon the inside surface of the inner tube. If this is found difficult the inner tube may be filled with fine shot or iron filings, which will answer the same purpose as the tinfoil.

The condenser should now be clamped to a support and the secondary of a good induction coil connected to the two tinfoil coatings. An oxygen generator is now connected to the condenser and the coil started.

The working of the apparata is as follows: A stream of oxygen gas is past slowly thru the condenser while the induction coil is in operation, the discharge taking place silently. This gives ozone best, as it does not involve any rise in temperature, which would cause the ozone formed to change to oxygen, as may be seen from the equation:

$$3O_2 \leftarrow 2O_3$$
$$3O_2 \rightarrow 2O_3$$

The reaction being a reversible one.

Ozone, its Properties, Test and Use: Ozone is a gas of deep blue color with a peculiar odor. It is more easily liquefied than is oxygen, and it is more soluble in water. Its density is one-half greater than that of oxygen, as seen by the formula O_3.

Ozone is an allotropic and an unstable form of the element oxygen. It oxidizes the same substances as does oxygen, but more vigorously. It rusts silver to black silver peroxide, Ag_2O_2

$$2Ag+2O_3 \longrightarrow Ag_2O_2+2O_2$$

If ozone is allowed to bubble thru a dilute solution of indigo carmine, a yellow substance of much paler tint known as *isotin* is formed:

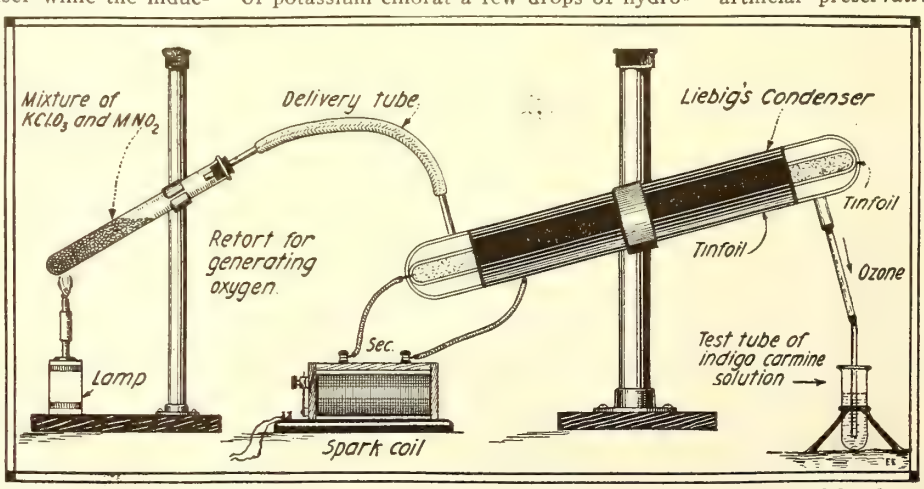
$$C_{16}H_{10}N_2O_2+2O_3 \longrightarrow 2C_8H_5NO_2+2O_2$$
$$\text{Indigo+ozone} \longrightarrow \text{isotin+oxygen}$$

If a bottle or empty test tube be substituted for the one shown in the drawing, ozone may be collected mixed with oxygen, and various other properties of the gas may be observed.

Ozone is used in some cities, as Paris, Florence and Petrograd, for purification of water. It is used commercially for bleaching purposes.

Ozone oxidizes sulfur dioxide to sulfur trioxide and sulfurous acid to sulfuric acid, as shown:

(1) $SO_2+O_3 \longrightarrow SO_3+O_2$
(2) $H_2SO_3+O_3 \longrightarrow H_2SO_4+O_2$



A Simple Apparatus to Produce a Silent Discharge of Ozone, Easily Constructed by Any Experimenter Who Wants to Study This Interesting Gas.

EXTEMPORIZED FRACTIONAL WEIGHTS.

Weights of small denomination—grains, and fractional parts of a grain or gramme—are generally too small to be conveniently handled, unless one uses a pair of forceps. The writer has found it convenient to make a fresh set of small weights from copper wire of small gauge. It is only necessary to find the exact length of wire required to balance a given weight, when a simple calculation will show the length needed to make weights of any required size. After cutting off the correct lengths for weights of 2, 3, 4, or 5 grains, the wire may be bent into a helix or cylindrical form, the number of turns serving to indicate the number of multiples of a grain. Similarly, a one-grain weight may be made in the form of a ring, while the fractions may be gridiron-shaped, each prong representing one-tenth of a grain.

Contributed by H. G. GRAY.

SYMPATHETIC INKS.

Euchlorin: Add to two or three crystals of potassium chlorat a few drops of hydrochloric acid and heat a moment. When the tube fills with gas add water and shake. This when used as ink and the writing heated will turn a golden yellow. Euchlorine can also be used as a test for iodin—proceed as follows: Make a solution of element to be tested and add some starch and a few drops of euchlorin; the blue color shows the test.

Sympathetic Inks: 1. Make a mixture of 1 part hydrogen peroxid, 1 part euchlorin, and 1 part Barium chlorid solution; when heated, the writing will turn black.

2. Write on a piece of paper with some undilute sulfuric acid and while the writing is wet, heat it in a flame, but do not let the paper get on fire, and the writing will appear in lines like engraving.

Cont. by STEVENS SANDERSON.

SOLDERS FOR ALUMINUM.

The use, serviceability, method of application, and composition of solders for aluminum are discussed in the light of special tests made at the Bureau of Standards on commercial and other compositions of solders. All soldered joints are subject to rapid corrosion and disintegration and are not recommended except where protection from corrosion is provided. Suitable compositions for solders are obtained by the use of tin with the addition of zinc or both zinc and aluminum within wide percentage limits. Solders are best applied without a flux. The higher the temperature at which the "tinning" is done, the better the adhesion of the tinned layer. A perfect union between solder and aluminum is very difficult to obtain, but the joint between previously tinned surfaces may be made by ordinary methods and with ordinary soft solder. Only the tinning mixture need be special. Tables of the composition of many solders are given.—Bur. Stand. Circular No. 78, 1919,

CHEMICAL TESTS OF MILK.

Artificial Preservatives in Milk—Put about 10 c.c. of milk in a beaker and add about 10 c.c. of concentrated Hydrochloric Acid in which a few grains of Iron Chlorid have been dissolved. Heat gently, and stir constantly. If the milk contains some artificial preservative (in this case, Formaldehyd), a purplish color will result.

Fat in Milk—Dip a piece of filter paper in some milk and carefuly dry, allowing no dust to come in contact with it. After it has thoroly dried, soak it in Carbon Di-Sulfid until all the residue is dissolved in it. Pour the liquid onto a watch-glass and carefully evaporate over a water bath. The substance remaining in the watch-glass is the fat.

Contributed by IRVING SIMPSON.

To Render Lamp Wicks "Everlasting" and to prevent smoking steep in a concentrated aqueous solution of tungstate of soda; dry thoroughly in an oven.

RADIO DEPARTMENT

The Submarine's Under-Water Radio

AN American hydroplane, 2,000 feet up, talked recently with a submerged submarine at Fisher's Island, six miles from New London Harbor, off New London, Conn. The conversation from both plane and submarine was listened to by a party of 250 engineers, members of the Edison Society of Electrical Engineers.

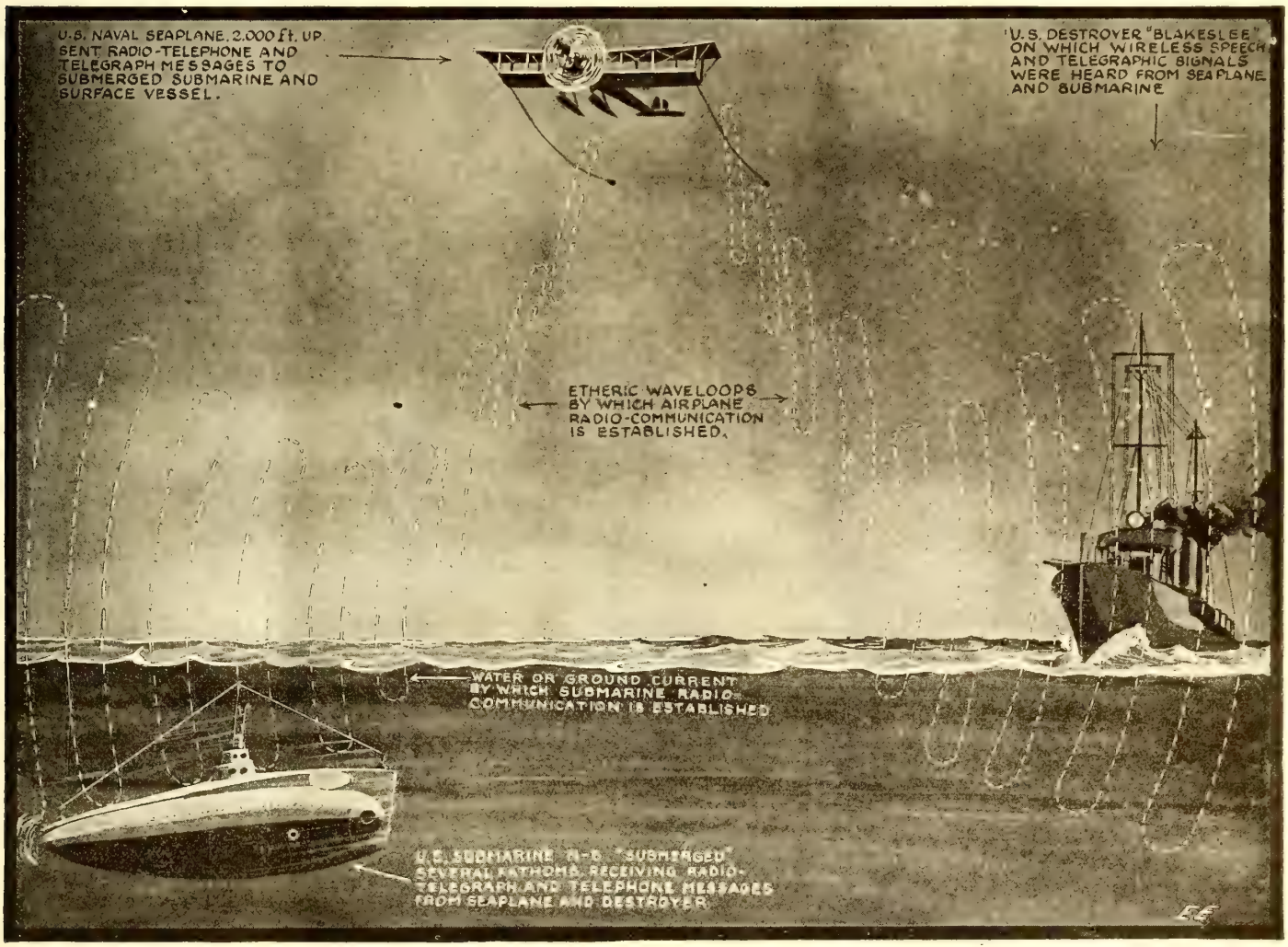
As guests of Captain J. R. De Frees, commander of the experimental station, about one hundred of the engineers boarded the destroyer U. S. S. *Blakeslee*, while others boarded a subchaser. The submarine N-6 dived several fathoms, and the water craft established both wireless and wireless telephone communication with her. At the same time a hydroplane established radio communication with the surface craft and with the submarine. The conversations were plainly heard by the engineers aboard the surface craft.

The system of radio communication thru both air and water was worked out at the local station, and will be made a part of the regular naval equipment when final tests are made. *The system enables an airplane, which can see submerged submarines, to direct a friendly submarine to the accurate firing of a torpedo at the enemy submersible.*

The airplane carries on radio-communication by means of an antenna wire, or wires, trailing down from the wing tips or else from the fuselage. These wires have weights at their lower ends, and are generally arranged to be quickly reeled in or out as desired. The aerial on submarine destroyers comprises several wires supported between the two masts.

Considerable experimental work has been carried on in the past year with submarine radio, and the tests between the airplane and the submerged submarine marked the culmination of a series of important researches in this direction by the government. The experiments have shown that communication at sea can be carried on under all conditions, more efficiently with an insulated closed loop than with an ordinary antenna now in general use. The loop is of simple construction, requires no mast and therefore does not interfere with submergence. Under storm conditions or during a submergence where the ordinary antenna is useless, communication by means of the closed loop is perfectly practicable. Details and results of the official tests were given in full detail in the *October* issue.

The design and specification of the submarine closed loop antenna are given below:



Copyright, 1919, by E. P. Co.

Recently a Remarkable Radio Test was Conducted by the U. S. Navy. A Submerged Undersea Boat Succeeded in Transmitting and Receiving Wireless Signals to and from an Airplane Flying Overhead. The Paths of the Traveling Ether Wave Loops are Indicated by the White Dotted Lines.

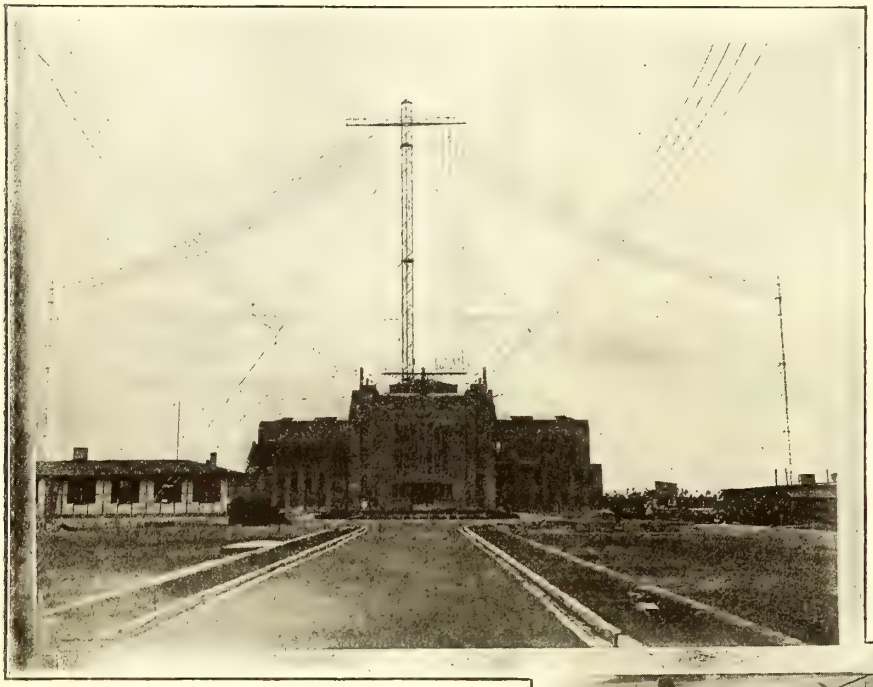
DETAILS OF SUBMARINE LOOP ANTENNAE.

The loop antenna consists of two insulated wires *grounded* at the extreme ends of hull carried over suitable supports to the bridges, and thence thru radio lead-ins to the apparatus.

(Continued on page 707)

Nauen Radio Opened Again

THE powerful German radio telegraph station located at Nauen, Germany, and from which during the war, thousands of messages were sent broadcast, both of an official military nature, and also in the form of propaganda to the outside world, is shown in the accompanying photographs.



The main building is of special brick as may be perceived in the photograph, and is quite an imposing structure. It is of typically German architecture and quite severe in some of its details,—in fact, in some ways it looks more like a fortress of mediaeval style than it does a modern wireless power station. These photographs are

The Vossische Zeitung, Quoting Official Sources, Recently Gave Details of the Arrangements of Wireless Communication Between Germany and America. The Newspaper Says Efforts Will Be Made to Induce the United States to Release Other Wireless Stations Than That at Belmar, N. J., for Service with Nauen. The Imperial Post Ministry Has Established a Special Department to Solve This and Other Wireless Problems Under Herr Bredow as Director. He Will Attempt to Make the Wireless Cheaper Than Cable Communication.

very interesting indeed to us, as they are the first to be taken of the Nauen wireless plant since the declaration of war by Germany in 1914. Visitors to this great radio plant, one of the most powerful in the world, even at the present day, will hardly recognize the grounds or the antenna system, as many changes were made by the ex-Kaiser's radio experts during the war. These changes were made from time to time as new improvements and greater ranges were necessitated by the exigencies of military operations. The Nauen station has a large number of the latest style masts stretching out for a great distance on all sides, from the tops of which there extend vast aerial wire net-works which are connected with the radio station building. Some of the steel masts tower 600 feet into the air, while other masts measure 400 feet in height. These latest style towers rest on massive glass insulators at their feet, and they are guyed in position by one-inch stranded steel cables which are broken up into short sections, by means of large strain insulators, so as not to permit a loss of energy either in receiving or transmitting, due to these different lengths of guy wires being in tune with the fundamental wave length used, or possibly upper or lower harmonics of the fundamental wave.

One of the accompanying photographs shows a very interesting view of the interior of one of the transmitting apparatus rooms of the Nauen Station. As will be noted, the station building which was erected before the war is quite ornate and somewhat resembles the interior of American radio and central stations. The ceiling is covered with glass panels thru which light is transmitted as well as thru the windows from the side walls.

Several motor generator sets, as well as tuning helices and high tension step-up transformers, are shown on the main floor of this room. The floor as well as the side walls are of colored tile, which is a very attractive and sanitary finish for the interior of such a building. The Nauen radio station has employed from time to time different transmitting apparatus, including arcs, quenched gaps and high frequency alternators. At one time the Nauen plant was reported to be using a 200 kilowatt Goldschmidt alternator.

GREAT GERMAN WIRELESS STATION RESUMES COMMUNICATION WITH AMERICA—The Great Wireless Station at Nauen, Germany, the Largest and Most Powerful in the World, Has Resumed Uncensored Radio-communication with American Stations. The Photo at Left Shows a Part of the Gigantic Aerial Wire System Erected During the War at the German Station. The Photo Below Shows the Interior of the Generating Plant of the Nauen Station, Rated at 600 Kilowatts.

The receiving apparatus used at this station is provided with recording as well as very efficient amplifying intsruments, and messages from all parts of the world are daily received and recorded at this station. The amplifiers now in use, and also those employed during the greater part of the war, utilized vacuum tubes similar to the

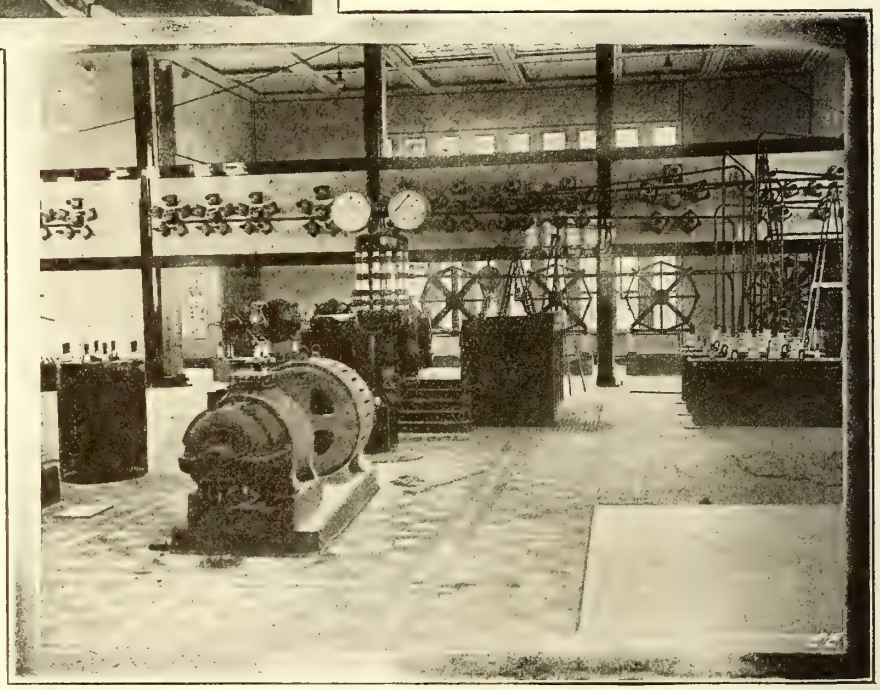


Photo Copyrighted by International Film Service.

De Forest audion, but the electrodes of which are coated with metallic oxides so as to give a very powerful electronic emission when heated. These bulbs were devised by Lieben and Riez, and are claimed to have a very high amplification factor,—in fact, superior to any other vacuum bulb amplifier in the world. But this hardly seems to be the case from the evidence which we have heard against it from time to time, gained from radio experts and officers who have become familiar with the German form of tube. Many of these tubes

(Continued on page 707)

The New Kolster Decremeter and Wave Meter

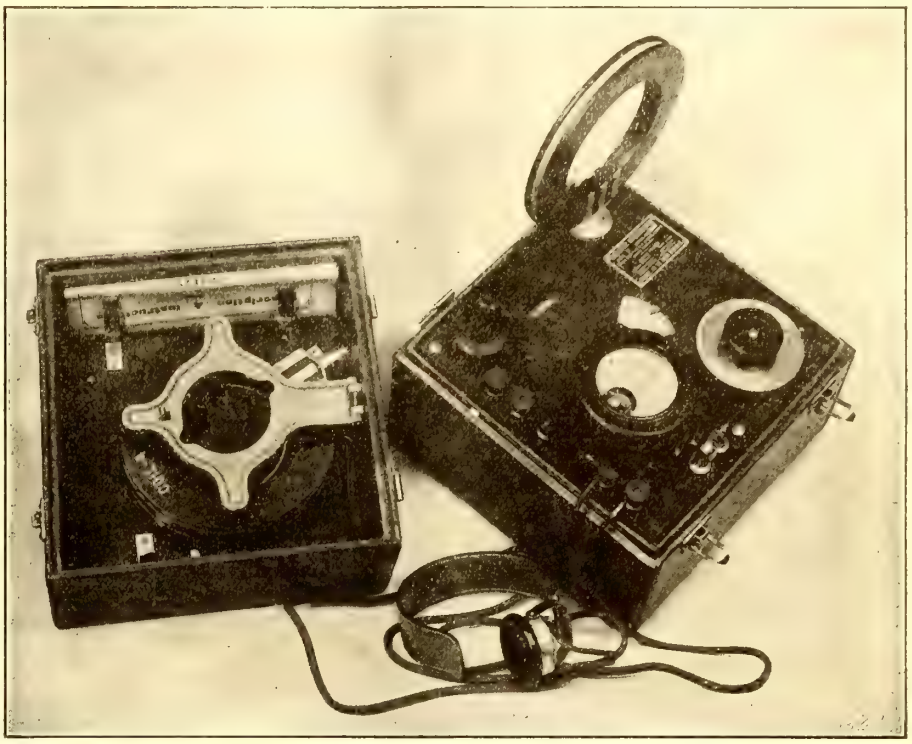
THIS instrument was designed for the purpose of facilitating the measurement of wave length and logarithmic decrement of radio circuits. It is portable and of rugged construction and may be used for field work as well as for laboratory purposes. The instrument is essentially a wave meter consisting of a variable condenser, four inductance coils and a sensitive hot wire indicating device, the readings of which are proportional to the square of the current passing thru it. A crystal detector and head telephone are provided and wave-length measurements may be made either with the crystal and telephone receivers or with the hot wire instrument. A buzzer is attached to the instrument in order that it may be used as a transmitter for calibrating purposes.

The inductance coils are connected in the circuit by placing them in the holder near the back of the instrument. The condenser may be varied by turning the knob, on the right-hand side of the instrument, care being taken to see that the lock on the opposite side of the case is released. The condenser scale, reading from 0 to 180 degrees, appears in a depression near the back.

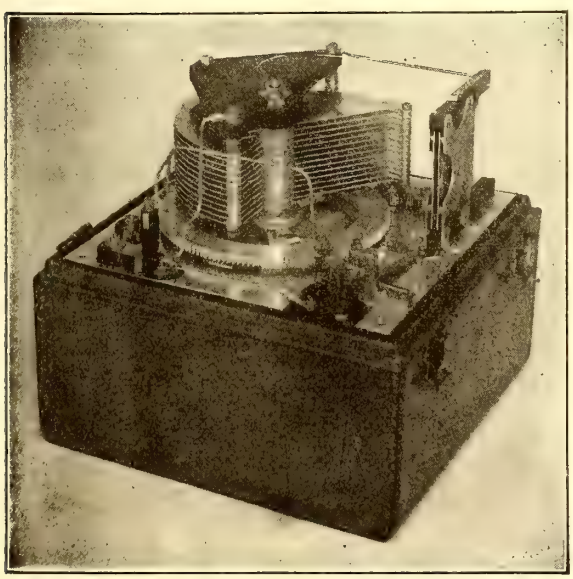
For the measurement of wave length, four scales are provided. The scale which is to be used with a given coil is indicated by a pointer which operates automatically by the insertion of the coil in position.

Beneath the condenser knob is a scale which is marked off to the right and to the left of the zero line from 0 to 0.30. These scale divisions represent the sum of the logarithmic decrement of the transmitter and of the decremeter, $\delta_1 + \delta_2$, δ_1 being the decrement of the transmitter under test and δ_2 the decrement of the instrument. δ_2 is given for each of the inductance coils for various settings of the variable condenser.

There is an index mark 0, which is movable about the knob and which may be rotated until it is in line with the zero on the scale. The hot wire instrument is connected in the circuit by placing it so that its lugs fit into the lugs on the top of the instrument. When the hot wire instrument is removed, its terminals are short circuited so that the wave meter may be used with the buzzer or crystal detector. Extending above the glass of the hot wire instrument is a small screw for adjusting the zero of the instrument.



Lower Case and Cover of New Direct Reading Kolster Decremeter and Wave Meter. The Four Inductance Coils Are Retained in the Lid by a Special Clamp as Shown.



View of Variable Condenser, and Other Parts of New Kolster Decremeter and Wave Meter Obtained by Turning the Lid of Cabinet Upside Down.

Measuring Wave Length.

In making wave-length measurements the instrument should be placed as far away from the coils of the transmitter as practicable, beginning with a minimum coupling, between the wave meter and transmitter, as the hot wire instrument is sensitive and will burn out if too much current is past thru it. When making wave-length measurements, it is not necessary to get full deflection of the hot wire instrument needle and it is best to use as small coupling between the antenna circuit and wave meter as possible.

The wave meter is in resonance with the transmitter when the deflection of the hot wire instrument is a maximum, as indicated by the fact that the deflection becomes less when the condenser is turned in either direction from this position. The wave length is then indicated by the pointer on the wave-length scale.

More accurate measurements of wave length may be made by observing the reading on the condenser when the instrument indicates resonance. The wave length may then be determined by referring to the calibration curves which accompany each instrument.

Separate calibration of the instrument when it is used with the crystal detector and with the buzzer are furnished.

When the instrument is used with the crystal detector, the telephone receiver should be connected to the binding posts so designated and the hot wire instrument and buzzer battery removed. The condenser scale should be observed and reference made to the calibration curve.

Measurements of Logarithmic Decrement.

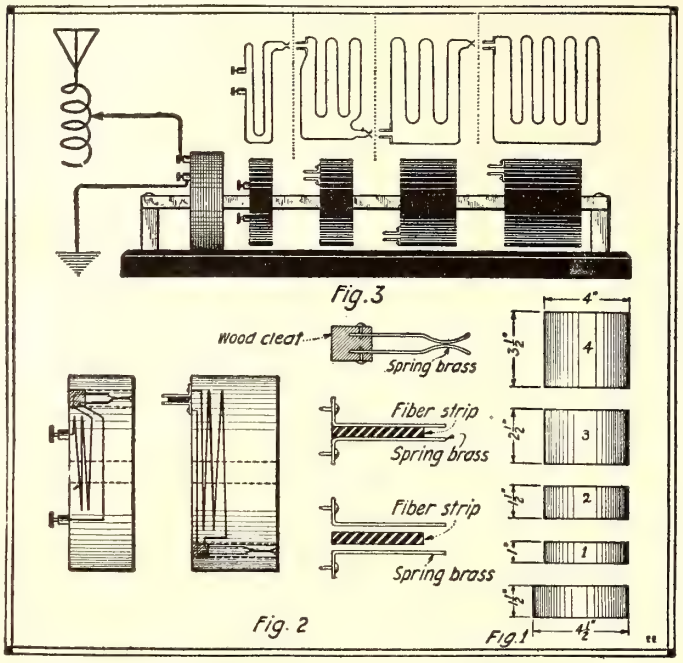
The well-known Bjerknes method of obtaining the *logarithmic decrement is used.* The task of making experimental observations and the necessary calculations required by the Bjerknes formula is, however, eliminated by the use of this instrument. The sum of the decrements, $\delta_1 + \delta_2$, is read directly from the scale under the condenser knob after proceeding as follows:

1. Before connecting the hot wire instrument to the decremeter set the needle to zero by means of the adjusting screw.
2. See that the detector point is not in contact with the crystal and that the buzzer battery is removed.
3. With very little coupling between the wave meter and the transmitter, adjust the variable condenser until a maximum deflection of the hot wire instrument is obtained.
4. Increase the coupling until the deflection of the hot wire meter is somewhat more than half of the scale, if this is possible without making the coupling too tight. In case the current in the transmitter is small the deflection used must also be small, otherwise inaccurate results will be obtained.
5. Carefully turn the condenser handle in either direction until the needle of the hot wire instrument drops to one-half of the maximum deflection.
6. Rotate the movable index mark around the scale surrounding the condenser handle until the two zero marks are exactly in line, taking care not to change the position of the handle.
7. Carefully turn the handle back until the needle of the hot wire instrument makes a complete excursion from half deflection thru the maximum and back again to half deflection. The reading on the scale now opposite the indext mark O, will be $\delta_1 + \delta_2$, or the decrement of the transmitter plus the decrement of the instrument.

Improving the Amateur Receiving Set

By EDWARD T. JONES

IN ordinary Amateur Radio receiving sets constructed by themselves the coupling coils which connect the detector and antenna circuits are a great source of loss of power, due to poor design and faulty construction principally. For these reasons I take great pleasure in laying before the everyday experimenter plans and specifications of a receiving set which will undoubtedly mark the line of *Efficiency* thruout its circuits and operation. A few words as to the reasons for such results will not be amiss. Absolutely no sliding contacts should be used, owing to the fact that they are of high resistance, gather dirt, and the filings produced by the sliding process lodge in between turns and short-circuit them. Taps should not be taken off the coils for the purpose of varying the inductance; this produces "dead-end" losses and results in a considerable weakening of the incoming signal. The coils should be wound on separate tubes or spools, as shown in the diagrams. Arrangements are made to connect the coils together when more inductance is necessary, and all windings are of stranded wire (Litzendraht) to minimize the high-frequency resistance.



New Sectional Loose-Coupler for Amateur Work. PRIMARY: Form —4½" diameter, 1½" wide, 1" winding, Turns 30, Feet 35, Six Strands No. 36 S.C.C. SECONDARY WOUND WITH 3 STRANDS OF No. 36 S.C.C. CORE DIMENSIONS—No. 1: 4" x 1"; No. 2: 4" x 1½"; No. 3: 4" x 2½" and No. 4: 4" x 3½". Winding Space—½"; 1"; 2" and 3", respectively.

THE LOOSE COUPLER.

Litzendraht was produced for the primary and secondary in the following manner: Three strands of No. 36 were twisted together for the secondary windings, and six strands of No. 36 for the primary winding. The primary consists of only thirty turns and arrangements are provided in the elementary circuit for cutting in either the loading coils or the variable condenser in series with the same, each at a time, in order to make it possible to increase or decrease the wave length beyond that of the tuner primary itself.

The wooden cores shown in Fig. 1 are the forms upon which the windings are placed, and in the same figure are shown means of connecting them together when necessary.

THE DETECTOR.

The detector is a great energy-consuming and generally a energy-wasting device of the receiving circuit, and can hardly be avoided. Of course if the audion is to be used in place of the crystal rectifiers conditions are greatly changed and amplification instead of loss of received energy is the result. Crystals vary immensely in resistance, but in order to obtain as little loss as possible, low resistance crystals should be used, providing, however, their rectifying qualities are good. Owing to the fact that measurements taken on the Wheatstone bridge will not show anything, because the high-frequency resistance will differ greatly when the crystal is under operation, the only thing to do is to get an assortment of different crystals and try them until a good one is obtained. The crystals should be fastened in the cup with copper-mercury amalgam, and all posts supporting either the cup or point should be strong and firmly held to the base so that when a good adjustment is arrived at there will be little chance of losing energy thru faulty connections.

CONDENSERS.

In the receiving set we have very low voltages, and for this reason our condensers are generally quite efficient. Nevertheless, a few hints as to its operation may be of value. The condensers should be dust and moisture proof to protect them from *short-circuits* and *leaks*. They should be kept away from tuning inductances to avoid losses by induction. The dielectrics used should preferably be those having little hysteresis loss, as in some dielectrics this loss does not depend on the stress under which the dielectric is placed, but is always constant and a source of loss.

In November "Radio Amateur News"

The Hanson Audio-Frequency Wireless Telephone.
By Edgar Terrain Johnstone
Developing Audions for the Amateurs.
By E. T. Jones
Notes on Crystal Detectors.
By C. H. Biron
Destruction of the Goldsmith Station at Laiken, Belgium.
By M. Gallaix—An eye-witness.
Receiving Cabinet of Latest Design.
By Palmer H. Craig
The Third Pill.
By J. K. Henney
San Diego California from London.
By M. Hall
Your First.
By C. H. Pfeiffer
Increasing the Secondary Voltage of Your Transformer.
By F. E. Terman
An Ideal Receiving Set—Second Prize.
By A. C. Burroway
Amateur Ethics.
By Ensign Pierre H. Boucheron
Improved Types of "B" Batteries.
By J. H. Reed

TELEPHONE RECEIVERS USED IN RADIO.

The factors of efficiency in receiver telephones are chiefly the following: The diafram should be placed as close as possible to the pole pieces to keep magnetic leakage low; however, space for variation should be provided. It should be as light as is consistent with sturdy construction. Heavy enamel should not be used for painting, owing to its increased weight without increased efficiency. The magnetic field in a receiver is quite weak, and the lighter a diafram is the greater will be the amplitude of its vibration, consequently the louder the tone. Also, the smaller the diameter of the diafram the easier will it move. Every article possesses a natural period of vibration, i.e., the number of times per second an object will vibrate if struck a blow. From the foregoing it will be easy to see that if a force acts upon it which strikes in the same number of times per second as is the natural period of the object (diafram in this case), it will vibrate to a much greater extent than if the period of the force were something else. Since a diafram vibrates in response to an external force (the pulsating magnetic field in the 'phone proper), if the natural period of the diafram is the same as that of the magnetic field, the resulting amplitude of vibration will be much greater than it ordinarily would be.

For instance, if we are receiving a message which is sent on a 500-cycle spark set, which gives a tone of 1,000 sparks per second, and the diafram of the receiver has a natural (vibrating period) of about 1,000 per second, the result will be a much louder note in the 'phones than would result from using a different diafram or one having, say, a vibrating period of 600 or 800.

The sensitivity of a receiver is the smallest current which will give an audible response when past thru it. A good, practical test for this is to tap the two telephone cord tips lightly on the end of the tongue; if they are what is termed *sensitive* they will produce a click in the 'phones, thus detecting a very slight amount of current generated by placing the two tips in saliva. The usual method of testing 'phones for their sensitiveness is to connect a buzzer to the primary of your loose coupler and the receivers to the secondary, making note of the distance which the two coils were separated when practically no signal was audible. The sensitiveness of two different receivers may be measured by the above mentioned method. The receiver which permits the greatest amount of coupling between the two coils is the *more sensitive one.*

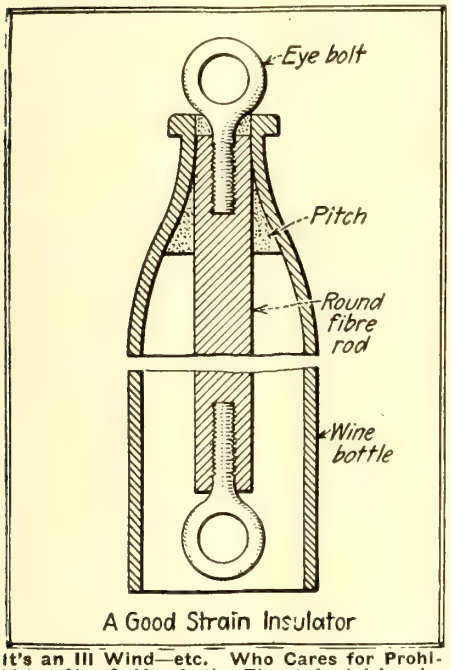
CONNECTIONS.

All connections should be stranded wire and well soldered. All switch contacts should be good, especially in button switches, and kept free from oxid and dust. No steel or iron should be permitted in any part of the set (not even steel screws) to avoid hysteresis losses.

A GOOD STRAIN INSULATOR

This strain insulator is cheap and efficient and easily constructed. Its efficiency is due to the glass petticoat keeping the insulator free from rain and snow. The insulator is a fiber rod ¾ inch in diameter and about 7 inches long, one end of which is turned to a taper to fit in the neck of a wine bottle which are usually long and slender. The bottle having been cut off near the bottom by tying a string around the bottle where the cut is desired, saturating the string with alcohol, igniting, and when flame is extinguished plunging in cold water. Each end of rod is drilled deep and tapt to take a ¼"-20 thread eye-bolt. The eye-bolt used in the tapered end is a little longer than the other, and is screwed in so that the eye just touches the neck of bottle. This holds the bottle in position. Pitch is poured in the space around eye-bolt and also around the fiber rod on the inside of bottle, to make it water-tight and more rigid.

Contributed by J. A. WEVER.



It's an Ill Wind—etc. Who Cares for Prohibition Now? Here's the Finest Aerial Insulator Ever—and It Has a Rain-Shedding Petticoat Made from a Once Proud Claret Bottle.

THE THERMO-COUPLE RADIO AMMETER.

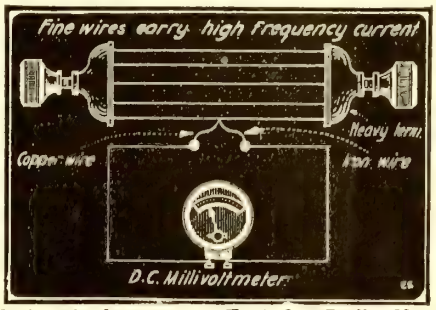
A very important commercialization of an old principle is made in the new thermo-couple ammeter for measuring high frequency currents, such as are met with in wireless work. Its superiority over the old hot-wire instrument is so great that it admits of no comparison.

The indicator used may be any high-grade moving coil-permanent magnet type of meter operating on the D'Arsonval principle, but it must be very carefully designed, for it must give full scale deflection on about 10 millivolts.

The "couple" consists of a straight wire of high resistance, preferably *nichrome*, connected to suitable terminals, and forms the path of the high-frequency current. Welded to the center of the wire and to each other are two fine wires, an iron and a copper, which are connected with their free ends to the meter circuit.

As the current passes, it heats the wire, and consequently the couple. The heat causes the couple to deliver a small direct current voltage, which is proportional to the effective value of the high-frequency current, which deflects the pointer. Consequently the scale may be marked to read in "amperes."

Up to about 10 amperes the resistance strip and couple may be placed inside of the instrument case, forming a self-contained meter, but higher currents are best measured by making the heating or resistance strip in the form of an external shunt. The terminals are of heavy copper, the same as a regular direct-current shunt, but



A Handy Instrument Fact for Radio Men. High Frequency Currents Are Measured by the D. C. Millivoltmeter Connected to a Copper-Iron Thermo-Couple as Shown.

instead of a single heavy conductor several fine wires are stretched between the terminal lugs so that each wire presents the same inductance and "skin effect" to the high-frequency current, thus insuring even division of current and enables the "couple" to be placed on one wire only, which is essential to the quick heating and cooling necessary to make the meter indication follow the changes in current.

The shunts may be made interchangeable to measure various current strengths with the same meter, and are connected to the meter with flexible leads, exactly the same as an ordinary direct-current meter. The accompanying sketch shows how the meter, heater and couple are arranged.

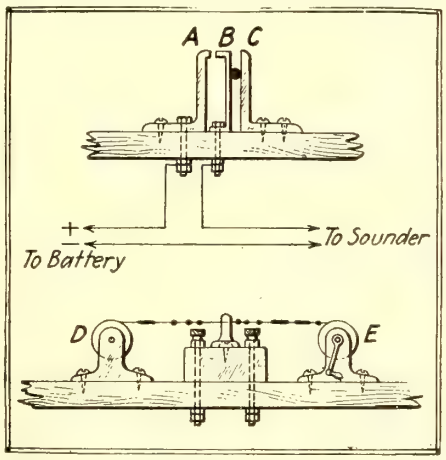
Contributed by VICTOR H. TODD.

CODE TEACHER MADE OF KNOTTED STRING.

A simple yet effective device for learning the telegraph code may be made in the following manner:

Screw two pieces of brass or other metal (A and C) to a block, allowing one screw in A to project thru the block. B is a thin piece of spring metal, fastened to the block with a screw that projects thru the block. Wires from the sounder and battery are attached to the long screws holding A and B. Small reels D and E are mounted on the block.

Take an ordinary white cord and tie knots in it, using a single knot for a dot and four knots close together for a dash. The alphabet or messages may be made in



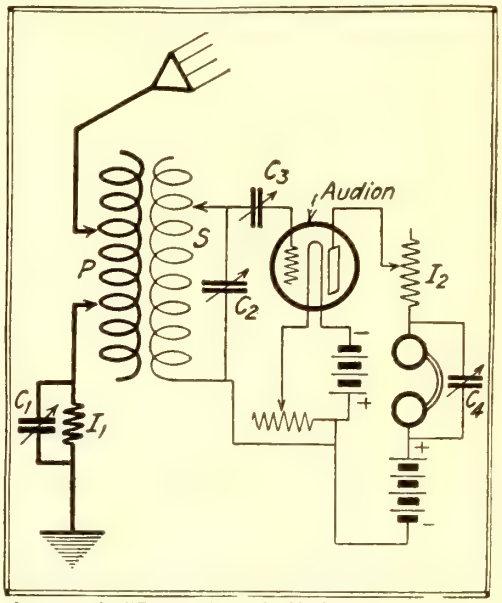
Simple? Well We Should Say So. A Code-Teaching Instrument Comprising a Knotted Cord Drawn Between Contact Making Members.

this way: Roll the string on reel D and fasten the loose end to reel E. Place the string between the B and C contacts and turn reel E. When a small knot passes between B and C, a brief contact is made between springs A and B, closing the circuit and causing the sounder to make a dot. When a group of knots passes the contact remains longer and causes the sounder to make a dash. The reel may be turned at any speed to suit the learner.

Contributed by ALTON D. SPENCER

DAMPED AND UNDAMPED AUDION HOOK-UP.

Since the ban upon radio reception has been lifted I have done a great deal of experimenting with undamped wave reception. I do not know whether this has ever been developed before or not, but for the sake of those that have not seen it before, I would like to make the following suggestion in regard to undamped wave reception. I have never received any results with the Ultraudion, Chambers or any other hook-up as I have always been troubled with the flexibility of the tones, not being able to "hold" a tone that was readable. I am now using this book-up for both damped as well as undamped wave reception, and it



Improved "Damped and Undamped" Audion Hook-Up for Radio Receiving.

is giving me fine results.

PS is the loose coupler.

I1 is a fixt inductance, 3" diam. 56 turns No. 22 S.C.C.

C1 is a variable condenser		.001 mfd.
C2	"	.001
C3	"	.0005
C4	"	.001

I2 is a tuning coil 3" diam. 30" long, No 22 enameled wire; the inductance is varied with a slider which gives minute adjustment. I2 makes the audion oscillate while C1 and C4 change the tone of spark signals. The sizes need not be followed exactly, but if the general scheme is followed I am sure the operator will be delighted with the results. For any further information, write me, fellow "Radio-Bugs."

Contributed by E. GARRATT ARNOLD.

OPERATING AUDIONS ON A.C. 110 VOLTS.

Radio operators, both commercial and amateur, will do well to read the fine article on operating audions on A.C. circuits, prepared by Elliot A. White, former instructor in Radio, Air Service School for Radio Mechanics, Carnegie Institute of Technology, in the July, 1919, issue. The day of expensive high voltage "B" batteries, and the still more troublesome storage cells required for the filament current, is rapidly passing. The efficiency is too low. Better to operate audions from a D.C. or A.C. 110 or 220-volt circuit, even if you have to drive a small dynamo from a water wheel

A Loose-Coupler Wrinkle

By Thomas Reed

THE freedom of wireless is here—its in the air (where it belongs), and the inmates of the "Radio - Bughouse" are beginning to rave of novelties in loose-couplers, just as the girls, on the approach of Easter, begin to study the fashion magazines and plan yet more bewildering styles.

The loose-coupler is such an efficient and willing little worker that it seems like "painting the lily," as Shakespeare says, to think of bettering it. It's only because we love it so much that we try to improve it still further—as Father used to say when he unrolled the trunk-strap and beckoned toward the shed.

Here's a wrinkle. If it's new, the "Ed." will publish it, and perhaps it'll become the fashion, like last Spring's tight skirts. Who knows?

As we make bigger and bigger couplers to deal with the longer waves, we seem to need some smoother and easier means of moving the coils than the present slide-rods provide. Well, why not make your secondary coil the stationary element, instead of the primary, and move your primary instead? It's the relative position of one to the other that counts, not the moving of either one especially.

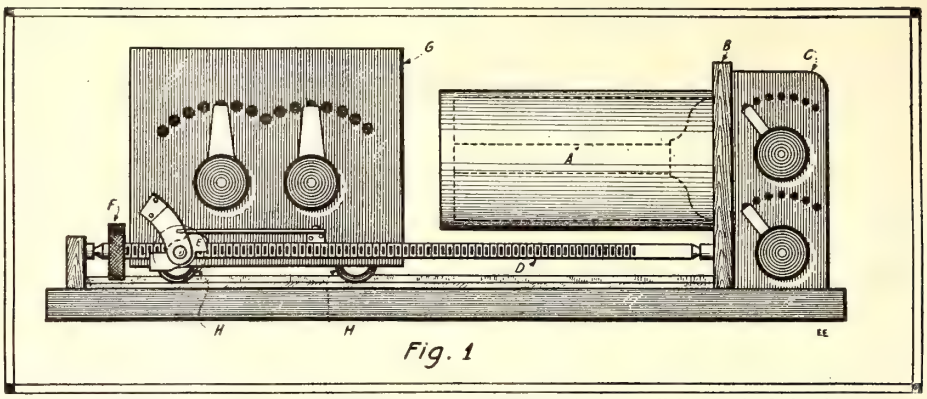


Fig. 1

Why Not Make an Innovation—Slide the Loose-Coupler "Primary" Instead of the Secondary. Sure! Why Not?

But the primary is heavier and more awkward to move than the secondary, isn't it? Yes and no. If you move the primary, you can mount it—coil, box, switches and all—on four grooved wheels, and let it run back and forth on a track, like a typewriter carriage. There's no reciprocating movement easier and more accurate than that, is there? No, he says, reluctantly but with conviction.

Fig. 1 shows a fixt secondary, mounted on a big stiff wooden dowel A, and this in turn on a stout backboard B, braced by the switchboard C. No wobble or sag to that secondary. There is also shown the primary G, running back and forth on the wheel H H. No wobble to that, either, so you can have a pretty *close fit* between your two coils.

But you want a fine adjustment, too? All right, what's more satisfactory than the feed-screw of a lathe? Rig up a miniature feed-screw D (must be brass) with a split nut like E to grip it or not, as you determine. (E has a knurled head attached, not shown in the figure, as it would obscure the clear view of the nut.)

Now you can roll your primary on its wheels into nearly the right position, turn the nut E till it bites the feed-screw, then roll the knurled wheel F back and forth, varying the coupling with extreme *precision*. Or in an instant you can disengage the nut, and without removing your hand, push the primary back and forth with a wide sweep, as you pursue some new and fleeting signal.

Fig. 2 (A, B, C, etc.) shows the action of the feed-nut, and the successive stages of forming it from a block of brass; not too much work, when you once get at it.

What do you think of the idea? As Nora Bayes used to say, "Will we kill it, or leave it live?"

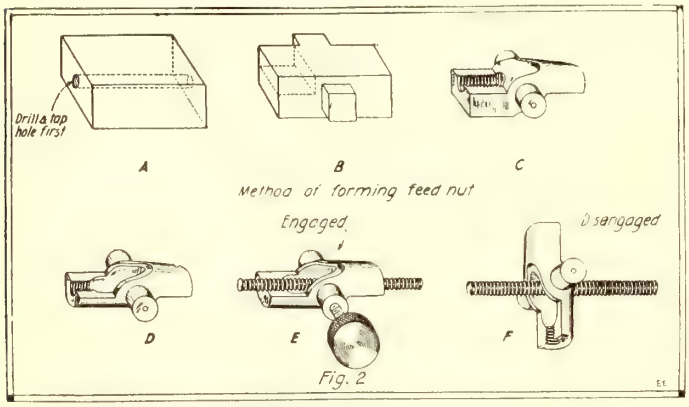
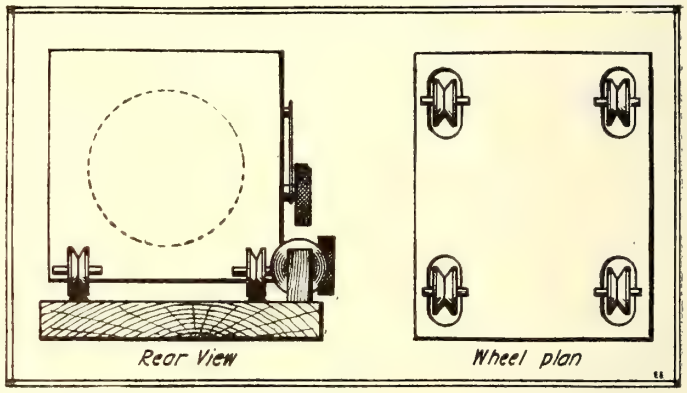


Fig. 2

Clever Disengaging Primary "Slide" Control.



How the "Primary" Is Mounted on Small Wheels and Tracks.

High Tension Condenser Switch

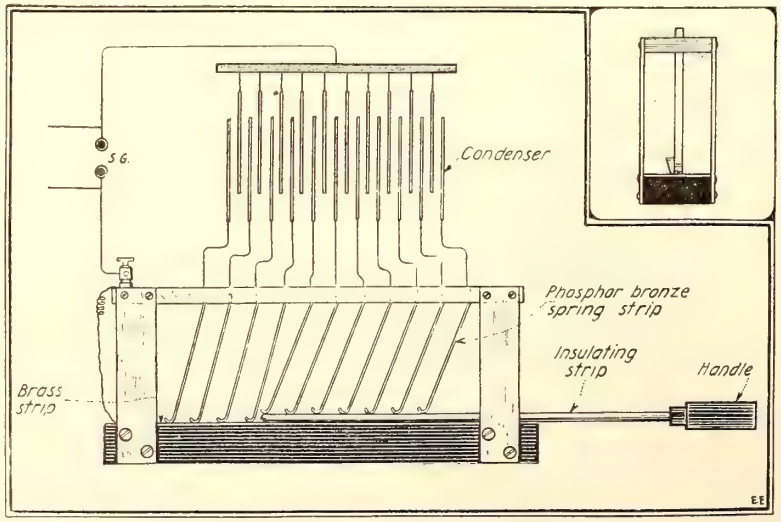
The following little arrangement will provide a means of connecting a (FIXT-VARIABLE) high tension condenser in the manner practiced in the various types of commercial devices.

Phosphor bronze or spring brass strips are mounted so as to rest tightly on the brass strip on the base; a thin strip of fiber or other (insulating) material has a handle and is forced between the spring contacts and the brass strip, thus serving as a means of increasing or decreasing (connecting or disconnecting) the plates of the condenser.

This switch can be used to connect batteries in parallel as well as any other apparatus. It furnishes a simple and efficient type of switch, which is well in the reach of the everyday experimenter, and the readers of the wireless fraternity will appreciate this timely article, where such switches can be advantageously employed to connect the condensers used in audion control panels, et cetera. The type of switch employed by commercial concerns to fulfill this purpose is beyond the average amateur's skill, while the switch described will prove an easy instrument to construct and will at the same time perform its duty efficiently. I have used them successfully in the radio laboratory.

Contributed by

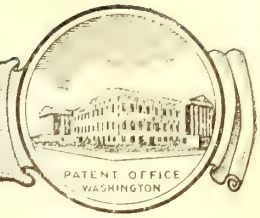
E. T. JONES.



A High Tension Condenser Switch That "Works"!



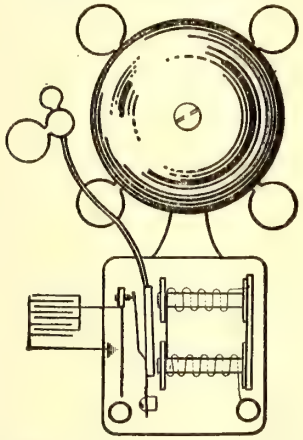
LATEST PATENTS



Variable Tone Bell.

(No. 1,312,610; issued to P. E. Chapman and R. H. Robinson.)

A method of building bells such that the tone of the device can be

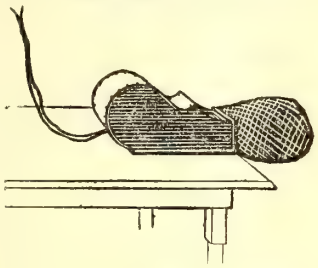


altered at will. The gong may be cast or else punched with several projections as here illustrated, one or more of which can be cut off as desired to give a different tone. The striking hammer is provided with several projections also, so that the degree of "loading" on the hammer can be changed, thus altering the rapidity of the beats.

Suction Fly-Catcher.

(No. 1,313,203; issued to Harry Pakeman.)

A suction type of flycatcher intended to be driven by an electric motor or other means, and providing a scheme whereby a swiftly moving air current is created by a fan, which current of air is so di-

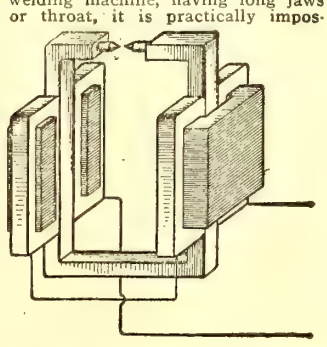


rected as to cause the entrapment of flies in such a way that they cannot escape. The flies are caught in a removable basket, which can be detached and emptied at any time. A bait holder is provided in which molasses, honey, sugar water, etc., or other similar fly bait may be disposed to attract toward the suction distributor millions and millions of the ever-pestiferous fly.

Electric Welding Machine.

(No. 1,312,845; issued to James H. Gravell.)

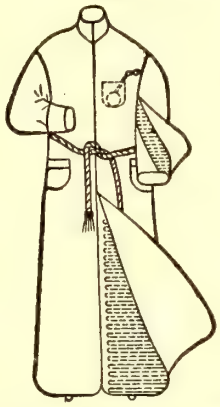
In the ordinary type of electric welding machine, having long jaws or throat, it is practically impos-



sible to secure a satisfactory weld at any great distance in from the edge of the work, owing to the fact the current, flowing in the arms of the machine, tends to produce a magnetic field in the work and space between the arms, which opposes the flow of the heating current. This reduces the efficiency of the welder. In the present design the inventor provides a special primary magnetic winding on an open core frame, which produces a magnetic field between the arms. This sets up a counter-current in the arms, which offsets the self-induction or bucking currents, and this permits the arms of the welder being extended for any length desired.

Electrically Heated Garment.

(No. 1,312,830; issued to Charles E. Camm.)

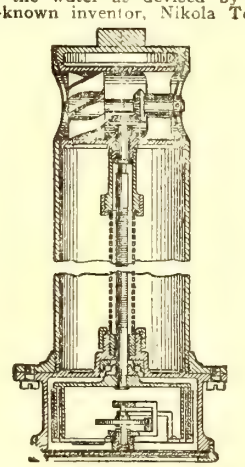


The inventor has devised a clever form of weave for producing a special fabric, in which the electric resistance or heating wires are interwoven. An automatic thermostat is provided in the garment in such a position that it will be actuated and controlled by the temperature of the garment.

Electric Ship's Log.

(No. 1,314,718; issued to Nikola Tesla.)

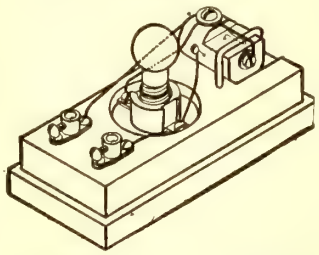
A very clever invention is this latest design for indicating the speed at which a ship is moving thru the water as devised by the well-known inventor, Nikola Tesla.



As the ship speeds along thru the water, a small turbine, mounted at the lower end of a tube extending down thru the bottom of the ship, is actuated, and the faster the boat speeds along, the more rapidly the turbine rotates. The revolutions of the turbine are conducted thru a flexible or other shaft to a revoluble head or drum in the top of the tube, and placed at the deck level, for instance. At this point there is mounted the indicating instrument of the log, with the dial marked in knots or miles per hour. The indicator of the instrument is moved by the friction or viscosity of the air between the shaft-driven drum and a similar shaped drum secured to the indicator and in close proximity to it, there being no direct mechanical connection between the two.

Electric Gas-Detector.

(No. 1,313,323; issued to Milton A. Nobles.)

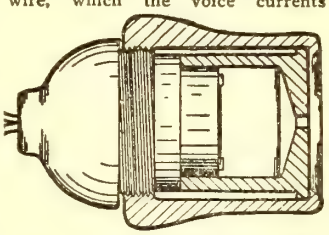


The device will detect and give an unmistakable alarm whenever certain gases are present in predetermined quantities. The construction comprises a lamp operated from a battery, such as the miners' headlight battery, which lamp is blinked on and off whenever gases are present. The complete device comprises a circuit-closing device involving the use of a catalytic element, such as a fine platinum wire and also a thermostatic bar. The instrument is not affected by changes in temperature.

Thermic Telephone.

(No. 1,312,504; issued to Robert Aernout Baron Van Lynden.)

The prior types of this device utilized a very fine platinum wire, which the voice currents

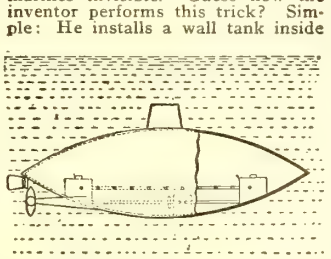


caused to become heated and cooled in correspondence with the voice undulations. But in the present design the conductor is in the form of an "S" and may be formed upon the base electrolytically, or it may be formed of a fine metal sheet or foil laid upon the supporting surface. Also, the conductor may comprise a mark on the porcelain or other support, such as that created by painting or printing the same upon the support surface.

Making Submarines Invisible.

(No. 1,312,595; issued to Henry H. Suplee.)

At last we have the master invention of the war, rendering submarines invisible. Guess how the inventor performs this trick? Simple: He installs a wall tank inside

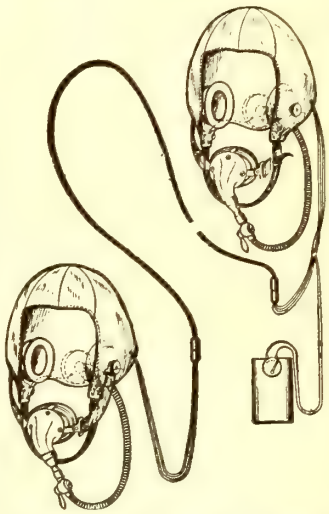


the "sub" from which pipes lead to a series of nozzles placed around the hull. Airplanes and blimps can spot "Mr. Sub" even when submerged 100 to 150 feet. But they will have to try a new one, for Mr. Suplee opens his valves and hides his little hornet by shooting out a colored liquid into the sea water that effectually nullifies the transparency of the water without making a smudge. Nigrosin may be used, mixed with water.

Helmet Telephone Set.

(No. 1,314,819; issued to Charles H. Lehman.)

The speaker's voice does not act on the microphone direct, but is carried thru a mouthpiece and speaking tube to this device, which is placed at the rear of the helmet. The usual telephone receivers are mounted in the sides or ear-flaps of the helmet. In the

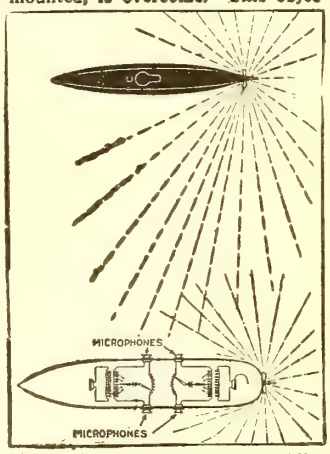


earlier forms of telephone and radio telephone devices of this type, the microphone was frequently mounted on a breast-plate, but when the aviator or pilot turned his head the voice was no longer impinged on the microphone.

Submarine Signal.

(No. 1,312,809; issued to C. E. Scribner and J. L. McQuarrie.)

Improved submarine signaling system in which the noise or sound from the propeller of the local ship, on which the microphones are mounted, is overcome. This objec-



tion is here overcome by providing two detectors, one of which is relatively insensitive and both of which are differentially related to a common telephone receiver. This makes it readily possible to balance out the noise due to the local propeller, whereas the distant propeller affects the sensitive microphone more than the insensitive microphone, and produces a resultant effect in the telephone receiver.

WITH the AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

The Editors desire to call to the attention of all owners of "Electrical and Chemical Laboratories" the fact that hereafter the MONTHLY PRIZE WILL BE $5.00 CASH, instead of $3.00. ALSO $2.00 CASH WILL BE PAID TO EACH "HONORABLE MENTION" ENTRY PUBLISHT. We have not received any "Laboratory Photographs" of late. So "go to it" and send us your photo, together with that of your laboratory. If they are particularly good we may list some new and bigger prizes. So get busy, Boys!!! It's up to you. Here's a way to earn some greatly wanted laboratory apparatus at no cost whatever. Don't be afraid to send in too many photos, Boys.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER—KENNETH STRICKFADEN

THE photos herewith show my electrical laboratory at Coney Island, New York. It's good to be back again in the good old U. S. A. and my "experiments," after a sojourn in France with the A. E. F. My "layout" at present comprises a photographic dark room, chemical "Lab." and electrical "Lab." One of the photos shows the large Oudin high frequency coil, which is excited by an 18-inch induction coil, seen at the extreme right of the photo. I have a goodly collection of telephone, telegraph and radio apparatus—some home-made and some standard stock. The Oudin coil outfit is excited by the 18-inch spark coil operated by an electrolytic interrupter on 110-volt circuit. A rotary spark gap is used. My radio receiving set includes amplifiers. I have a Ford car, specially fixt up and decorated, in which "Yours Truly" and all the "junk" will attempt to fly across the continent to sunny California, my old home town—Santa Monica.—Kenneth Strickfaden (home address, 1217 11th Street, Santa Monica, Cal.).

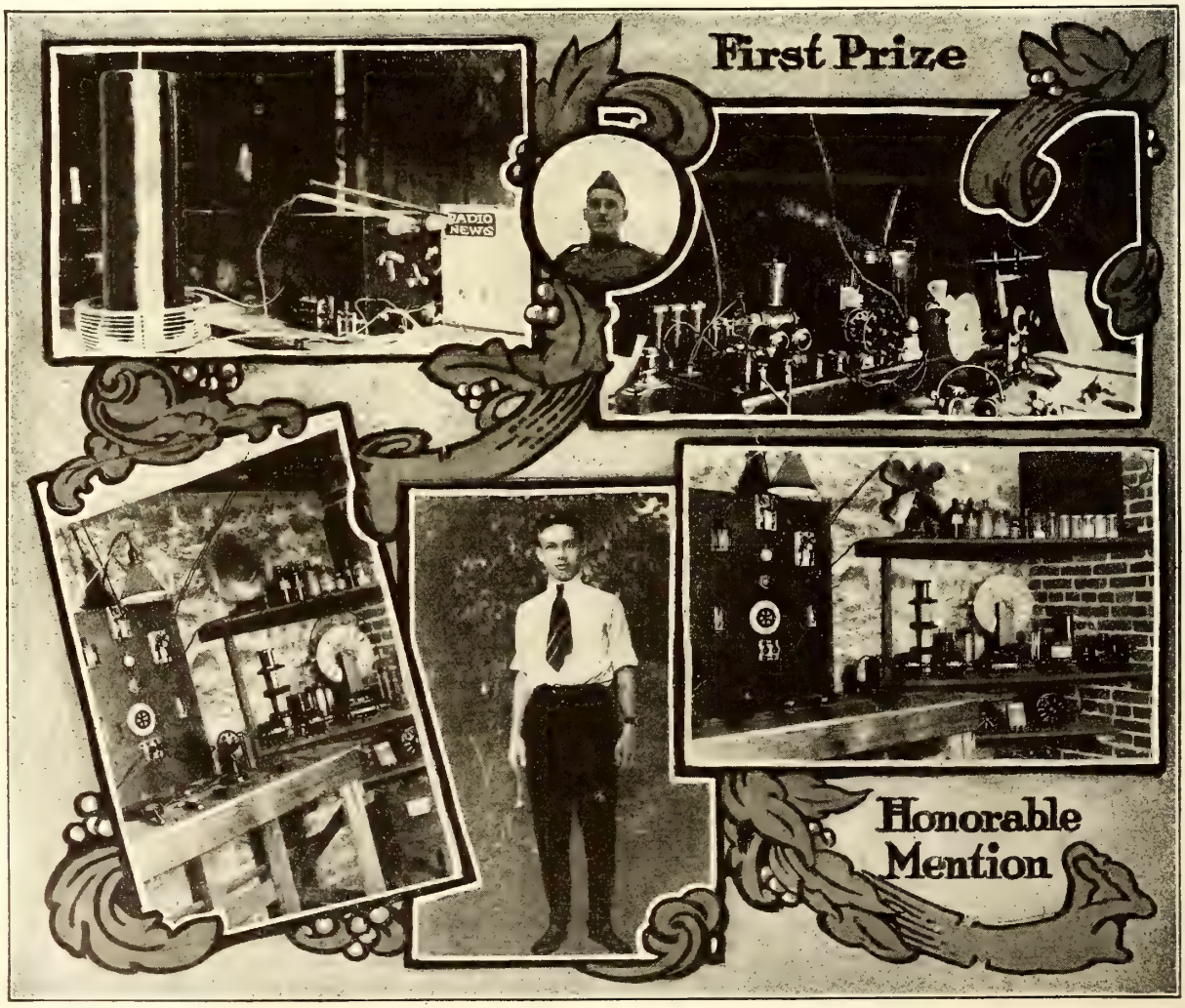
HONORABLE MENTION—ELLWOOD R. RUTENBER

$2.00 PRIZE PAID EACH "HONORABLE MENTION"

THE accompanying photos show my experimental electrical laboratory. I am sixteen years of age and have been experimenting for more than six years. My laboratory equipment includes the following:

15 V. 10 Amp. D.C. Generator; 6 V. 3 Amp. D.C. Generator; 110 V. 175 Amp. D.C. Motor; 1/20 H.P., A.C. Motors; 1/6 H. P., A. C. Motor; 6 cylinder Auto Magneto; 6 V. 40 Amp. Storage Battery; Combination Volt-Ammeter, 24 V. 50 Amp.; Electric Fans; Home-made Static Machine; Home-made Medical Coil; Switchboard; Ammeter,, 30 Amp. Capacity; Rheostat; Test Buzzer 1½, 6, 8, Volt Transformer.

I have spent many happy hours in this laboratory performing experiments of all kinds with the apparatus here described. I have a variety of chemicals and acids for experimental purposes, also three mining trays and other paraphernalia necessary for the work. I also have a number of small motors, batteries, switches of various kinds, spark coils, bells, and how-to-make-it odds and ends. I have a very useful home-made low-voltage rheostat which I will describe for the benefit of other laboratory owners, at the earliest opportunity, in the columns of the ELECTRICAL EXPERIMENTER.—Ellwood R. Rutenber, 127 N. Washington Street, Marion, Ind.



Science in Slang

By EMERSON EASTERLING

"I SAW in a magazine some time ago some guy's idea about entering into a gab-feast with the Martians, or Martonians, or Marites—or whatever you want to call 'em," remarked one of our crowd as we sat in the Union Depot at Portland, Oregon, waiting for a train to Pendelton.

"Yes," replied Jazz, "I saw that. It struck me as being sort of sensational stuff. I guess it is alright—in some respects—but there is a lot of stuff evidently overlooked."

"How is that?" asked Punk, looking up from his *Police Gazette*.

"For one thing," began Jazz, "did you see the write-up?"

"Oh," returned Punk. "I have seen some of the bird's stuff on the subject O. K.—but all that stuff is so far from home that I never paid much attention to it."

"Well," continued Jazz Stokes, "as I was going to say—the late Percy Lowell gazed up at the Martian bunch of dirt and discovered that it was stript all over with stringy marks. If you had seen them without any explanation you might have pronounced them railway tracks, or road ways — but old Lowell must have been awful 'dry,' or something; so he thunk up the canal idea. It took."

"I thought that a bird by the name of Schiaparelli—a German wop, or something — discovered the canals," put in Bender.

"I believe you are right," returned Stokes. "It was Sarsaparelli that dug up the canals and Lowell that extended the theory and kept them open to the astronomical public.

"Anyway, a Harvard 'Proff' by the name of Pickering got it into his head that we could construct a huge mirror and do flash light stunts on them and take chances on them catching on, and some more on our getting them if they do catch on."

"He was not a proff in finance, was he?" questioned V. Dago Hule, with a sort of a smile.

"Proff Wood (not referring to his head exactly) figured out a plan wherein we would stretch a few hundred acres of black cloth over some blinding sands of the great African desert and have some monster motors to roll and unroll the 'window shades' in such a fashion as to give them an optical impression that we are kidding them into saying 'Hello' to us by some such way. Of course such a stunt would cost the price of a young war—but what's a billion or two to a scientist's young life! Wood himself didn't intend to foot the bill."

Talking with Mars

"Don't you think that that was just a sort of figure of speech? I don't think that he really thought of doing exactly what he said. He probably proposed that as some example of how it could be done—don't you think?" rattled off Bender.

"More than likely—I don't know—besides I don't much care. But both the men are exceptionally intellectual specimens of our modern breed.

"A Frog by the name of Flammarion, a 'proff' in some *La Belle Universite* or something, let's out some of his think tank juice and proposes to have an immense bank of incandescent globes layed out on a dark stretch of land and let some official throw in and out the switch to the tune of 'Do you get us, Mars?'"

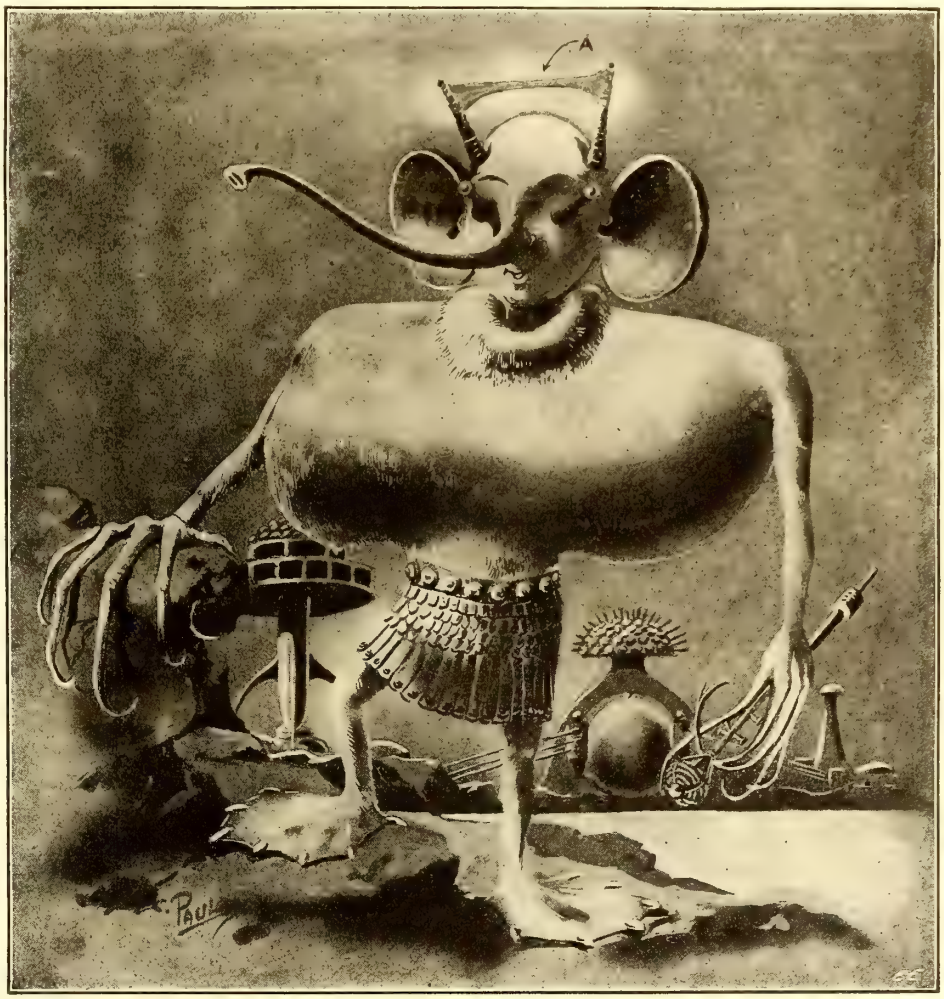
"Well," interrupted Punk, handing his *Police Gazette* to a preacher, "have you any better hunch for our transetherial communication? Why tear down when you can't put up a better castle than you ripped out—even if the one that you propose is warmer than the one you jerked out of commission?"

"Well," replied Jazz, "can't I kid the kids? They are smart men and have a few smart faults They have it all over the rest of us in many ways — but they cannot be perfect in all ways. In one or two respects they have fell down in their hypothetical proposals. Some of us who sit back and find fault with the Peace Treaty and so forth see a weak joint in their pipe dreaming and up with the 'heehaw.'

"Now will you let me rave?

"In the first place, how are we to know that the beings that inhabit Mars — if it is inhabited — are gifted with a physical and mental combination that results in what we explain as sight? We don't know but what they have evoluted past us—if we are evoluting—and are getting into their knowledge what we do with sight by some other sense? As the dog, for instance, has its sense of smell developed to a much greater degree than has the human race, so might we have our sense of sight developed to a much greater degree than have the Martians. And are we sure that they have developed up in the same way that we have? Take the different forms of life on our own planet: how different

(Continued on page 699)



AS SCIENCE SEES THE MARTIAN.

Due to the very rare Martian atmosphere, the Martian's chest must be enormous to accommodate his ponderous lungs, necessary to supply his oxygen. Rare atmosphere conducts sound very poorly, hence the large ears, required to catch the very weak sounds. Due to the poor atmosphere, it is exceedingly cold on Mars, except at the equator. Hence Martians are covered with a while polar fur from head to foot. A rare atmosphere conducts odors but poorly—hence the elephantine nose, which goes to the odor, as the odor can't come to the Martian. Gravity on Mars being much less than on earth—1 lb. on earth weighs 0.35 lbs. on Mars—the pull on his body is very small. Therefore, his height is from 10 to 12 feet. To support such a tall body where gravity is small, better footing is necessary, hence the big feet. The tremendously civilized Martian always rides or flies from place to place; his legs are thus almost useless, hence devoid of muscles, consequently thin. The Martians stopped all physical work millions of years ago; machines do his work. His arms thus are weak and thin. But the hands and eyes—the Martian's most important organs—are used and worked constantly—therefore are developed wonderfully. As his food is all taken in highly concentrated form and as he does not talk, the Martian's mouth has shrunk to very small dimensions. Talking in a rare atmosphere being almost impossible, the Martian communicates by his telepathic organ, "A," a sort of sensitive skin stretched between antler-like prominences on top of his head. The same organ sends out the telepathic waves.—H. G.



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered. Your correct name and address must be signed.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.

4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

VOLTAGE DROP IN RAILS.

(1027) Chas. Hora, New York, N. Y., rites us:

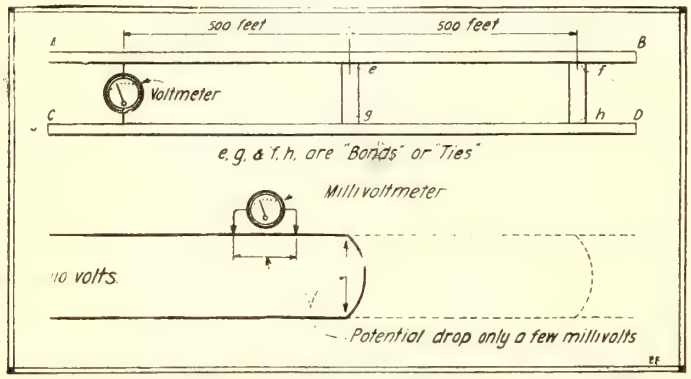


Diagram Showing How Drop in Voltage Across Rail Bonds Is Measured.

Q. 1 The problem I wish you to solve is this: Two rails, A, B,—C, D, are charged with 110 volts; what would be the voltage at e g and f h if the voltmeter is put across these two points? Will it register the same at A C, e g or f h, or will there be a drop in the current, and if so, how much? The rails are 1,000 feet long (such as are used on the Elevated Railroads).

A. 1. If we understand your problem correctly, what you wish to determine is the drop in milli-volts across the two bonds e g and f h on a track system such as is used on the elevated railroad, and which are of the same polarity. We can assure you that the drop along these rails or crossing bond such as e g or f h is very small in any case, and for a three-foot section of track, or measuring across a good bond, the drop should be but a few millivolts. The drop in potential on a 1,000-foot length of track will of course, in proportion, be greater than that measured across a bond or cross-section of, say, three feet of track, but would be quite small in any event.

AUTOMATIC TRAIN STOP.

(1028) E. M. G., of New London, Conn., inquires:

Q. 1. What is your opinion of the "M-V all weather train controller" as shown and described in ELECTRICAL EXPERIMENTER for February, 1918?

A. 1. In answer to your query asking our opinion on the "M-V all weather train control" as illustrated and described in the February, 1918, issue of the ELECTRICAL EXPERIMENTER, would advise as follows:

We have had no chance, of course, to see this invention in actual practise in order to see for ourselves just how it would work out under various weather conditions, but from a theoretical point of view we would say that the device should certainly work out very well. The electrical operating theory of the invention is correct, so far as we can see, and an electrical engineer who has done some work along similar lines with magnetically operated train stops, which have been tried out on the Pennsylvania Railroad recently, so we understand, has spent a great deal of time and money working out a device quite similar in principle. Engineering reports which he showed us demonstrated that the device possest considerable merit and some features heretofore not fully realized, or at least their practical significance for such a difficult task as this. This experience has tended to all the more reinforce our opinion as to the practicability of such magnetic train controls.

The device you are interested in would seem to be all right if properly developed and applied. We understand that heretofore, and even now, there are one or two objections to all such automatic train stops and controls of an electrical and magnetic nature, which the railroads object to, and that is that the currents passing thru the rails are liable to conflict or nullify the electric currents operating the block signals.

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New eclipse photos; star and moon effects caught by the camera; comets; shooting stars; progressive moon studies.

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Odd double and triple exposure effects; novel and striking effects due to unusual exposures.

MECHANICAL PHOTOS—
Electrical and Mechanical apparatus of unusual news interest.

RADIO PHOTOS—
New stations, both commercial, government, and private. Owners of private or amateur stations will find a special contest for these photos on another page of this issue.

And don't send us plate or film "negatives"; send unmounted or mounted "prints" prefarably a light and dark one. Enclose stamps if photos are to be returned.

Address photos to—Editor "Odd Photos", Electrical Experimenter, 233 Fulton Street, New York City.

HUGHES BALANCE CONSTRUCTION.

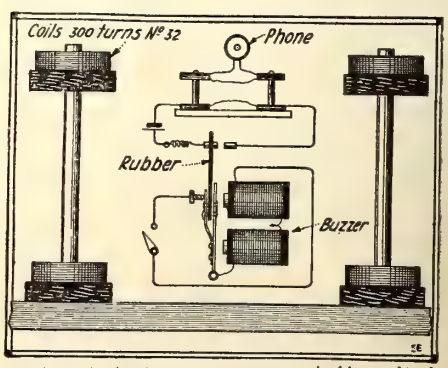
(1029) C. H. Jones, McAllen, Texas, asks:

Q. 1. For data on building a Hughes induction balance.

A. 1. We give herewith diagram showing a Hughes balance constructed with an ordinary buzzer as the exciter.

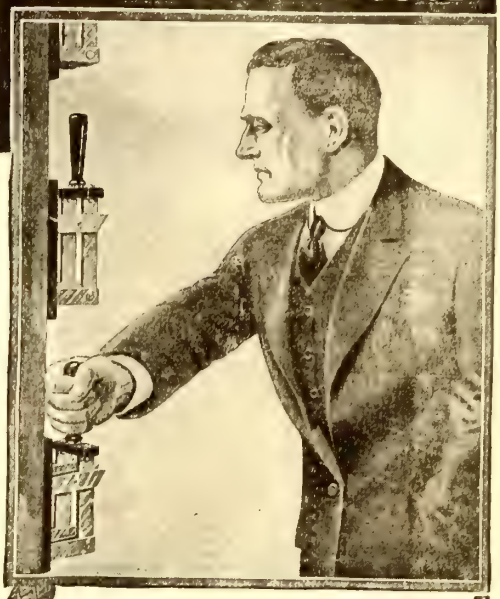
The coils are wound with No. 32 silk-covered wire. About 300 turns are necessary for each one. This winding must be placed on the spools very evenly, and great care should be taken to have all coils precisely alike. The lower two coils are connected in series with the buzzer, the upper two with a telephone receiver of about 75 ohms. A more sensitive receiver will, of course, give more efficient results. These coils are placed so that the winding opposes that on the coil beneath it on two upright posts, spaced the desired distance apart. The exciting buzzer is now started and the coils above shifted until no sound is heard in the phones. If a metallic object is now placed between the two coils, the phone instantly responds because of the disturbed balance.

The buzzer is a very simple device, made by riveting a piece of hard rubber to the armature. Said hard rubber has a metal contact, which is connected with another screw, so that the excitation of the coils is entirely dependent upon these two contacts, and only one cell is necessary in this coil circuit, whereas two are used to actuate the buzzer.



Hughes Induction Balance and How It Is Constructed.

Why Electrical Workers Are Needed.



Consider for a moment what part electricity plays in every-day life, in the comfort, convenience, pleasure and even health of the whole civilized world.

Think of having to ride in horse cars again—

of waiting days for what the telegraph does in a few minutes—

of writing a letter every time you now phone—

of no automobiles or moving picture shows—

Electricity takes millions to and from work. Without it the automobile and airplane would be impossible—the telephone and telegraph would be useless. All the civilized world relies on it for light, heat, transportation and communication. In a thousand ways electricity is used in factories, offices and in the homes.

Electricity is almost as essential as the air we breathe. Business would be almost at a standstill if deprived of its energy.

To say that electricity is still in its infancy is no exaggeration. Every-day brings into practical use some new method of controlling it, some new device or appliance for using it. In industrial work there are still scores of operations where electricity will be utilized sooner or later. The day is coming when the railroads will entirely replace steam with electricity. Doctors, dentists and scientists are only beginning to realize the possibilities af electrical energy.

These facts merely touch the high spots, yet they prove beyond a doubt that electricity plays a vital part in business, in our individual lives, and that there is unlimited scope for those who make electricity their life work.

The electrical worker provides other men light to work by, the telephone and telegraph to convey their orders, the power to run their machines and transport their goods. He supplies power in the homes to operate washing machines, vacuum cleaners; for ironing, heating and ventilating. In short, it is the electrical worker who makes it possible for the world to live more comfortably, to enjoy more pleasures and to do a bigger, more profitable business.

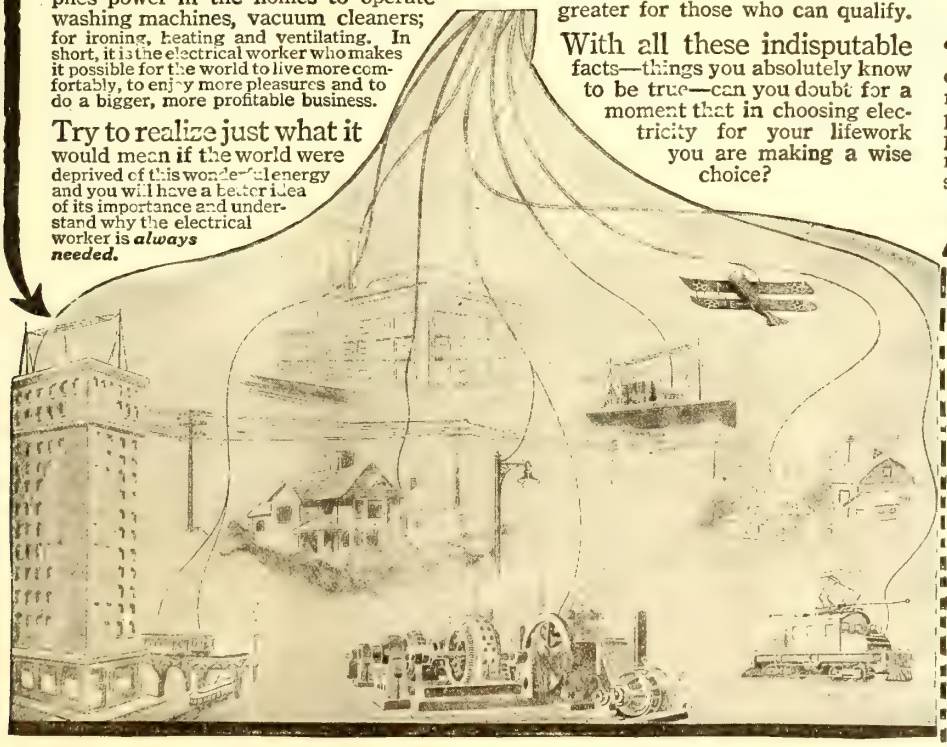
Try to realize just what it would mean if the world were deprived of this wonderful energy and you will have a better idea of its importance and understand why the electrical worker is *always needed.*

What Electricity Offers You

Once you have mastered the A-B-C of electricity you are confronted with unlimited opportunities for advancement. You can specialize in extending and perfecting the wonders already accomplished in the field. You may take up those branches of electrical and mechanical work which cover the design and manufacture of electrical apparatus or start in to qualify for a well-paid position in the designing, construction, operating or consulting branches of the electrical engineering profession, and to fit yourself eventually for a position as Distribution, Operating, Testing, Erecting or Designing Engineer.

In the automobile, airplane, telephone and telegraph lines there is also great scope for the trained electrician. Many wonders of electricity have yet to be unfolded—its uses multiplied—and opportunities still greater for those who can qualify.

With all these indisputable facts—things you absolutely know to be true—can you doubt for a moment that in choosing electricity for your lifework you are making a wise choice?



How You Can Qualify

You don't have to interfere with your present work while qualifying for a good electrical position. The American School can give you just the training you need in your SPARE TIME. Our electrical courses have been specially prepared for home study—are written so you can understand everything quickly—and from your first lesson until you get your Diploma expert instructors coach you. Our training will enable you to get into the game RIGHT.

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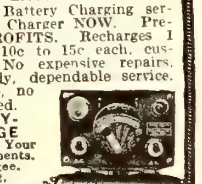
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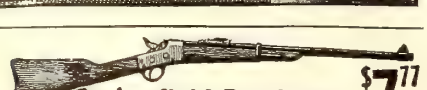
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Advertising Talks

NUMBER 5

IN my preceding articles I have tried to show you just why it pays to buy advertised goods—given you real tangible reasons proving that advertised articles are always the best and cheapest and wide-awake concerns who advertise always the most satisfactory firms to do business with.

But there is one point I haven't brought up and I want to take it up now. And that is the fact that the systematic reading of advertisements is an education in itself. If you want to keep abreast of the newest and latest developments in your business, your studies or your pet hobby you cannot expect to do so unless you make a habit of studying the advertising pages of your favorite magazine.

More care is taken and more time and money is spent by advertisers in preparing their advertisements than is expended in preparing even the editorial matter that goes into an everyday magazine. With the volume of advertising that is carried each month in a large magazine like the ELECTRICAL EXPERIMENTER, and the great number of advertisers who compete in offering their products in every issue, each advertisement must be prepared, first, to attract your attention, second, to give you the advertiser's story as easily and quickly as possible, and third, to so convince you of its merits that you will want to know more about the article or offer advertised. This being true, it stands to reason that real advertising must make attractive and educational reading. Attractive because of the short, snappy style used in all high class advertising of today and educational because, while reading the advertisements you are learning about all the newest inventions and developments of science, and actually improving your mind at the same time that you are broadening your knowledge.

I know a bright, intelligent inventor who somehow never could seem to get along. He was always wasting his time on foolish ideas and impractical schemes. One day I called his attention to the ELECTRICAL EXPERIMENTER, then a much smaller magazine than it is now, and asked him why he didn't read the ads carefully and get an idea as to what was successful in his line and what the people wanted. He followed the suggestion and the last time I saw him he had perfected a revolutionizing invention, the idea for which he had received from an entirely different advertisement in the "Experimenter.' If I told you his name you would all know him, most of you have probably used or are familiar with his invention.

This just goes to show that you can never tell in what way an advertisement may help you. Make a practice of reading ads—go through the advertising pages of the good magazines as carefully as you do the text. Don't lay this month's issue of the "Experimenter" aside until you have read every line of advertising. Digest the ads—get all the information you can from the advertisers themselves by writing to them. Keep yourself posted on what they have to offer and when you need anything in their line patronize them.

Advertising Manager.

SKINDERVIKEN TRANSMITTER BUTTON

Most Sensitive Microphone



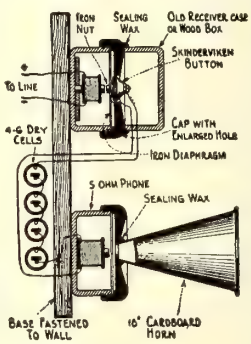
Actual size

for $1.00

You can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. This outfit was used by secret service operatives during the War. It is being used on the stage.

One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons can not be seen by any one in the room, as they are so small and light. Only a small brass nut is exposed to the view.



Full directions for connecting up the button for use as a detectophone are given in booklet which is sent with each button.

The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

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We have the utmost faith in this transmitter button. We guarantee satisfactory service or we will refund the purchase price. Boys—young and old—send in a dollar bill RIGHT NOW! You can't lose. If you're not satisfied, you receive your dollar back. Isn't that fair?

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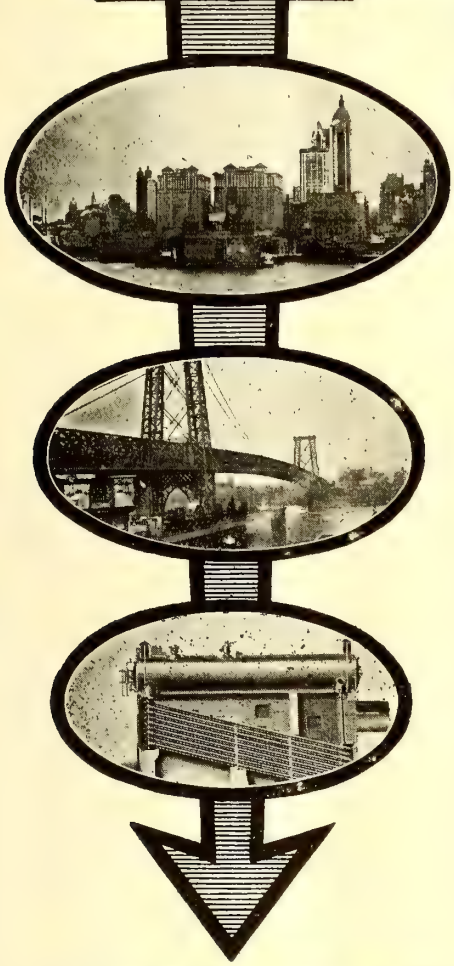
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Raise Your Income



Every Big Construction Job
Must Pass Through the Drafting Room

Do you realize what that means in the way of opportunity with big pay for Draftsmen? Think of the enormous volume of building operations now going forward all over the country with the return of peace—the big engineering, construction and manufacturing projects that must every one first go through the drafting room before the plans are ready for the workmen.

Never before in this country was there such a demand for skilled draftsmen—and this condition is true of European countries in which the destruction of war calls for vast re-building programs requiring the services of an army of draftsmen. All this world-wide demand means great prosperity for men who become trained in draftsmanship.

$25 to $100 a Week

All you need is training to be ready to accept a call that should mean $25 to $100 a week easily earned. You have the same opportunity to secure the valuable training in spare time at home or by personal attendance from the Chicago Technical College that many other men had who are now holding fine positions and earning big pay through their knowledge of draftsmanship.

Act Promptly—Now

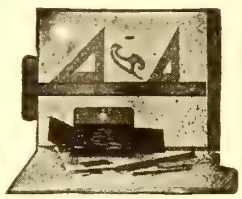
The longer you wait, the longer you will postpone the time when you will begin to draw a tempting salary as an Expert Draftsman. Manufacturers, Architects, Contractors, Engineers, Builders, Railroads and other big employers of trained draftsmen are ready with the work—when **you** are qualified to handle it.

Come to the College or Train at Home

Whether you decide to take one of the resident courses or to study in spare time at home you will have the personal direction of practical engineers, builders and architects, who give you the benefit of their vast experience and the successful methods they use in their own work. No time wasted. Every minute counts under men like these—every one a specialist!

We train hundreds of men by the most modern methods and see them quickly succeed, because we give them a technical preparation that not only makes proficient draftsmen of them, but also enables them to fill higher executive positions in big construction enterprises. There is no limit to your progress after you have equipped yourself with what the Chicago "Tech" can give you.

Drawing Outfit



No Extra Charge

Every student of the Chicago "Tech" Home Study Course in Draftsmanship receives the drawing outfit—set of instruments in case, drawing board, T square, triangles scale, curve, drawing paper, pencils, etc., or a cash credit in case he already has an outfit. These instruments are of the same make and sizes as used by high salaried experts in drafting rooms of factories, shops, railroads, etc. You use them while learning—then take them right into your practical work.

Easy Payment

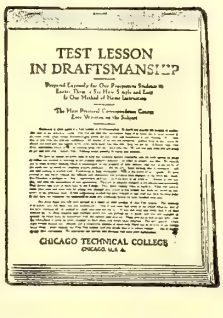
Chicago "Tech" training costs you little compared to the great benefits conferred, and payment of tuition fees may be made in easy installments, if desired. This splendid training will soon enable you to pay for the course from extra earnings.

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CHICAGO, U. S. A.

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The Chicago "Tech" method is the quickest, easiest way to become a skilled draftsman in spare time, without interfering with your present position. But we don't ask you to decide until you **know** how well qualified you are for this prosperous profession.

Other institutions ask you to pay first—and then find out later what their instruction means to you. We send the free lesson first and place you under no obligation at all. Discover your qualifications before you pay anything. And see for yourself just what Chicago "Tech" offers you in training which will bring a ready market for your services and open opportunities which are closed to the untrained man.

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All about automobile mechanism—its construction, operation and REPAIR—taught by mail. You train directly under the Chicago "Tech" automobile experts. Splendid opportunities open now.

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Most complete instruction in auto repair work. Equips you for high pay or to start a business. Big demand for trained repair men.

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A Modern King Canute

The people who lived in the good days of the wise King Canute thought he had the power to make the ocean recede at a mere word of command. Today the Bell Telephone Company finds itself in a position not unlike that of the ancient king. Its mere word will not hold back an ocean of expense.

Rigid economy and the most modern methods of operation have made it possible for the Bell Company to keep its rates at a far lower level than that of the commodities which it must use in construction and upkeep. But it has felt the rising tide of costs just as certainly as has every business and every family.

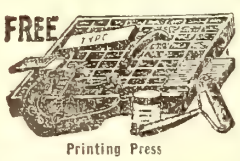
The one source of revenue of the Bell Company is the price you pay for service. If this price fails to cover fair wages and necessary materials, then both you and your telephone company must suffer.

For one year the Bell Company was under Government control. The Government analyzed methods and costs; and established the present rates as just. All the Bell Company asks is a rate sufficient to provide satisfactory service to every subscriber.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

One Policy *One System* *Universal Service*

FREE No Money Required WE TRUST YOU



Printing Press

We are giving away thousands of dollars worth of valuable presents, such as Watches, Air Rifles, Guns, Moving Picture Machines, Musical Instruments, Cameras, Printing Presses, Typewriters, Books, Puzzles, Games, Tricks, Toys and Novelties, Rubber Stamps, Household Labor Saving Devices, etc. All you have to do is to send your name and we will send you, without any charge, 20 large beautiful colored pictures or 20 packages of postcards, to sell at 15 cents each. When sold send us the money and we will give you goods of your own selection to the value of $3.00 from our wonderful premium catalog. Remember, you get these goods as a premium for selling the pictures or postcards and sending us the money. You do not have to pay one cent for them.

By continuing the sale of our goods you can earn a magnificent bicycle and many other expensive presents. Send in your application at once, stating whether pictures or postcards are preferred and we will immediately send you the first lot, accompanied by our catalog to select your premium from.



Moving Picture Machine



Sterling Silver Water Set

Spencer Publishing Co. Dept. 310 Chicago


Simplex Typewriter

HELIUM GAS WAS TO AID IN BOMBING ENEMY

Some of the secrets regarding the production of helium, the non-inflammable balloon gas which was developed and produced in considerable quantities during the war, were disclosed recently by a statement based on a memorandum prepared by the Bureau of Steam Engineering. In part the statement says:

"If the war had lasted until Spring, the British and American Governments would have sent helium-filled rigid airships over strategic points in Germany, each capable of dropping a total of ten tons or more of high explosives, either in a single tremendous discharge, or in a number of smaller ones during its passage over a fortress or city. These airships would have carried batteries amply sufficient to repel airplane attack.

"The success won in producing helium has resulted in the War and Navy Departments allotting funds for the production of the gas on a large scale for the use of the military and naval service. It is expected the plant will be in active operation in a few months. It draws its raw material from a natural gas field which is the largest and richest in helium now known in the world. A ten-year lease of this field is held by the Government for practically its entire output. During the war this helium gas was camouflaged under the name of 'Argon.'

"Since helium is noninflammable," said the statement, "an observation or dirigible balloon filled with it cannot be destroyed by incendiary bullets. The only effective method of attack would be by driving an airplane bodily thru the great gas bag. With the fire risk eliminated, the rigid airship or Zeppelin will hence be one of the most powerful weapons known.

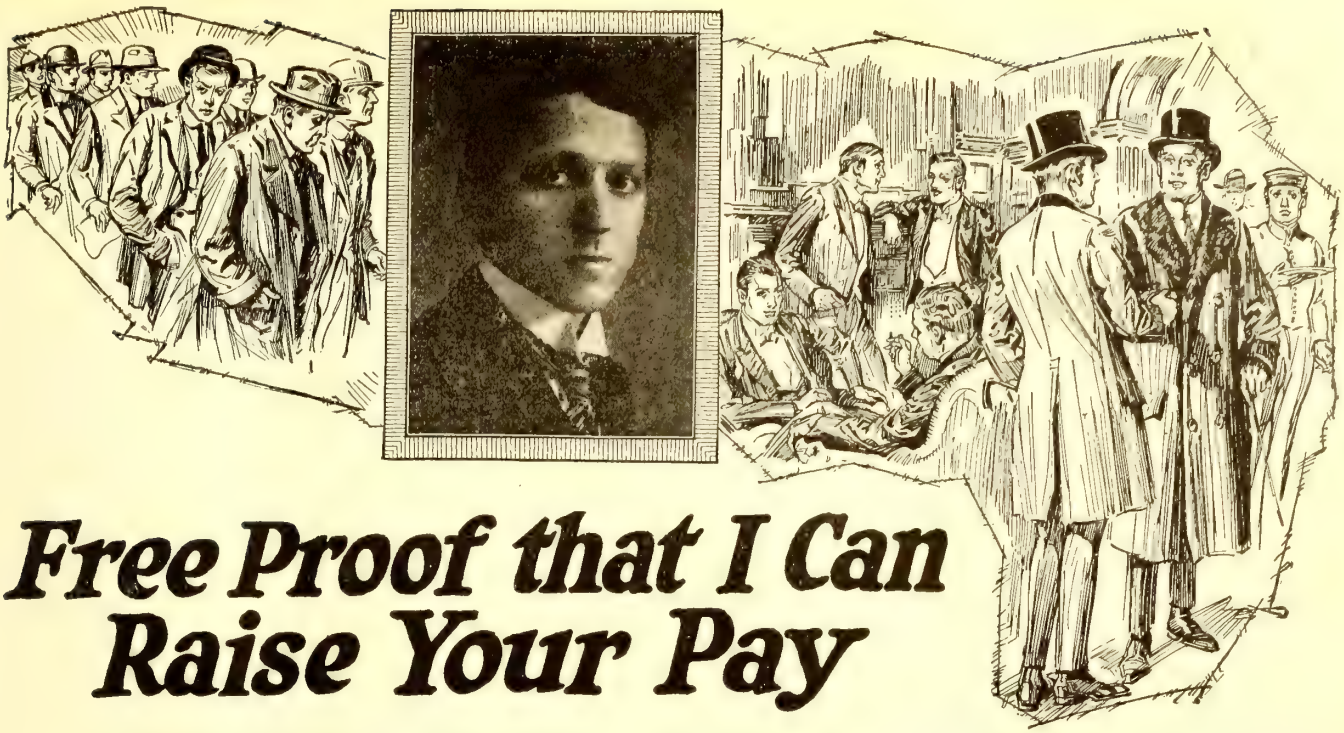
"Just prior to the armistice a shipment of 150,000 cubic feet of helium was sent by our Government to Europe. The problem of an ample supply of helium has, therefore, been virtually solved by American energy and resourcefulness. This shipment was made in a relatively brief period after contracts were made for its production.

"The high military value of helium was recognized by the Allies in the early stages of the war, but it was not until the United States began hostilities that methods for obtaining the gas in serviceable quantities could be devised. Helium is a component of natural gases, and the quantity of the richest helium-bearing gases which the British used for their early experiments was relatively very poor, having only one-third of 1 per cent of helium.

"Prior investigation indicated, however, that there were in this country deposits of natural gases far richer in helium than any known to exist in the British Empire.

"The result was that the Bureau of Mines made contracts with the Linde Air Products Company and the Air Reduction Company, both of New York, which were operating organizations producing large quantities of liquefied oxygen and nitrogen, and were hence especially fitted to undertake the production of helium, which is obtained by the liquefaction of the other components of natural gas, leaving the helium free.

"During the experimental period of this work, the Bureau of Mines, assuming that the plants designated by its organization would soon be in successful operation, advised that the experimental work on the two commercial plants should be stopped The War and Navy Departments, and particularly the Naval Bureau of Steam Engineering, which was concerned with the production of helium, insisted upon a continuation of the experimentation of those plants. Their judgment was vindicated within a few weeks, when it was shown that helium could be produced in quantity and at a reasonable price by both these plants.



Free Proof that I Can Raise Your Pay

No matter how much you are earning now, I can show you how to increase it. I have even taken failures and shown them how to make $100—$200, and in once case as high as $2,000 weekly. I am willing to prove this entirely at my risk and expense.

LET'S have a little chat about getting ahead—you and I. My name is Pelton. Lots of people call me "The Man Who Makes Men Rich." I don't deny it. I've done it for thousands of people—lifted them up from poverty to riches.

I'm no genius—far from it. I'm just a plain, everyday, unassuming sort of man. I know what poverty is. I've looked black despair in the eye—had failure stalk me around and hoodoo everything I did. I've known the bitterest kind of want.

But to-day all is different. I have money and all of the things that money will buy. I am rich also in the things that money won't buy—health, happiness and friendship. Few people have more of the blessings of the world than I.

IT was a simple thing that jumped me up from poverty to riches. As I've said, I'm no genius. But I had the good fortune to know a genius. One day this man told me a "secret." It had to do with getting ahead and growing rich. He had used it himself with remarkable results. He said that every wealthy man knew this "secret,"—that is why he was rich.

I used the "secret." It surely had a good test. At that time I was flat broke. Worse than that, for I was several thousand dollars in the hole. I had about given up hope when I put the "secret" to work.

At first I couldn't believe my sudden change in fortune. Money actually flowed in on me. I was thrilled with a new sense of power. Things I couldn't do before became as easy for me to do as opening a door. My business boomed and continued to leap ahead at a rate that startled me. Prosperity became my partner. Since that day I've never known what it is to want for money, friendship, happiness, health or any of the good things of life.

That "secret" surely made me rich in every sense of the word.

MY sudden rise to riches naturally surprised others. One by one people came to me and asked me how I did it. I told them. And it worked for them as well as it did for me.

Some of the things this "secret" has done for people are astounding. I would hardly believe them if I hadn't seen them with my own eyes. Adding ten, twenty, thirty or forty dollars a week to a man's income is a mere nothing. That's merely playing at it. In one case I took a rank failure and in a few weeks had him earning as high as $2,000.00 a week. Listen to this:

A young man in the East had an article for which there was a nation-wide demand. For twelve years he "puttered round" with it, barely eking out a living. Today this young man is worth $200,000. He is building a $25,000 home—and paying cash for it. He has three automobiles. His children go to private schools. He goes hunting, fishing, traveling whenever the mood strikes him. His income is over a thousand dollars a week.

In a little town in New York lives a man who two years ago was pitied by all who knew him. From the time he was 14 he had worked and slaved—and at sixty he was looked upon as a failure. Without work—in debt to his charitable friends, with an invalid son to support, the outlook was pitchy black.

Then he learned the "secret." In two weeks he was in business for himself. In three months his plant was working night and day to fill orders. During 1916 the profits were $20,000. During 1917 the profits ran close to $40,000. And this genial 64-year-young man is enjoying the pleasures and comforts he little dreamed would ever be his.

I COULD tell you thousands of similar instances. But there's no need to do this, as I'm willing to tell you the "secret" itself. Then you can put it to work and see what it will do for you.

A Few Examples

Personal Experiences

Among over 350,000 users of "Power of Will" are such men as Judge Ben B. Lindsey; Supreme Court Justice Parker; Wu Ting Fang, Ex. U. S. Chinese Ambassador; Assistant Postmaster General Britt; Lieu. Gov. McKelvie of Nebraska; General Manager Christeson of Wells-Fargo Express Co.; E. St. Elmo Lewis, former Vice-Pres. Art Metal Construction Co.; Gov. Ferris of Michigan, and many others of equal prominence.

$300 Profit from One Day's Reading

"The result from one day's study netted me $300 cash. I think it a great book and would not be without it for ten times the cost."—A. W. Wilke, Faulkton, So. Dakota.

Worth $15,000 and More

"The book has been worth more than $15,000 to me." Oscar E. Sheppard, 1117 E. Locust St., Decatur, Ill.

Would Be Worth $100,000

"If I had only had it when I was 20 years old, I would be worth $100,000 today. It is worth a hundred times the price."—S. W. Taylor, The Sante Fe Ry., Milans, Tex.

Salary Jumped from $150 to $800

"Since I read Power of Will my salary has jumped from $150 to $800 a month."—J. F. Gibson, San Diego, Cal.

From $100 to $3,000 a Month

"One of our boys who read Power of Will before he came over here jumped from $100 a month to $3,000 the first month, and won a $250 prize for the best salesmanship in the State."—Private Leslie A. Still, A. E. F. France.

I don't claim I can make you rich over night. Maybe I can—maybe I can't. Sometimes I have failures—everyone has. But I do claim that I can help 90 out of every 100 people if they will let me.

The point of it all, my friend, is that you are using only about one-tenth of that wonderful brain of yours. That's why you haven't won greater success. Throw the unused nine-tenths of your brain into action and you'll be amazed at the almost instantaneous results.

The Will is the motive power of the brain. Without a highly trained, inflexible will, a man has about as much chance of attaining success in life as a railway engine has of crossing the continent without steam. The biggest ideas have no value without will-power to "put them over." Yet the will, altho heretofore entirely neglected, can be trained into wonderful power like the brain or memory and by the very same method—intelligent exercise and use.

If you held your arm in a sling for two years, it would become powerless to lift a feather from lack of use. The same is true of the Will—it becomes useless from lack of practice. Because we don't use our Wills—because we continually bow to circumstance—we become unable to assert ourselves. What our wills need is practice.

Develop your will-power and money will flow in on you. Rich opportunities will open up for you. Driving energy you never dreamed you had will manifest itself. You will thrill with a new power—a power that nothing can resist. You'll have an influence over people that you never thought possible. Success—in whatever form you want it—will come as easy as failure came before. And those are only a few of the things the "secret" will do for you. The "secret" is fully explained in the wonderful book "Power of Will."

How You Can Prove This at My Expense

I KNOW you'll think that I've claimed a lot. Perhaps you think there must be a catch somewhere. But here is my offer. You can easily make thousands—you can't lose a penny.

Send no money—no, not a cent. Merely clip the coupon and mail it to me. By return mail you'll receive not a pamphlet, but the whole "secret" told in this wonderful book, "POWER OF WILL."

Keep it five days. Look it over in your home. Apply some of its simple teachings. If it doesn't show you how you can increase your income many times over—just as it has for thousands of others—mail the book back. You will be out nothing.

But if you do feel that "POWER OF WILL" will do for you what it has done for over a quarter of a million others—if you feel as they do that it's the next greatest book to the Bible—send me only $3.50 and you and I'll be square.

If you pass this offer by, I'll be out only the small profit on a three-and-a-half-dollar sale. But you—you may easily be out the difference between what you're making now and an income several times as great. So you see you've a lot—a whole lot—more to lose than I.

Mail the coupon or write a letter now—you may never read this offer again.

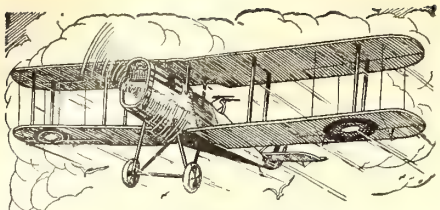
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You can build a perfect Model of a famous Aeroplane, that will look exactly like the real one, and that will rise from the ground or water by its own power and fly in the air. Build one now; it's the greatest sport you ever had! You can learn a lot about Aeroplanes; how they are built; operated and controlled. Ideal Model Aeroplane Construction Outfits make building easy. They contain all parts, fittings, materials, plans drawn to scale and complete building and flying instructions. You put the parts together and build your Model like a real Aeroplane mechanic.

Pick Your Model from These Celebrated Aeroplanes

You can get from Ideal Dealers Complete Construction Outfits to build scale-reduction Models of any of these well-known machines:

N C-4 (Naval-Curtiss Seaplane). The first 'plane to fly across the Atlantic Ocean. 4½ ft. Model. Shown below.

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Curtiss Military Tractor. The 'plane used to train our Aviators. 3 ft. Model.

Bleriot Monoplane. The first aeroplane to cross the English Channel. 3 ft. Model.

Nieuport Monoplane. A famous French 'plane used in the War. 3 ft. Model.

Cecil Peoli Racer. A racing-type aeroplane with a record for distance flights.

Ideal Model Aeroplane Construction Outfits for building any of the above Aeroplanes are sold by Leading Toy, Sporting Goods and Department Stores. Ask for them at your store. Be sure you get IDEAL Model Aeroplanes because they are the only ones that are true copies of actual Aeroplanes.

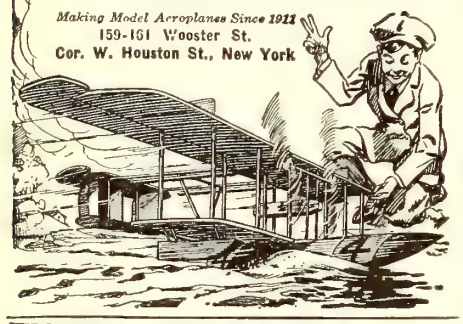
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Tells all about Ideal Aeroplanes and Flying Toys; gives complete descriptions and prices; contains list of stores where you can get them. Get this 48-page book.

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Noiseless Target Practice

Fit your .22 with a Maxim Silencer and get no end of fun this winter practicing in your backyard and basement.

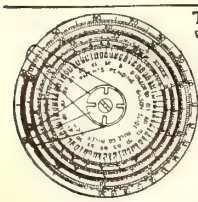
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THE MIDGET SLIDE RULE will solve any problem in addition, subtraction, multiplication, division and proportion. A Log-Log Scale gives any root or power of any quantity. Gives Logarithms, Sines, Tangents, Cosines, Cotangents and the decimal equivalents of fractions to six figures. It is grease and water proof and will give years of service. This rule is not to be compared with the paper utility rules which sell for $1.00 and are put together with paper fasteners. It is accurate, simple to operate and comparison shows that it is undoubtedly the fastest and most complete rule made. Our refund guarantee protects you from loss or disappointment. An instruction book 16 pages, 12 illustrations, is sent with each rule. Diameter of rule 4 in. Made in two models: Metal (white coated steel), **$1.00**; White Celluloid, **$1.25**. Leather Case **50c** extra. Send for catalogue of Slide Rules. Your money back if you are not satisfied.

Gilson Slide Rule Co., Niles, Mich.

TELEGRAPHING PHOTOGRAPHS FROM NEW YORK TO DENVER

If you should ask the man in the street as to whether or not he knew about the new method of telegraphing photographs of prominent people and news events across the United States from New York City to Denver, Colorado, daily, he would probably gasp once or twice and let it go at that. Probably many readers of technical journals are somewhat familiar with the Korn system of telephotography, by means of which it is possible to telegraph pictures of scenes, personages, etc., over circuits 300 to 400 miles in length. This, and several other systems which have been developed in Europe, are not very speedy, however, and they have several drawbacks.

An entirely new system, devised by Mr. LeRoy J. Leishman, of Salt Lake City, Utah, is being used daily *to transmit by regular standard telegraph dispatch* over the Western Union wires, at the usual rates, photos of prominent personages and events, from New York City to Salt Lake City and Denver. By this system the photograph, sketch or drawing to be transmitted has to be *coded*. To do this, the photograph is placed on what is known as a *coding board*, which resembles a small drafting board provided with sliding scales, *graduated with the letters of the alphabet*. It at once becomes evident how a given point on the picture can be thus checked exactly by taking the reading from a scale passing thru the point *horizontally*, and then taking a secondary reading on the same point, by taking another reading on the *vertical* scale. It might be thought that these subdivision lines would be numbered 1 to 10, but it has been found more scientific and expeditious all around to use the letters of the alphabet, which gives theoretically 26 letters. However, only 17 letters are used, owing to the similarity of several of the letters, which might be subject to error in telegraphic transmission. Not only has the Leishman system been worked out to give rapid coding and decoding methods, but there are five different degrees of shade lines transmitted by code, *i. e.*, special letters which are transmitted by the use of index letters, so that anyone familiar with sketching, such as an artist, or even a student at the game, can decode the telegram and reconstruct the picture. The inventor, altho he is not an artist, as he stated in a recent interview, can quickly decode the picture and obtain very excellent results.

To give a clear idea of just how the system works, suppose we have a photograph which is to be coded for transmission from New York to Denver. The photo is mounted on the coding board, and the complete telegram giving the positions of the various component points of the picture, is completely worked out by a fairly expert person in about one hour and a half. Then what you get is a string of words like this—"bxfas dmgdq," etc., etc. The average photograph, for example a likeness of President Wilson, will require a telegram containing about 250 words. This may be sent by day telegram rate or by night letter, in order to gain the lower cost of transmission. The telegram, of course, is transmitted practically instantaneously to the western city or other point, and the picture completely reconstructed in a time period corresponding approximately to that for coding the picture in the first place. It may be thought by the reader that such a picture would be nothing but a scratchy looking pen drawing, which would not preserve the exact features of a person very faithfully. But such is not the case. The original master photograph is mailed from the eastern city, arriving several days after the telegraphed picture has been on exhibition. As soon as the master photograph has arrived, it is placed on exhibit side by side with the telegraphic reproduction, and it is practically impossible to tell one from the other.



Boys! Win an Auto-Wheel

In This Interesting Contest

TO THE BOY who can think of the most interesting uses for the popular AUTO-WHEEL COASTER, for earning money and for play, we shall award one of our large models absolutely FREE. It's a mighty generous prize for a few minutes' work. And the following eleven valuable prizes will be given to those sending in the next best uses:
Camera, Camping Tent, Mess Kit, Scout Knife, Fleetwing Steering Sled, Compass, Ingersoll Watch, Axe, Bank, Electric Flashlight, Poncho.

INFORMATION ABOUT CONTEST

1. Any boy or girl not over 15 years may compete.
2. Contest will be judged by three men well-known in the Boy Scout organization.
3. Write to Business Idea Dept., Buffalo Sled Co., for pamphlet explaining the Contest, and colored catalog telling all about Auto-Wheel.
4. At end of letter write names of three Coaster Wagon Dealers in your town. If any carry the Auto-Wheel put an "x" after name.

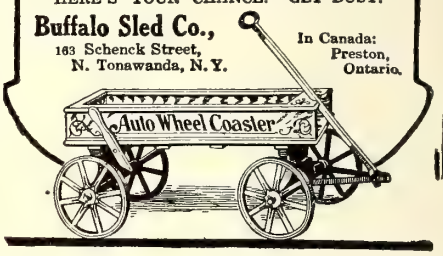
YOU CAN DO IT. Any live boy who knows how to get fun and earn money out of a good, strong coaster wagon, has a fine chance to get the Auto-Wheel as a prize. **Here are a few pointers:** The Auto-Wheel is a wagon for work or play. It's built for strength and speed. Has roller bearings, steel axles and tires, body white ash, maple gear.

If there's an Auto-Wheel dealer near you, he'll gladly let you see the Auto-Wheel Coaster in his store, and he'll give you some good ideas for your letter. CONTEST CLOSES NOVEMBER 30, 1919.

HERE'S YOUR CHANCE. GET BUSY.

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Lightning Racer Experimental Model. This is not a toy. It is a practical, scientific flying model, guaranteed to fly hundreds of feet; designed and built from the finest selected materials, by Model Experts. This machine and our famous "Montauk Flyer" are the only Complete Model Aeroplanes guaranteed to fly 500 ft. selling for less than $5.00. This model, shipped with monoplanes detached, ready and guaranteed to fly, $3.75 prepaid. Send stamps for circular describing this wonderful model.

Blueprints of the following models 1-2 actual size 50 cents post paid in U. S.

Bleriot Racer, flies 600 ft. Manhattan Racer, flies 2000 ft. Montauk Flyer, flies 500 ft. 3 ft. Curtiss or De Haviland Biplane, 75 cents each, postpaid.

HEC Flying Boat guaranteed to rise from the water and fly 500 ft. Two sheets blueprint $1.00 postpaid U. S.

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BOOK REVIEW

Behind the Motion-Picture Screen, by Austin C. Lescarboura. Cloth bound. Over 300 illustrations, 420 pages. Size 6¼ x 9¼ inches. Publisht by Munn & Company, New York City, N. Y. 1919.

The author has attempted to give the motion picture public an interesting and entertaining story of the screen drama and how it is made. The work is elaborately illustrated with scenes taken in various "movie" studios, and practically all the standard types of cinematograph apparatus are illustrated and clearly described. A new and important feature is that there is one picture to every page of text and the story corresponding to each illustration is found opposite it.

The opening chapters tell how the working plans of the motion picture are drawn up, the essentials of a scenario, the photoplay director, the actor, the camera man, how the director coaches the actors. The motion picture camera, the film and the lens. How battle scenes are photographed several miles away. American and foreign "movie" cameras, close-ups, fade-ins and fade-outs, vignettes, double exposures for one film, multiple printing of scenes. An interesting section deals with the scenery and "props" used in making the wonderfully realistic castles, ships, and even whole cities that never existed except in the "land of make-believe." A chapter is assigned to tricks of the "movie" screen, including those "nerve-racking" 'railroad collisions. Then we read just how the motion picture film is developed, printed and checked or censored. The "screen reporter" is an interesting personage—he travels everywhere, in the airplane, motor-boat and on the battlefield. An explanation is given of the talking picture, as well as the cartoon "movie."

Motion pictures taken on the ocean bottom are illustrated and discust, as well as film presentations of fish in action. The motion picture in the home as well as in business receives the importance it deserves, a particularly interesting section describing the various types of "home" cameras and projectors, including those utilizing paper instead of celluloid film. The concluding chapter deals with the future of the motion picture, both for amusement and business. The field of the "movie" is widening daily; the business man and salesman use it to show machinery in actual motion; the scientist and engineer find the cinematograph of inestimable value in studying the many difficult problems.

CENTRAL STATIONS, by Terrell Croft. Cloth covers, 332 pages, 306 diagrams, size 5⅝ x 8⅜ inches. Price $2.50 net. Publisht by McGraw-Hill Book Company, Inc. New York.

Mr. Croft has here provided a well illustrated and very clearly explained treatise on central stations, and this work can be confidently recommended to all those interested in central station operation and design. This work is not an exhaustive text book filled with mathematics for the professional engineer, but comprises an exceptionally clear exposition of all the modern factors which influence and concern the design and operation of light and power stations, and the generation and distribution of electric power, whether it is for lighting, heating or other purposes. Some of the first principles treated on in this work are distribution loss and distribution loss factors; maximum demand and demand factors, including demand meters and how they operate, diversity and diversity factors; plant factor and connected load factor; load graphs and their significance—a very interesting and illuminating chapter, written so the layman can understand it at last; the general principles of circuit design, including direct and alternating current circuits.

THE ENGINERS' MANUAL, by Prof. Ralph G. Hudson, S. B. Flexible cloth covers, 316 pages, illustrated with many diagrams, size 4⅞ x 7⅞ inches. Price $2.00. Publisht by John Wiley & Sons, Inc., New York.

A most useful handbook of mathematical formulas and tables covering both electrical and mechanical engineering, for the use of draftsmen, designers and engineers. The first part of the work deals briefly with the various terms and expressions encountered in algebra, trigonometry, mensuration of surfaces, both plane and solid, analytic geometry, differential and integral calculus, differential equations, complex quantities, vectors, etc.

(Continued on page 680)

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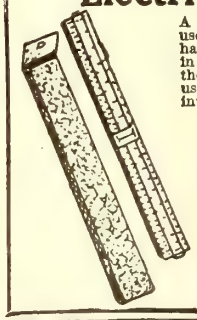
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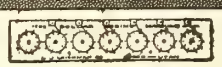


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The Cause of Stomach Acidity and Fermentation

How to Remove It in 48 Hours

By R. S. Thompson

IF I were asked to sound a health warning that would be of the greatest possible benefit to mankind, I should say emphatically—"Beware of acid stomach." For acid stomach is the cause of fermentation which, bad enough in itself, is the forerunner of a hundred ills that sap the energy and vitality of its victims. I venture to say that ninety per cent. of all sickness starts with acid stomach. Yet the cause of stomach acidity can be removed in 48 hours!

Nature provides hydrochloric acid as one of the digestive fluids, but too much of this acid causes fermentation, hurries the food out of the stomach, and carries the acid all through the body. As a consequence, poisons (toxins) are formed which are absorbed into the blood, causing autointoxication, nervousness, mental depression, and countless ills of which this is but the beginning.

Every one of the vital organs in time becomes affected—the heart, the liver, the kidneys, the intestines, the nerves, and the brain all decline, for the stomach is the Power Plant of the body. Even the teeth are affected by acid stomach, for the gums recede and pyorrhoea will be the result.

Stomach remedies only neutralize the acid because they are stronger than the acid. This ultimately ruins the lining of the stomach. The acid being neutralized is absorbed into the blood only to come back to the stomach in greater quantities at the next meal.

How much more sensible would it be to attack this disorder at its source. Instead of attempting to neutralize the acid after it has formed, why not prevent it from forming in the first place?

Superacidity is caused by wrong eating, and the remedy must be found in the field of the cause—in eating correctly.

The individual sufferer from indigestion, acidity, fermentation, gas and such disorders has not carried his experiments with food very far. If he had he could easily cure himself, in 48 hours, as Eugene Christian, the famous food scientist, has proved beyond all doubt.

The reason which led Eugene Christian to take up the study of food in the first place was because he himself, as a young man, was a great sufferer from stomach and intestinal trouble.

So acute was his affliction that the best specialists of the day, after everything within their power had failed, gave him up to die. Educated for a doctor himself, Christian could get no help from his brother physicians.

Believing that wrong eating was the cause and that right eating was the only cure, he took up the study of foods and their relation to the human system. What he learned not only restored his own health in a remarkably short space of time, but has been the means of relieving some 25,000 other men and women for whom he has prescribed with almost invariable success, even though most of them went to him as a last resort.

Christian says that all stomach and intestinal disorders, with their countless sympathetic ills, are caused by wrong selections and wrong combinations of food, and that right combinations of food will positively remove every stomach and intestinal disorder by removing its causes.

No one would think of putting salt into an open wound, and yet we do worse than that when we keep putting irritating acid-creating food combinations into our stomachs already surcharged with acid.

The word diet is one which has an unpleasant sound—it makes us think of giving up all the things we like for those we have no taste for. But Eugene Christian's method is entirely different—instead of asking his patients to give up the things they enjoy, he prescribes menus which are twice as enjoyable as those to which the patient is accustomed.

Christian believes in good foods deliciously cooked—the kind all of us like best and which may be obtained at any home store, hotel, or restaurant. He says that most of the things we eat are all right—but that we don't know how to combine or balance them.

Often, one food good in itself, when combined with another food equally good, produces an acid reaction in the stomach; whereas either of the foods alone or eaten in combination with some other food would have been easily and perfectly digested.

Unfortunately, each food we eat at a meal is not digested separately. Instead, all of the foods we combine at the same meal are mixed and digested together. Consequently, if we eat two or more articles at the same meal which don't go well together, there is sure to be acidity, fermentation, gas, and all kinds of digestive trouble.

At Eugene Christian's New York office there is a constant stream of men and women who go to him for treatment after having tried everything else, and rarely are they disappointed in the outcome. Some of the results he has attained read like fairy tales. I know of a number of instances where his rich patrons have been so grateful for their restoration of health and energy that they have sent him checks for $500 to $1,000 in addition to the amount of the bill when paying it.

There have been so many inquiries from all parts of the United States from people seeking the benefit of Eugene Christian's advice and whose cases he is unable to handle personally that he has written a course of little lessons which tells you exactly what to eat in order to overcome the ailment which is troubling you.

These lessons, there are 24 of them, contain actual menus for breakfast, luncheon, and dinner, curative as well as corrective, covering all conditions of health and sickness, including stomach acidity, constipation, and all intestinal disorders from infancy to old age and all occupations, climates, and seasons. They also tell you how to reduce and how to gain.

With these lessons at hand it is just as though you were in personal contact with the great food specialist, because every possible point is so thorough covered and clearly explained that you can scarcely think of a question which isn't answered. You can start eating the very things that will remove the causes of your disorder the day you receive the lessons and you will find that you secure results with the first meal. Many people who have suffered for years from acid stomach find that their ailment vanishes completely in 48 hours.

If you would like to examine these 24 Little Lessons in Corrective Eating, simply write The Corrective Eating Society, Inc., Dept. 16411, 443 Fourth Avenue, New York City. It is not necessary to enclose any money with your request. Merely ask them to send the lessons on five days' trial, with the understanding that you will either return them within that time or remit $3, the small fee asked.

Please clip out and mail the following form instead of writing a letter, as this is a copy of the official blank adopted by the Society, and will be honored at once

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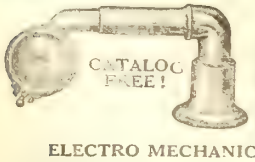
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Book Review

(Continued from page 678)

The section on mechanics takes up the subject of kinetics—velocity, acceleration, circular motion and relations of mass and space. This is followed by excellent tables giving the properties of various plane sections with formulae for computing the moment of inertia, radius of gyration and distance to center of gravity. There is also a very excellent table giving the properties of different solids. Another table and the accompanying text cover the calculation and working stresses in various shaped beams, the properties of standard I-beams, standard angles, channels, etc., with fractional differences.

One of the chapters treats on hydraulics and hydrostatics, and practical working formulae are given for the flow of water thru orifices, pipes and wires. Further sections deal with various properties of steam, steam boilers and engines, refrigeration, heating and ventilation. Thence we come to the section dealing with electricity. Only working formulas are included in this section, so as to make the handbook of the utmost value to the practising designer and engineer, who invariably wishes to look up the formula and not a long explanatory text. This section covers electro-magnetism, electrostatics, direct currents, transient currents, harmonic alternating currents, with the various formulas for computing power factor, impedance, current, reactance, etc. The mathematical relations concerned with the functioning of alternating and direct current machinery are given, as well as those for transformers and induction motors. The work concludes with an elaborate series of tables giving the values of squares, cubes, square root, cube root, etc., of numbers as well as logarithms, sines, co-sines and tangents; weight of materials, weir and orifice co-efficients; channel co-efficients for use in Kutler's formula; properties of saturated and superheated steam; and a very excellent and exhaustive table giving the conversion factors for translating all of the usual and commonly employed electrical and mechanical engineering terms, from metric to decimal equivalents and vice versa.

FINAL DIGEST FOR WIRELESS STUDENTS, by J. Henstock. Cloth covers, 88 pages, size 5 x 7⅜ inches. Price $1.25, postpaid. Publisht by James Munro & Co., Ltd., 15 and 60 Brown St., Glasgow, Scotland.

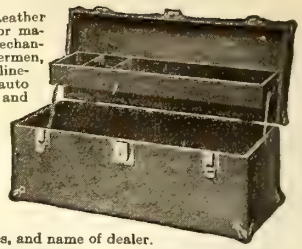
The aim of this manual by Mr. Henstock, which has been written from the English point of view, is to supply wireless students, especially those taking the postoffice examinations in England, with the most pertinent and useful instructions and directions, so as to prepare themselves for the government examination, which is held under the direction of the Postmaster General. During an examination for the Postmaster General's certificate of efficiency, the candidate is often confronted with a radio installation, which a great number of superficial faults have been purposely made in order to test his knowledge, and so by studying such a work as the present one, he may provide himself beforehand with the necessary information so as to be sufficiently grounded in radio matters in order that he may at once perceive what the trouble or difference is in the set placed before him.

It is necessary for all persons operating a wireless telegraph apparatus on board ships registered in the United Kingdom to hold either a first- or second-class certificate of efficiency from the Post-Master General, in accordance with article ten of the regulations annexed to the International Radio-Telegraph Convention. The operator, under such conditions, and holding such a certificate, must be able to send or receive by sound message in plain language in the International Morse Code, at a rate of not less than twenty words per minute, five letters being accounted as one word for a first-class certificate. To hold a second-class certificate, the sending and receiving speed in the International Morse Code is specified at from twelve to nineteen words per minute.

The first part of the book deals with elementary electrical problems, such as magnetism, induction, etc. The author then proceeds to deal with the various salient points in radio-telegraphy installations, such as the power set, its principal component parts and how they function, etc., the method of presenting the work being in question and answer form such as:—What is the main difference between the 5 K.W. and the 1½ K.W. high tension circuit? What does the primary low frequency circuit consist of? etc. Further sections deal with choke coils, fuses, various types of keys, air core chokes, transformers, condensers, jiggers, high frequency or sliding inductances, coupling, aerials, detectors, telephones, emergency set, spark discharger, accumulators, faults in sets, such as:—Q. How do you overcome leaking in aerial due to wet weather? O. What would happen if the voltmeter were placed in the position of the ammeter in the circuit, and the ammeter transposed to the circuit position normally occupied by the voltmeter?

(Continued on page 682)

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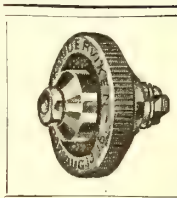
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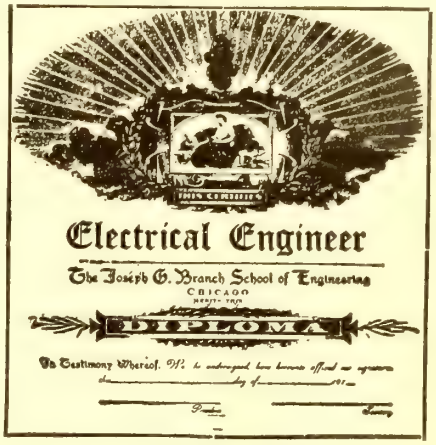
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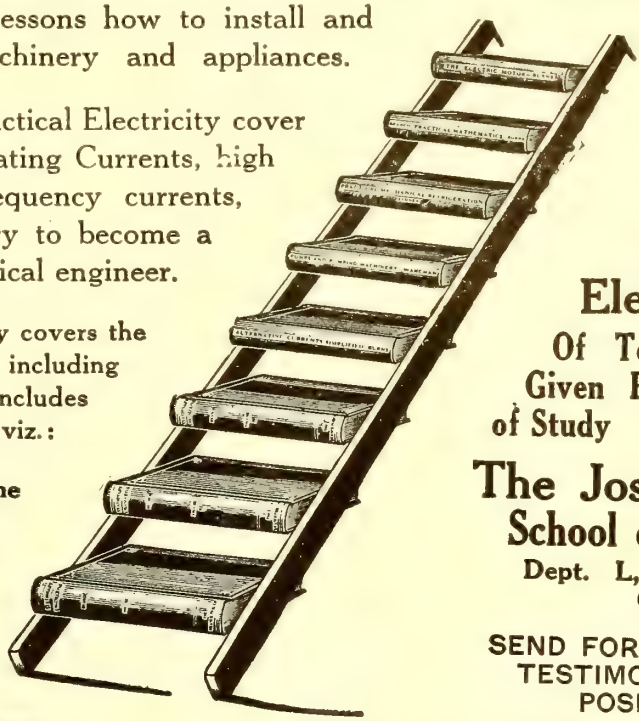
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31x4	8.00	2.25	35x5	12.50	3.50
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Book Review

(Continued from page 681)

SECRETS OF THE SUBMARINE, by Marley Fotheringham Hay. Cloth bound, 229 pages, illustrations from photographs, size 7⅝ x 3 inches. Price $1.50. Publisht by Dodd, Mead & Company, New York.

This excellent work is written in non-technical English and tells all about submarines. Readers of all classes may thoroly enjoy it, and at the same time learn the more technical and predominant features connected with their operation and strategy. The opening chapters deal with the design and construction of ubmarines, and give us some very interesting comparison figures as to the buoyancy and also the relative size of the submarines of different navies. Next we learn about the various forms of power plants and motive power which are practicable for submarine operation. Then follows an explanation of the general equipment, including steering gear, diving gear, air system, water piping system, refrigerating system, heating system and navigating appliances.

Chapter five takes up the armament, including torpedo tube and guns and the author discusses these important features in an interesting and non-technical manner. Next we find a discussion on periscopes and methods of range finding; safety devices and how they work; the safety keel as applied to submarines and other features coming under this category, such as the telephone buoy and submarine signaling apparatus, including wireless telegraphy.

EVERYMAN'S CHEMISTRY., by Ellwood Hendrick. Cloth covers, 374 pages, size 5½ x 8¼ inches. Price $2.00. Publisht by Harper & Bros., N. Y.

The author of this popularly written book happily combined an extraordinary gift of writing entertainingly and with authenticity on the matter with which he deals, which is usually the exception and not the rule in text-book writing. On the other hand, the author has shown us that he has the courage of his convictions, in that he was not afraid to carry the student reader rapidly forward as he progresses thru the opening chapters, so that by the time the student reaches the intermediate sections of the work, he will unconsciously have absorbed considerable of chemical lore. Some of the introductory chapters treat of the phases of matter; elements and compounds, chemical names and phrases, inorganic chemistry, air and water; the red-headed halogens; sulfur and sulfuric acid; phosforous, arsenic; sand and clay; lime and magnesia; iron and steel; paraffins and petroleum bodies; olefins; alcohols and some relatives; fats, oils and their products; sugar, starch and gums; aromatic compounds; coal-tar and finished products, etc., etc. The appendix contains a special explanatory table of the elements, which will be of great help to the general reader. It also contains a very useful bibliography of practical chemical books.

AVIATION ENGINES—DESIGN, CONSTRUCTION AND REPAIR, by Major Victor W. Page, formerly of the A. S. S. C., U. S. R. Cloth bound, size 5½" x 8¼", 590 pages, 250 illustrations. Publisht by Norman W. Henley Publishing Co., New York City, N. Y. Price $3.00.

The book is unquestionably one of the finest and most exhaustive treatises of the subject of aviation engines that has ever been publisht. It contains about six hundred pages, full of absolutely valuable data. Not only are the engines themselves discust, but the measurements involved are covered in a masterly and authoritative fashion.

Early in the book, the explanations offered are of great value to the student. Here the essential differences between the single and multiple cylinder engines are explained on a page opposite four illustrations depicting the actions which takes place within the cylinders. This excellent arrangement of reading text and illustrative matter is consistently maintained.

The main portion of the book, however, is what actually makes no apology necessary for the publication of the book. Aviation engines of all makes are here covered by detailed explanations, diagrams and photographs in such a manner that their individual characteristics and methods of function are clear to the aviation mechanic ond the mechanic-to-be.

The Curtiss, Standard, Hall-Scott and other well-known types of airplane motors are described, together with the method of installation, upkeep and repair.

(Continued on page 689)



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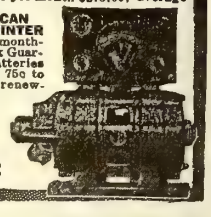
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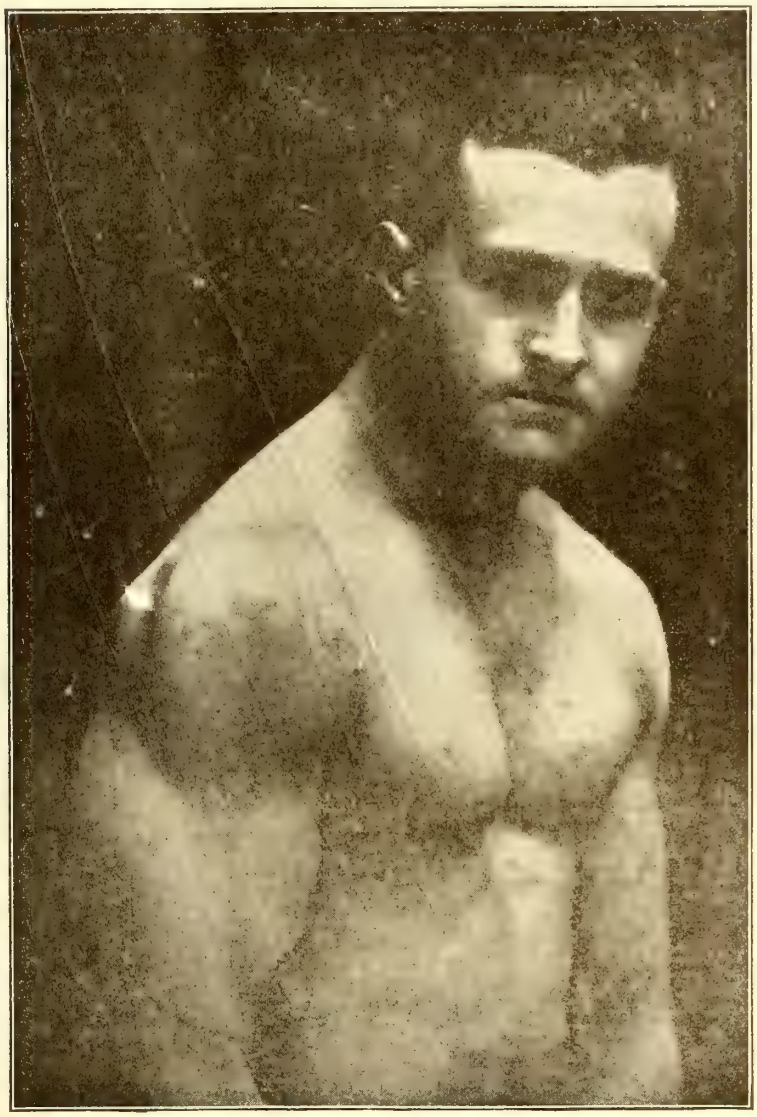
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You cannot expect to control others or command their respect until you can first control yourself.

THE MAN YOU WOULD LIKE TO BE does not heed the temptations placed before him in daily life. He does not waste his best years in dissipation following the ignorant crowd. He takes care of himself and reaps his reward. His offspring are bound to inherit his qualities. His mind and his body are clean. He can do things that others cannot do. **HE IS A SUPERMAN.**

WHY NOT BE LIKE HIM?

YOU ARE JUDGED BY YOUR APPEARANCE. The world sizes you up by your own opinion of yourself—as expressed in your looks, your actions, and the force of your ambition. It is the strong, clean-cut virile man, the man of tireless energy, that gets to the top. You cannot be alert, you cannot have full control of your faculties, you cannot have that inexhaustible supply of vitality and energy that means success in life unless you have **perfect health.** Your physical condition is the root of your whole life. Build up your body and muscular strength and you build up your mind and vitality and insure success.

Get a good healthy color in your face, feel strong look strong, be somebody—**BE THE MAN YOU WOULD LIKE TO BE.**

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Or suppose you remonstrate with a man for striking a smaller man, and the bully turns on you. Can you hold your own? Wouldn't you like to?

Or, if one of your pals says, "Come, put on the gloves and have some fun," can you do it, and get any "fun" out of it?

Less than 2 per cent of all men and boys know anything about the art of self-defense. That means when the test comes, less than 2 per cent are ready. Wouldn't you like to learn to box easily and quickly at half the usual cost?

Marshall Stillman has developed a unique "Shorthand Method" of teaching Boxing. You can learn the fundamentals in six lessons and can outbox older and stronger opponents after two weeks' study. His original principle has enabled him to teach professional boxers difficult blows and guards they could not learn by the old method. Professor Mike Donovan, former middle-weight champion of the world, who taught for thirty years at the New York Athletic Club, endorsed this "Shorthand Method," and helped prepare the lessons we send you. Boxing instructors and Y. M. C. A. physical directors are taking the course to use in their own work. Thousands of men and boys in this country and Canada,—boys as young as 12 and 15, and men as old as 50 and 60 have taken the course both for the boxing instruction and to keep in good physical condition and develop confidence and self-reliance.

It is the first time boxing has been successfully taught by mail, and it is only possible because Marshall Stillman starts with movements you are familiar with—holding out your hand for a coin, the breast stroke in swimming, etc. The first thing you know, he has led you into striking correct blows with both hands, putting the body weight behind them, guarding, ducking, feinting, etc. He teaches you the rudiments in front of your own mirror, before you face your first opponent. When you finally meet an opponent, you know how to hit him, what to expect in return, and how to guard against it.

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Name.....

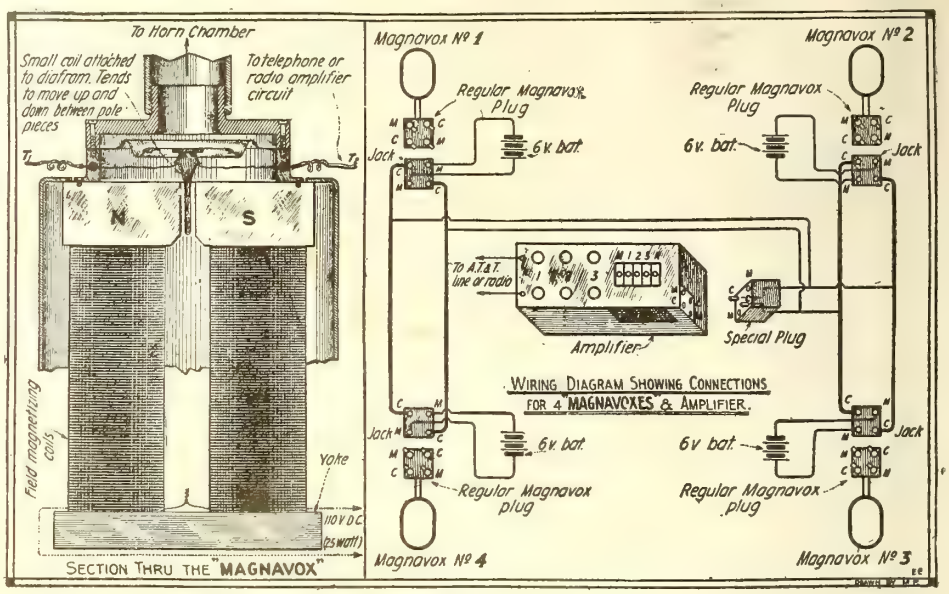
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Church Sermon Heard Over One-Half Mile

(Continued from page 636)

played on the violin could be heard easily for *half a mile*. Preaching from the pulpit can be heard distinctly for the same distance.

N. Burglund, radio and electrical engineer of the concern manufacturing the Magnavox. Referring to the diagram herewith, we see that this remarkable sound-reproducing instrument is of the *electro-dynamic*



Sectional View of the "Magnavox" Loud-Talking Amplifier.

This installation was a special test conducted by the Signal Corps, U. S. Army, under the personal supervision of Dr. B. W. Burglund.

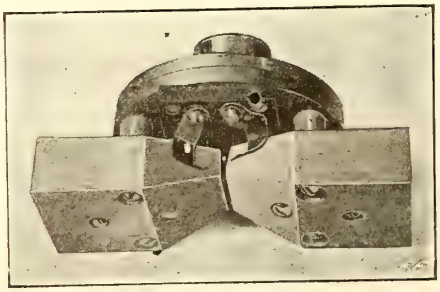
The amplifier is so constructed that one, two or three steps may be used. The cam switches on the Bakelite panel are as follows: M, master switch, controlling all currents; 1, 2 and 3 are respectively steps of amplification; R, special switch for "cutting in" a radio winding into the first step and cutting out the voice transmitter. Two binding posts are provided for attachment to any radio detector or telephone circuit.

In the circuit diagram are shown the four Magnavoxes (two for each tower) and a small 6-volt storage battery for exciting the magnetic fields of each Magnavox. This is not necessary unless the Magnavoxes are so far away from the amplifier that the drop of voltage would seriously weaken the fields.

For the sake of portability, special plugs are furnished for connecting to storage battery transmitters and plate battery (600 volts). They are not shown in diagram, but attach to the front of the amplifier.

Description of the Magnavox Reproducer.

The following details of the interior mechanism of the Magnavox reproducer are available thru the courtesy of Dr. B.



View Showing Pole Pieces and Diafram of the Magnavox Sound Amplifier. The Diafram Coil Lies Between the Pole Pieces.

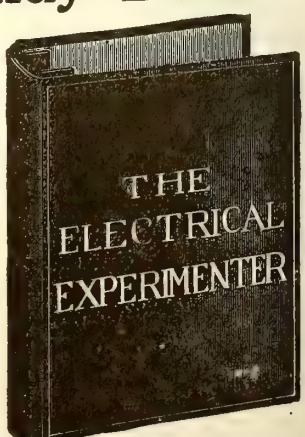
type, and in this respect differs from the usual telephonic devices intended for reproduction of speech. The ordinary telephone receiver operates on the electromagnetic principle, wherein variations in the magnetic field act upon a flat iron diafram about two inches in diameter, causing the diafram to be attracted and repelled alternately, so as to cause it to vibrate. The vibrations of the diafram in the well-known manner give rise to air vibrations corresponding to the originating voice waves at the transmitter end of the circuit.

In the Magnavox, the principle is *electro-dynamic*, and the diafram is not acted upon directly by the magnetic flux from the electro-magnet. Instead, a minute insulated wire coil is placed in a small air gap about $\frac{1}{16}$ inch long between the pole-

(Continued on page 686.)

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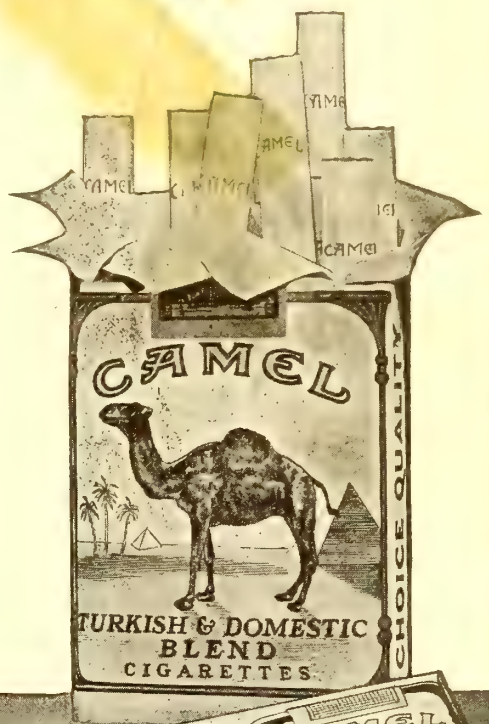
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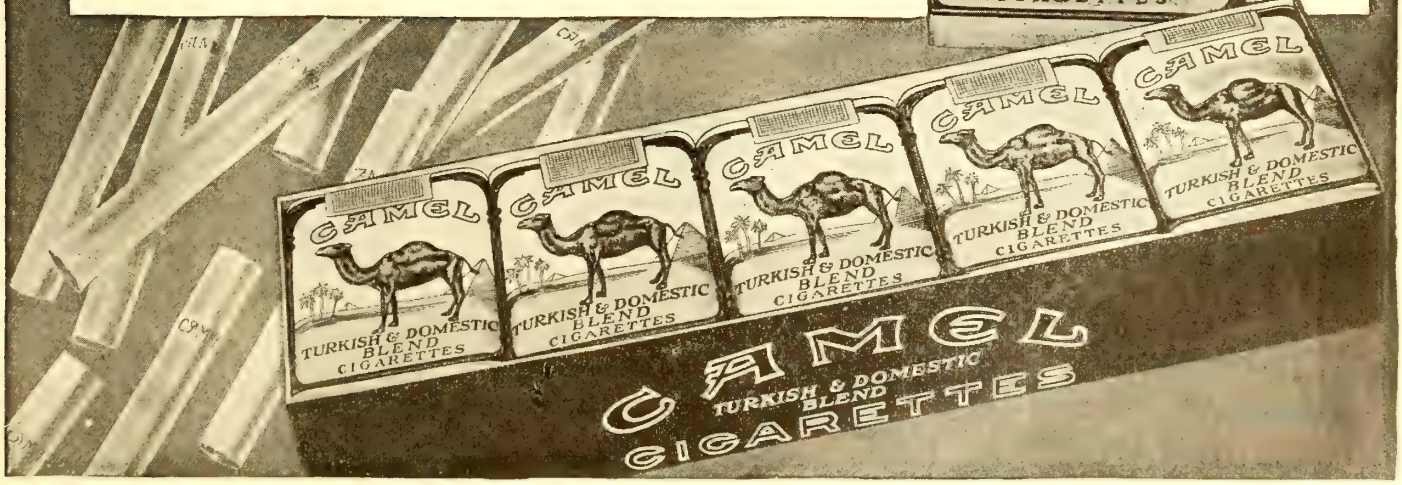
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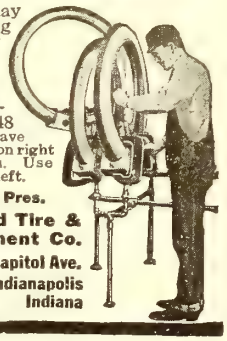
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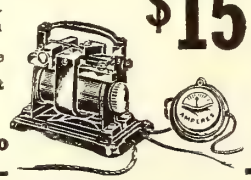
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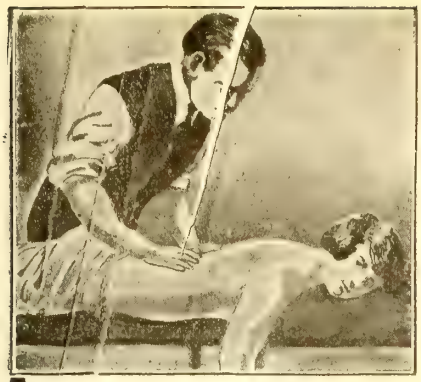
(Continued from page 684)

pieces of the powerful electro-magnet, which pole-pieces are magnetized North and South, as shown in the accompanying drawing. No permanent magnets are used in its make-up. As the fluctuating or alternating currents from the microphone at the distant end of the circuit (or else the oscillatory audio-frequency currents coming from an audion amplifier) are past thru this small coil attaching to the diafram, the coil is acted upon by the powerful magnetic field between the pole-pieces in such a manner as to be either *repelled* or *attracted* alternately (up and down) in a rapid manner, and at a rate corresponding to the voice wave pulsations. The movements of the small coil are, of course, immediately communicated to the diafram, and it is attached firmly to the latter, and in turn the movements of this diafram set up powerful air waves which issue from the sound amplifier horn attached to the instrument, and which is shown in one of our photographs. The odd shape of this horn has a special bearing on the acoustic quality and sonority of the sound waves its sponsors claim. The upright poles of the electro-magnet have one-inch round cores of annealed Norway iron, the pole-pieces and yoke members being of similar material. The magnetizing coils consume a very small amount of current, or about 25 watts, and they are supplied to operate on 6, 8 or 18-volt D.C. from battery, as desired or on 110 volts D.C.

Contrary to the general opinion, no noticeable effect is caused in these speech reproducers when the latter current is used, due to the *commutator ripple,* owing to the high impedance of the windings, which smoothes out the pulsation so that they are not noticeable at all. Another very interesting feature of the Magnavox, which its inventors have ascertained after careful research on the acoustics of the instrument, is the *diafram.* As is well known, no phonograph or talking machine with a small diafram can be capable of producing the full sonorous quality of the average voice, such as a baritone, and particularly the music from string or wind instruments of the medium or lower tonal register. This is because of the fact that the smaller the diameter of the diafram the higher the natural period or pitch at which this diafram will vibrate; the greater its diameter, within certain limits, of course, the lower the natural period or pitch of the diafram and the more quality will it give to the average class of music, especially vocal or instrumental eproductions in the baritone or base register, for example. So the experts who have designed the Magnavox found that wonderful results were obtained by using a large diafram; in fact, it measures three and one-half inches in diameter. The diafram is neither of iron nor mica, but of German silver, and, furthermore, it is not flat, but has a double ogee groove or rib prest into its surface a short distance from the outer perifery. This helps to stiffen the diafram, and together with the peculiar properties of the material with which it is made, also tends to nullify any effects of natural period vibrations of the diafram itself.

It may be imagined from what has been said before that the new sound, music and speech reproducer must be used with an audion or vacuum tube amplifier—but such is not the case at all. This reproducer

(Continued on page 688)



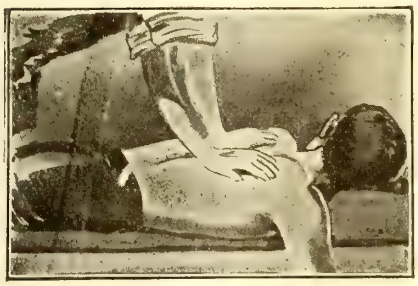
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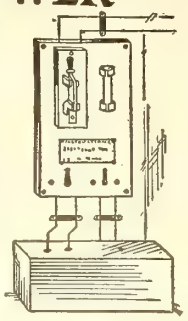
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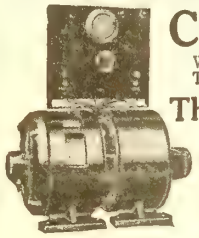
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Church Sermon Heard Over One-Half Mile

(Continued from page 686)

in itself possesses very remarkable amplifying properties and articulates the spoken word very beautifully. It has satisfied the most exacting test of the U. S. Signal Corps at Washington, as well as many experts of the Army and Navy Departments who have heard the instrument and tested it. The loud talker talks in a very loud and clear manner, with no vacuum bulb amplifiers attached. It is simply connected to a microphone, preferably a special microphone designed to be used with it, and comprising four standard microphone buttons connected in parallel, all enclosed in a single casing. In one test made with the instrument in this fashion, using a 12-volt battery current, a single reproducer was successfully employed to talk to 15,000 people, or covering a sound area equivalent to the average city block. In a test made at the Navy Department building at Washington, D. C., Dr. Burglund successfully transmitted the "tick of a watch" so as to be heard *one-half mile away* by experts who were listening for it. These tests proved very interesting, and also the manner of carrying them out. Dr. Burglund hooked up first one stage of a vacuum tube amplifier, and then successive stages. When he hooked on one amplifier he would ask thru the Magnavox that the listeners stationed about one-half mile away lift their right arms to a horizontal position if they heard the voice clearly and distinctly, and to raise the arm vertically if they heard the voice extra loud and clear, which was the case when he connected two and three stages of vacuum tube amplifiers into the circuit with the Magnavox. The amplifying horn used in these different tests mentioned has been invariably a 24-inch quarter-sawed oak horn of the particular curved form as shown in the photograph of the instrument.

One of the most astounding features of the Magnavox is that, contrary to what the reader may at first believe, it is possible when the instrument is talking loudly to place the head directly into the horn with no uncomfortable feeling of having your ear drums shattered, or any rocking of the head, as is generally caused by a very loud sound, and at the same time you can walk away one-half mile and still hear the Magnavox talking to you clearly and loudly, and on a quiet day much farther than this. This instrument has many hundred uses, and one of the applications to which it is now being applied is for use on shipboard, and the ships being built by the U. S. Shipping Board are to be fitted with it for the purpose of giving orders from the officers' bridge, or chart house, to the engine room below decks. This has always been one of the most difficult features to install on any vessel, especially on war vessels, where it was imperative that orders should be accurately reproduced and heard at all times. Due to the peculiar construction of the balanced Magnavox microphone, which has found wide application in Airplane Radio telephony and the Magnavox itself, either of these instruments can be used where there is a perfect bedlam of noise, such as created by the turbine and dynamo running in the engine room, and the noise of other auxiliary machinery, without there being the least effect on the telephonic transmitting and reproducing qualities of the apparatus. In fact, in one instance, the Magnavox was fastened on the reduction gear case of a turbo-generator on a war ship. This, we must concede, is the acid test of any telephonic device.

Book Review

(Continued from page 682)

PRACTICAL AVIATION FOR MILITARY AIRMEN, by J. Andrew White, major, American Guard. Cloth covers, 198 pages. Profusely illustrated. Size 6¼ x 9½ inches. Price $1.75. Publisht by Wireless Press, New York City, N. Y.

The excellent compilation is designed as a textbook for the student of military aviation, and its arrangement makes it highly satisfactory for the purpose. The opening chapter is devoted to definitions of the various terms which enter into a consideration of aeronautical subjects. This is followed by a description of the principles involved in the design of airplanes for various purposes. The author states that airplane design is restricted by opposing essentials which require the aerofoil (lifting surface) characteristics and velocity to produce either maximum climb or maximum velocity. A compromise between the two is affected in all airplanes, and he proceeds to illustrate these principles in a manner so lucid as to require no further explanation to the reader.

After several chapters of design, construction, and assembly of the various types of machines, the author enters upon the field of gasoline engines with which the airplanes are equipt. This section of the work is treated in a very complete manner, as is the rest of the book. The first of these chapters upon gasoline motors is entitled "Fundamentals of Motor Power," and the statements made thruout are so clear as to make one wonder at the inherent simplicity of motors. These chapters on the engines are worth-while reading for themselves, even if one be not particularly interested in airplanes. Major White carries the reader from the single cylinder engine of antiquity to the ultra-modern, high-powered machine which the modern bombing and battle-plane carries.

After these purely constructional details come the chapters which deal with the fundamentals and tactics of aeronautical manuvering.

LESSONS IN ASTRONOMY. Revised edition. By Charles A. Young, Ph. D., LL. D. Cloth covers, 420 pages, about 350 illustrations. Size 5 x 7½ inches. Price $1.60 net. Publisht by Ginn & Company.

There is, indeed, cause for rejoicing at this new edition of what may be called the most popular book on Astronomy which has ever appeared in the English language. But slight changes have been made in the text of this new edition—changes which were but necessary to bring the book up to the second and in line with the most modern researches which have displaced older theories.

The book, as a whole, however, remains as it always was: an unsurpassedly concise, clear and comprehensive text on a subject which should be known by all who have any pretentions at all to a knowledge of science. The book is particularly adapted to the needs of those who desire an unmathematical analysis of the Universe.

The section on the Moon is particularly interesting—more interesting, in fact, than the wildest romance that was ever written. This section is also of interest at the moment, because of the recent discussion regarding the motion of the moon as prompted by Tesla's startling revolutionary statements. It should be noted that Professor Young's text is based on the strictly logical, conservative theories.

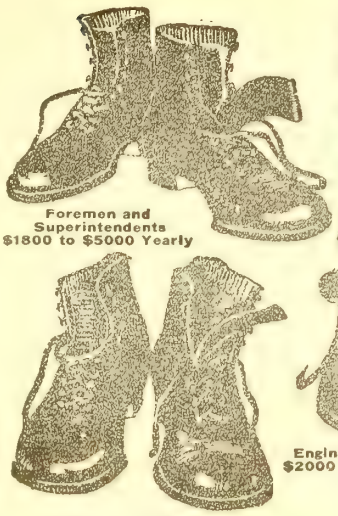
As to the appearance of the Earth from the Moon, Young is quite complimentary to our planet. He says: "It is easy to see that she (the Earth) would be a very beautiful object, on account of the changes which would be continually going on upon her surface—due to snow, storms, clouds, growth of vegetation, etc."

The entire planetary system is treated in a commendable manner. Each planet is thoroly considered in its relation to the rest of the system, and no reader can fail to obtain a thoro survey of the field during the many pleasant hours that may be spent with the book.

The stars, comets and other bodies are also treated thoroly. The phenomena accompanying comets and nebula are given careful consideration. Here it is of interest to notice the divergence of opinion on astronomical subjects by accepted authorities, as demonstrated by the hypothesis advanced by many men for cometary and nebulary phenomenons—which have caused so many foolish predictions and stupid prophecies among ignorant elements of population.

There is a meritorius appendix which includes descriptions of astronomical apparata in use thruout the world. The use of these instruments, their origin and construction, are described. The appendix also includes a description of the method employed to locate a ship at sea, the determination of time at sea, and various other problems which are well within the realm of astronomy. All presented and demonstrated with the same clarity that characterizes the entire book.

(Continued on page 690)



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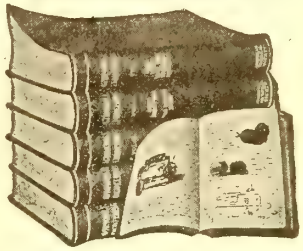
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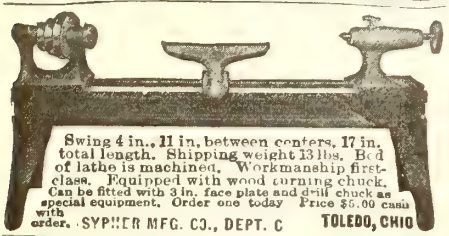
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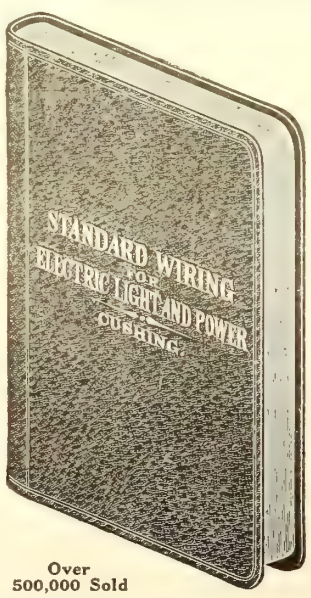
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Popular Astronomy
Earth's Atmosphere

By Isabel M. Lewis

(Continued from page 651)

Nitrogen and oxygen, which occupy 99 per cent of the volume of the earth's atmosphere, have practically no absorbing effect on the earth's radiations, but they do strongly absorb and scatter the short solar rays in the blue and violet, and, therefore, produce the intense brightness and characteristic blue color of the sky.

When the sun's rays enter the earth's atmosphere they are diffracted or broken up to a certain extent by passing from a rarer to a denser medium. The short blue and violet rays suffer the greatest diffraction and are largely lost in the upper atmosphere, while the long orange and red rays penetrate to the lower depths of the earth's atmosphere.

The beautiful sunset hues and the reddish tinge so characteristic of the sun and moon when rising or setting is due to the breaking up of the rays by the dense lower strata of the atmosphere and the trapping of the blue and violet rays by the atmosphere.

Were it not for the scattering and diffusion of sunlight by the atmosphere the sky would always be inky black and the stars and solar corona would always be visible in the daytime. All shadows would be harsh and as black as the inky sky.

Without the atmosphere there would be no winds, no clouds, no rainfall, no rainbows, no twilight, no beautiful sunsets, no living beings. The dry and barren surface of our planet would be constantly pelted with the meteorites and meteoric dust that are now almost entirely consumed by friction with the atmosphere, and only in exceptional cases reach the earth's surface. The extremes of temperature between day and night would be intense. The blistering heat of a torrid day would be followed by the frigid cold of an arctic night.

In our satellite, the moon, we see the earth as it would appear without a protecting and life-supporting atmosphere—a dry and barren waste.

One effect of the atmosphere on our planet is to gradually wear down and disintegrate the rocks and mountains thru the action of water vapor and air-currents. This disintegration of the rocks is continually setting free gases that are to a certain extent increasing the atmosphere of the earth. Moreover, many stray molecules of gas exist in interplanetary space and are swept up continually by the earth's atmosphere in our journeys around the sun. These are probably equaled in number by the molecules that escape from the earth's upper atmosphere, so that, on the whole, the atmosphere is probably neither increasing or decreasing appreciably.

The auroral displays, known as the northern and southern lights, are electrical phenomena of a nature not yet clearly understood that are associated with the rare gases of the earth's upper atmosphere. They are rarely seen outside of certain belts in northern and southern latitudes in the vicinity of the north and south magnetic poles of the earth, where they occur in great intensity. The lower streamers are at altitudes of about one hundred miles or less, and the upper streamers reach heights of five or six hundred miles. The aurorae are in some way intimately associated with the sun spot cycle and never occur except when there is unusual activity on the sun in the form of sun spots or prominences.

There is, indeed, a close connection between the conditions of the sun and many atmospheric effects, such as temperature, rainfall, cloudiness and magnetic storms.



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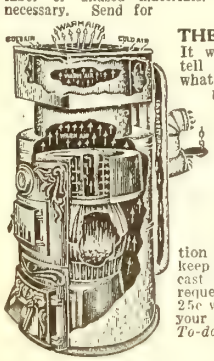
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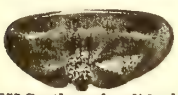


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and such progress is now being made in the investigation of the effect of changes in solar activity upon the atmosphere that it is expected that before long certain of the weather effects dependent on the sun spot cycle will become largely predictable in advance.

The earth's atmosphere shares the earth's motion of rotation on its axis, moving eastward with the same speed as the surface; that is, at the rate of 1.017 miles per hour. At high elevations, however, there is a strong tendency for the higher atmosphere to lag behind the solid surface of the earth and lower atmosphere.

Were it possible for an aviator to travel *eastward* in an airplane around the earth at the equator with the speed of the earth's rotation, 1,017 miles per hour, he would circumnavigate the globe and return to the same point on the earth's surface in twenty-four hours, but since he would travel in the direction of the earth's rotation, the sun would apparently move westward at *twice* its usual rate and would rise and set for him *twice* in the twenty-four hours. If, on the other hand, he should take a *westward* course at the *same rate*, he would, as before, return to the same point on the earth's surface after twenty-four hours; but since the earth is now turning in a direction *opposite* to his direction of flying, and *at the same rate*, the sun will move westward at the same rate that he is flying and will, therefore, appear to remain immovable in the sky during the twenty-four hours.

Were it possible for our aviator to pursue his journeys *outside* of the earth's atmosphere under the same conditions, but freed from the effects of the earth's rotation, he would find, if he traveled *eastward*, that he would make one rotation with respect to the sun in twenty-four hours, but the same place on the earth's surface would remain immovable beneath him all the time since the earth would also rotate eastward at the same rate.

If, however, he should turn and travel westward he would make, as before, one rotation with respect to the sun in twenty-four hours (only in the opposite direction), but points on the earth's surface would speed past him at the rate of 2,034 miles per hour and he would pass the same point on the earth's surface twice in twenty-four hours.

Interplanetary Communication

By Dr. C. S. Brainin, Ph. D.

(Continued from page 641)

still another point of view from which we must examine our knowledge of Mars—its physical condition. Mars is so much further away from the sun than the earth that it only receives about *forty per cent* as much solar energy per unit of area. Then, too, calculation shows that its average surface temperature, therefore, must be well below zero, as compared with 60° F. on the earth. There is evidence of the existence of an atmosphere, tho extremely tenuous, for small clouds are seen at rare intervals and sometimes the entire disk is obscured by a haze. It is of the greatest importance to ascertain whether this is water vapor, as on the earth, or not. The presence of water vapor on a planet is the *sine qua non* of our kind of life. The evidence here is again contradictory. The two famous American astronomers, Keeler and Campbell, have failed to discover any traces of it with their spectroscopes, but more recently Lowell's successor at Flagstaff has announced affirmative evidence. We must bear in mind that negative results are never as certain as positive ones, but in any case the amount of water vapor necessary to produce the polar cap phenomena

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which have been observed on Mars is very small, indeed, at the low temperature which prevails there and might be absolutely inadequate to support human life; the spring decrease in the polar caps may be due to sublimation and not to fusion.

The final possibility is Venus. Here we know that water vapor is present in abundance, for the planet is always wrapt in a heavy, cloudy atmosphere, the nature of which the spectroscope has divulged. The surface itself cannot be observed. There is some doubt as to whether the daily rotation period is about the same as the earth's or equal to Venus' year. In the latter case, it would always turn the same face toward the sun and there would be a great difference in temperature between the two faces, while along their boundary there would undoubtedly be a region with a moderate, habitable climate. In the case of the shorter rotational period the conditions on Venus would be much like those of the earth, but the average temperature would be higher.

It seems to be the opinion of most astronomers that of all the fellow planets of the earth, Venus is the most likely planet to support life, but, certainly, no evidence of it exists. In the case of Mars, we can only say that IF the observations of the "canals" should be established beyond the preadventure of a doubt, we would be safe in drawing the conclusion that life really exists there. As the matter stands to-day, there can be no doubt in the mind of anyone who will take the trouble to investigate the question that the chances in favor are next to zero. It makes a great sensational story but is far away from the truth. On the other hand, there may be life on Mars, of a kind entirely unknown to us, in spite of the fact that the "canals" are an optical illusion.

We turn now to the second phase of the subject: If there is life on Venus or Mars, can we get into intelligent communication with the inhabitants, particularly thru a wireless method? Our guess is yes. In the case of these planets it would be only a matter of a few minutes between the sending and the receipt of the message, so that the difficulty noted above with planets of other systems does not hold here. We must assume, further, that the Martians or Venereans, as the case may be, have attained the degree of scientific development represented by the possession of wireless, which is by no means a necessary conclusion. A great many more or less detailed plans have been proposed for opening such interplanetary conversations, but it seems to us that they all depend too much on the assumption that these foreign plantearians must necessarily be something like us Earthians. We would suggest, therefore, that if some rash soul makes the attempt, the basis of the code should be something which would of necessity be the same for the other planets as for the earth, *i. e.*, some astronomical phenomenon. In the case of Mars it might be something connected with the satellites, and this is probably the only sure way of getting upon common ground.

Some have suggested gigantic lights as the best way of opening communication between two planets, in the belief that foreign planetarians would be enough like us to have organs like our eyes, sensitive to the same rays to which our retina is attuned. But this does not follow at all; our imaginary neighbors might have "eyes" sensitive to ether waves which "see" ultra-violet infra-red or electromagnetic waves of lower frequency such as are used in Radio. Of course, those who believe firmly in the existence of Martian inhabitants, discarding all the contrary evidence and evading the absence of affirmative proof, are perforce led to the conclusion that these are greatly

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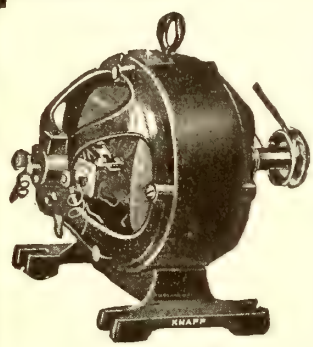
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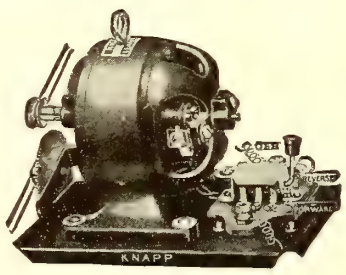
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advanced over us in scientific attainments, as is proven by the wonderful "canals." If that were the case, we should also be justified in assuming further that these Martians have far surpast us in their development of Radio in all its branches. In fact, as we discard the limits of the science of astronomy why should we put any check on our pleasant speculations? No doubt, then, the Martians possess a perfect unidirectional sending and receiving outfit, and one which is so sensitive that they can easily pick up signals from the earth in spite of the great diminution of energy which these would undergo on their way thru space. And no doubt they can send out signals with sufficient energy to be picked up by us. Some people have announced the reception of mysterious signals which they were convinced were not of terrestrial origin. We do not feel competent to discuss the electrotechnical phase of the interplanetary communication problem. It seems that the most difficult part of the game would be the first conscious interchange of probably meaningless signals; intelligent speech would soon follow.

Often science is more astounding than the greatest romance spun by the most vivid imagination, and sometimes she is a destroyer of pretty dreams. We may conclude with this unsatisfactory statement: There undoubtedly is life on planets of stars other than the sun, but communication with their inhabitants is at present certainly out of the question; in the solar system itself, where interplanetary communication is not without the realms of possibility, no evidence of extra-terrestrial life has been found, tho its existence is not precluded.

HOW WE COULD TALK TO MARS BY RADIO.

In connection with Dr. Brainin's above article in which the professor advocates the use of the radio to bridge the gulf between the Earth and Mars, it is pointed out that in 1919 already Mr. H. Gernsback advanced such a plan. His article which was printed in the May 1910 issue of *Modern Electrics* magazine shows that the idea is not only feasible but eminently practical. In those days it was not possible to cover by radio one thousand miles, unless we had a power of at least 2 kilowatts at our disposal. Today with our sensitive vacuum tube amplifiers, it is possible to bridge one thousand miles with a ½ K. W. with ease, and in exceptional cases ¼ K. W. will bridge the distance. It should be borne in mind that this distance is thru the earth's atmosphere which greatly impedes propagation of radio waves. If radio waves are a manifestation of the lumiferous ether, and few scientists doubt that it is, then the earth's atmosphere not only greatly restricts the sending impulses, but cuts them down enormously.

Take a ray of light, as any astronomer knows the stars overhead are always seen best for the reason that in this case the light ray only passes thru thirty or forty miles of atmosphere. On the other hand when stars are observed low down in the horizon where the ray must pass thru hundreds of miles of atmosphere, it is very difficult and somtimes impossible to see the stars at all. It is a well-known fact that light rays and electro-magnetic waves (such as radio waves) belong to the same family and only differ in respect to wave length.

For that reason, it should be possible to send radio waves thru interstellar space with much greater facility than thru the terrestial atmosphere. Where it takes today one half or one quarter K. W. to transmit radio waves over one thousand miles of Earth, there is no doubt that this distance can be increased ten or twenty fold in the outer space, providing always that it is possible to propagate the waves on the *outside* of our atmophere, which fact we do not know as a certainty. It is a specula-

tion among scientists today if the radio waves can pass beyond the atmosphere at all.

Inasmuch as the light rays pass thru the Earth's atmosphere with ease, however, there seems but little doubt that radio waves will act in a similar fashion. Once we grant this truth, it should be simple for us to telegraph or telephone to Mars. If we figure at the rate of ½ K. W. per thousand miles on Earth thru our atmosphere, it should be possible to telegraph over the space of 35 million miles which separates the Earth from Mars at the time of oppostitution by using anywhere from five to eight thousand K. W.

In his article in May 1919, Mr. H. Gernsback proposed using 70,000 K. W. to telegraph from the Earth to Mars. At that time it was figured that this tremendous energy would be required as then it was necessary to figure at the rate of 2 K. W. per thousand miles. Mr. Gernsback proposed at that time to use all existing radio stations in the United States and Canada, *operating them* simultaneously by means of telegraph lines connecting all the stations together and working them from one central point.

In other words, a station in San Francisco and another one in New Orleans was to be operated from a central key at Washington. This idea would accomplish two things. In the first place it is even today impossible to operate a station of four or five thousand K. W. capacity. No station could hope to handle such a tremendous energy. But by using separate stations, the object can be readily realized providing these stations can be operated simultaneously.

Connecting such stations together by means of a land wire, however, is only a theoretical consideration and is not practical. The reason is that electricity in passing thru a long land line of several thousand miles takes a good deal of time in transmission, sometimes as much as three quarters of a second. For this reason if the key was pressed in Washington, the station at San Francisco *would lag behind* for a fraction of a second from the one in New Orleans. For this reason, except if signals were being sent out at a very slow rate, the scheme would be impractical. In our illustration shown elsewhere, this difficulty has been overcome by connecting these stations together not by means of a wire, *but operating them by means of radio control.* This is a thing not very difficult of accomplishing these days when distant control by radio has been tested out. The scheme would work thus:

An operator seated in Washington would press his master key. This key in turn would operate his own radio station. The impulses sent out from this station will cover the entire globe practically instantaneous, and reaching the various high power stations, *will operate these stations the same as if an operator were seated at each one of these stations.* In other words, instead of using land wires, radio would be used. The advantage of this system is that all stations can be operated simultaneously down to the smallest fraction of a second, and the important part of this scheme is that it costs practically nothing or only a relatively small sum to put the idea into operation any time when we are inclined to make the experiment. The important other consideration is of course that all the stations would have to be tuned to a certain wave length so that all of them would work in unison, the same as if there were only one single huge station. We have enough power in existing stations in the United States and Canada today to bridge the 35 million miles between the Earth and Mars.

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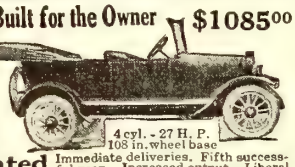


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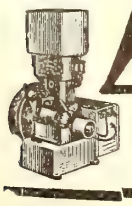


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(Continued from page 627)

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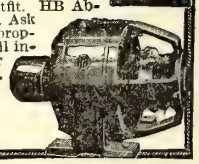
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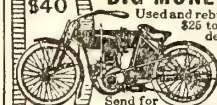
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"Old Phonograph Record" Contest.

(Continued from page 646)

turbine can be made with any size records. When finished it may be coupled with a small dynamo. First slip a threaded iron rod thru a record, slip on a washer, then a record, etc. I used five "Little Wonder" records and obtained satisfactory results. When the records are on, screw a nut on the ends to keep them from wobbling. Now make the box. Make it just large enough to fit over the records. It may be made round, but it is easier to make it square and fill in the corners with wood as in the figure. Bore two holes in the sides and put a piece of pipe in firmly to make good bearings for the shaft. On each side put washers and a nut. A pulley can be put on or just couple it with a dynamo, etc. Put two pipes in the housing, one to lead the water in and the other to serve as an outlet.

Contributed by W. P. Jones, 176 Mutual Street, Toronto, Ont., Can.

FOURTH HONORABLE MENTION.

An Electric Egg Tester.

This is an idea for making an electric "Egg Tester" from a 10-cent record. A holder is cut from a piece of tin or brass with a hole in one end to fit on to the neck of an electric light bulb, and fastened to the record as shown. Then a hole is made, either round or egg shape, in the center of the *record*. The light is turned on, and the egg is held over the hole. The record is black and the light coming thru the hole makes the egg show up, and in this way indicates if it is good or bad.

Contributed by Lawrence Bean, Lock Box 7, AuSable Forks, N. Y.

FIFTH HONORABLE MENTION.

Radio Compass Antenna.

The Radio Compass Antenna described on page 328 of the August *Electrical Experimenter* may be constructed by procuring two 10-inch old phonograph discs. On one disc draw diameters at right angles. Cut a perfect square, whose side is 4½", from white paper and draw diagonals. Paste the square on one disc so that the center of the square will be over the center of the disc's circle.

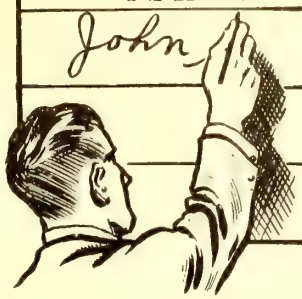
One-sixteenth inch "in" from each corner of the square, drill the holes A, B, C, D, Figure 1, with a No. 27 drill. Bisect each side of the square and drill holes E, F, G, H. Clamp the discs together and drill the second one the same way, using the first as a guide.

Eight 1¼", 6-32 screws are now procured and put thru the holes in the first disc and fitted with fiber tubes ¾" long and just large enough to fit over the screws. The second disc is then placed on and fastened with 6-32 nuts.

This completes the form. A coil consisting of 240 turns of S. C. C. wire is wound on the form. This aerial, properly connected, should prove very useful to those unable to erect a large outdoor antenna.

Work of this antenna as a Radio Compass: Such an antenna, under certain conditions, when properly connected, as is shown on page 328, of the August issue, will operate the radiodynamic "Ionic Machine" described by the writer in the May 1917, issue. In my above mentioned article, the binding posts of the "Ionic Tuners" are shown directly above the "Ionic Tuners" (and rectifiers), which are themselves shown at "7" and "8," Figure 1.

It is to these binding posts that the leads of the "Radio Compass" antenna should be connected. The buzzer of the "Ionic Machine" will then start, as soon as the coil

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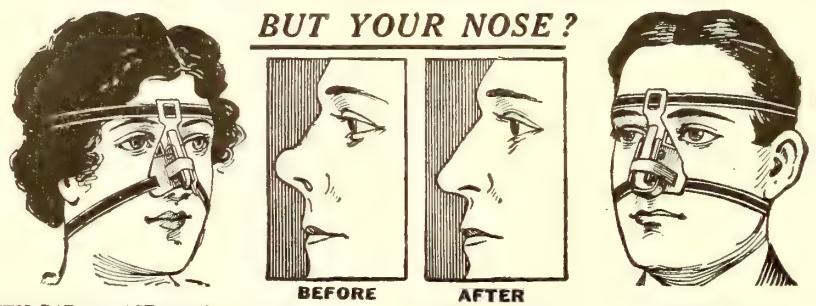
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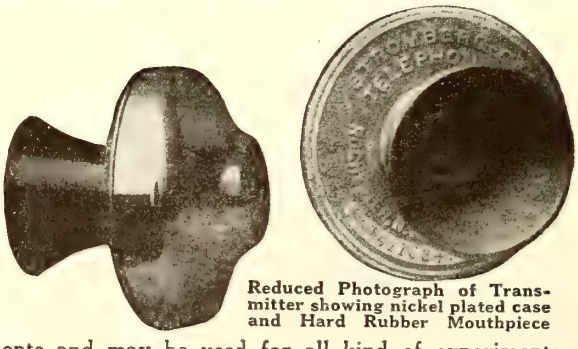
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Ship. Weight, 2 lbs.

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of the antenna becomes by rotation directly in line with the plane of the propagation of the wave radiated from any station which is sending.

I thought that it might be interesting to know that the "Radio Compass Antenna" is capable of directional radiodynamic control.

Contributed by Otto E. Curtis, 84 St. Stephen Street, Boston, Mass.

SIXTH HONORABLE MENTION.
Cylindrical Records for Oudin Coil.

The old cylindrical Edison records make a fine form to wind coils on, as the grooves hold the wire in place. Such forms can be used for a small Tesla or Oudin coil, primary or secondary for small loose couplers, tuning coils and loading coils. They give far better insulation than cardboard tubes, which often shrink and then the wire slips or loosens.

Contributed by G. Edwin Smith, Wanchula, Fla.

SEVENTH HONORABLE MENTION.
Transformer Section Translators.

I give nerewith a sketch of a practical use for old phonograph records—for insulating between the "pies" or sections of transformers or spark coils. The drawing, I think, is self-explanatory.

A square hole is cut in the center of the record to receive the core and they are placed one between each pie.

Contributed by Benedict V. K. French, 225 Allen Street, Buffalo, N. Y.

EIGHTH HONORABLE MENTION.
Radio "Loading Coil."

Herewith is a diagram of how to make a "loading coil" out of old phonograph records. You take two 10-inch records, a piece of wood 2" in diameter and 2" thick and then shellac (or, bolt) them together as shown. Then wind No. 28 cotton insulated copper wire on it, until there is only one inch space left on the records, take out a tap every layer or so, and bring to a switch point on top of the record. Put on a switch arm and hook it up. I have used this for some time and it works as well as a regular purchased one.

Contributed by Howard B. Bogue, 812 N. Ainsworth Avenue, Tacoma, Wash.

NINTH HONORABLE MENTION.
Sharpening Razors with Old Records.

First take an old record, sandpaper it with coarse sandpaper, then with a fine sandpaper, and finally moisten the record and put a little kitchen cleanser on and with a block of wood rub it until a fine surface appears. When fully cleaned and dry, put it on the Victrola and let it run and hold the razor against it. If razor is very dull put a little "Bon Ami" on and it will sharpen with ease.

Contributed by Jos. Ruhland, Oconomowoc, Wis.

(Our office boy "Fips," who saw this suggestion, barked out thus: Suppose Mr. Ruhland sandpapers the *reverse* side of the record and leaves the music side alone. Then let him cover his Victrola turn-table with leather. Insert the razor between the record and turn-table and one side of the razor will be sharpened, the other stropped! Then don't neglect to play the music on top of the record *at the same time.* I'll apply for patent on this rinktum at once! Bad, eh?)

WIRELESS TAPPING DONE BY BELA KUN.

By "tapping" the wireless exchanges between Paris and Gen. D'Esprey, with the powerful wireless plant at Caepel, Bela Kun, the Bolshevik dictator of Hungary, was enabled to foretell every move made by the Rumanians in their contemplated offensive or by the counter revolutionary government in Hungary.

Bela Kun has been enabled to read cipher messages by means of a code book which was stolen from the Allies.

Science In Slang

By Emerson Easterling

(Continued from page 669)

are they; and cousins, we might say. How about the life forms on the other planet? A different compositional environment would produce a different sort of beings, wouldn't it? You know that Man was manufactured out of the dust of the Earth. Well, Mars has a little differently compounded dust—not much, I guess, but somewhat different—sufficient to make a different being. Of course that is just my idea of it—but all of this Mars stuff is mostly *idea.*

"If we concede that Mars is on the lookout for some expression from us, or is waiting for some response to some of their signals that past over our heads; what do you think that they dream we are trying to tell them by the evidence given in the way of smoke and surface altering in our past battles—especially the last European shooting match? Don't you think that they could see us making the big smoke and everything? Of course, accepting that they can see."

"I don't suppose that they could hear us—thru all that thirty-five or forty million miles of ether," put in Bender.

"They may have their sense of hearing developed like a dog's smell," said Punk sardonically.

"Talking of the optical demonstrations that are proposed to attract Mars' attention, what do you suppose they think of our volcanos? I suppose they understand them, probably know more about such things than we do———"

"Prohibition and the sex question included," snapt in Punk, licking his lips and not even looking at the pretty young woman that past by our crowd and almost turned the subject.

"I suppose that their time intervals are the same as ours—being that that goes in as one of the basic creative fundamentals—if you know what that means, I don't, hardly. In that respect we are homogenous—if there is any one at the other end of our proposition to make a *we.*

"The telegraph idea will probably make the gap better than the ash and darkness stuff. The etherial disturbances are more than likely better adapted to the Martians' receivability. Perhaps they have not developed along that line tho. Perhaps they have not the natural resources in the electrical line, due to different mineral composition or planetary relation. However, I don't think that that would make any difference, tho.

"Anyway we will sit tight and watch such guys as Marconi, Tesla, Wood and the like and see what turns up with Mars at the other end of the line. We are *doing* things today in that line. We, the world in general, will not be more surprised at finding that we have neighbors on Mars than were we at the discovery of the force of electricity, the air-ship, the telephone, wireless, or the shimmie.

"Our train is ready to get on its way to Pendleton," spoke up Punk, "Row-de-dow!"

"Here's to talking to Mars over the back yard fence," said Stokes, as we walked out thru the gate to our waiting train. "We may pick up a paper tomorrow and read that some one has just received a message from Mars."

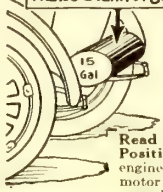
"Yes," replied Bender, "and it might be a false alarm too."

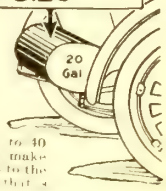
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ONE MAN MADE $210.00 IN ONE DAY. READ THESE LETTERS.

These are extracts from actual letters received from sales agents. They tell the story better than we can. Here's what O. V. Darling wrote us:—

"Made a test of Miracle Motor-Gas today on a 103 mile trip. Had two Fords. The one with the Miracle-Gas used only 3¼ gallons of gasoline; the one without Miracle-Gas used 7 gallons." As a result of this test he sold Miracle Motor-Gas like hot cakes. In one day he sold enough to make a clean profit of $210. We have his letter to that effect.

Next comes this letter from Dave Isom: — "My whole heart and soul are in this work. The Commercial Club of 4,000 members is boosting for me. Everyone is well pleased. Have two more men working for me. Send me 800 more packages by express. I can't afford to be waiting for goods. Sold 90 packages yesterday." (That's over $60 profit.)

And then read this one just received from R. Vollbrecht:—"Miracle Motor-Gas a big success. My 6 dozen were gone in two hours. Ship 50 dozen by return express. Will have to order in carload lots soon. Miracle Motor-Gas is a wonderful proposition."

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Are you going to "get in" on this opportunity,—are you going to be one of the big money makers. Why work for a bare living when you can make hundreds every week. Don't let this chance slip by. Sit right down now and write us. Show the kind of stuff you are made of,—show folks that you too can make big money. Anyone with ambition and a willingness to work can make good with Miracle Motor-Gas. Read all those letters again. They prove you take no chances. Or, wire our bank. They'll tell you how we stand.

GET BUSY! DON'T WAIT!

Don't make the mistake of being a doubter and losing the opportunity. Our guarantee protects you. Or, better still, if you order two packages at the 50c trial price, and after testing them you aren't satisfied, send back the unused goods and get your dollar back. Miracle Motor-Gas is a proven proposition. It has demonstrated what it will do and now we want hundreds more good live agents to sell it. So get busy—get your order to us at once and tell us what territory you want. But you'll have to act quickly. Better get the Coupon on the way to us by return mail. Wire if you want terms for exclusive rights in your State.

CHAS. A. BUTLER & CO.,
193 Wayne Bldg., TOLEDO, OHIO
Reference: Home Savings Bank, Toledo.

CHAS. A. BUTLER & CO.,
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If your proposition is all you claim for it, would like the exclusive agency for . . . County. Send full particulars.

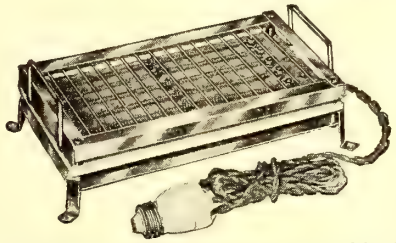
Enclosed is $1.00 for two packages of Miracle Motor Gas. (Retail price $1.00 each.) If I am not satisfied after I have used them, it is understood that you will refund my dollar.

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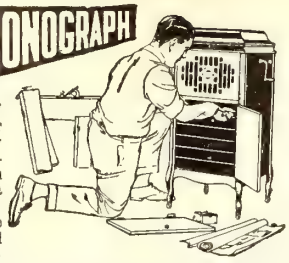
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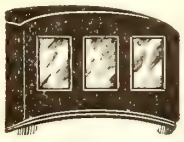
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New Electrical Gyro Compass

(Continued from page 639)

Gyro Compass two wheels are used, so that both wheels combine their effect in fixing the meridian. When the ship rolls one of these rolls opposes the forces thereby set up, while the other holds and indicates the *true north.*

Figure 1 shows the binnacle stand with the glass dome cover taken off and the lower case dropt down, so as to show the two sensitive elements. Each wheel is mounted within a case which is suspended from a main frame and spider, as shown in figure 2. Following the standard practise of the U. S. Navy, the compass card is marked in degrees, instead of points of the compass, as formerly used by navigators on the old magnetic compasses.

The cross-section drawing, Fig. 2, shows the method of suspending the wheels from the framework, and also indicates the trolley, which is merely a very sensitive contact for detecting any movement of the wheels. It forms a pilot contact of a secondary system, whereby the compass card and other parts of the compass are operated by means of a motor, so as to relieve the wheels of all duty other than indicating the *true north.* As shown in the plan view, figure 3, the *azimuth motor* accomplishes the work of moving the card. It is a very small electric motor geared to a continuous rack under the compass card.

On the opposite side of the compass from the azimuth motor is a *transmitter.* This transmitter consists of three fingers which have electrical contacts, and are operated by means of a small cam shaft acting in under each contact. As the card is moved by the azimuth motor the same rack also operates the pinion that is connected to the cam shaft of the transmitter. Contact on the three fingers is made in such sequence as to connect in various pairs of poles in a step-by-step motor, mounted in the *repeater,* Fig. 5.

The main *Master* Gyro Compass is placed down below deck so as to protect it from weather and sea, as in Fig. 4. It has *repeaters,* however, that show its exact reading at any instant. A similar and familiar application of the repeater principle is that used in hotels and public buildings, where a master clock operates a number of repeater clocks. As stated above, a step-by-step motor is contained within the repeater, operated from a transmitter on the Master Gyro Compass. The step-by-step motor operates the card of the repeater mechanically, and its movements shadow those of the Master Compass. A number of repeaters are used on the ship, such as on the bridge, the Master's Cabin, on the stern deck, pilot house, and at all auxiliary steering stations.

The workmanship of a Gyro Compass must be of the very best. It will be seen how necessary this is when it is considered that each of the twin gyro wheels revolve at 12,000 revolutions per minute, or 200 r.p. second. Each wheel is driven by a small three-phase, induction motor.

A switchboard panel for controlling the ship's supply current, usually 120 volts, is also furnished. The ship's supply current is usually direct current and is converted by means of a motor-generator set to three-phase electricity for spinning the gyro wheels.

In case of failure of the ship's supply current the compass will still operate for a period of two hours, as a storage battery is connected in on the line and is automatically cut in when the emergency occurs.



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PATENT ADVICE

Edited by H. Gernsback

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

Automatic Release Air Valve.

(350) T. A. Ayes, Ilion, N. Y., writes:

Having applied for a patent on an "Automatic Release Air Valve," am writing you to get your opinion as to its merits, aad whether you think it advisable to try to commercialize it or not.

The idea of the valve is to release the remaining pressure from the air hose after the valve has been closed, and do it automatically, not leaving it to the trainman to do it or not, and by the use of such a valve you are reducing the chances of wrecks and accidents by doing away with the cause of such accidents.

There are hundreds of accidents (and wrecks) caused by air hoses bursting while the train is in motion, and in every case it can be traced to a weak air hose; and what caused the air hose to be weak? It was all O.K. when it was put on the train, because the railroads will not have anything but the best in air hose, knowing the responsibility resting on it. Then what made it burst? One thing, and only one thing, and that is the very thing my valve does away with, which is: pulling the hose apart when an uncoupling is made, while the pressure is still in the hose. With a pressure of 85 lbs. it takes quite a pull to part two hose, and the pull either bursts them at once or it strains them so that the jar and vibration of the running motion of the train causes them to burst, with a consequent wreck, with loss of life in lots of cases.

The valve used at the present time is the cause of it all, for the reason that it will not release the pressure from the hose when turned, and the trainmen will not run the risk of uncoupling the hose by hand, as they run the chance of getting hurt every time they do so. So in either case my valve is cutting down the chance of accidents either to the trainmen or train.

Another incident: A week or so ago, at Dunkirk, N. Y., a train ran into the rear of another train because the airbrakes refused to function, for the reason that a tramp stealing a ride on the train had (accidentally or otherwise) turned one of the air valves (or cocks), so that when the engineer applied the brakes they only worked on the engine and tender, because the line was cut at the valve turned by the tramp. Now, if that valve had been one of mine, the accident would never have occurred from that cause, for the simple reason that as soon as the valve had been turned by the tramp the brakes would have been set either on the train or on the engine, according to whichever value he turned.

I am only asking you as to what you think of the idea, as I have a working model and know it will do everything claimed for it, and will cost but very little more than the present valve.

A. If our correspondent's release air valve works in the way he claims, he certainly should have a valuable patent, and we are sure that the railroads would welcome such an improvement on their airbrake system, which improvement is badly needed. We would advise our correspondent to get in touch with a patent attorney.

Automatic Sign.

(351) Robert N. Rose, Queens, L. I., has this to say:

I would like to ask your advice concerning a new idea of mine and hope to see the answer in a near issue of your magazine.

Perhaps you have noticed on some of the subway stations electric signs which announce the destination of the trains as they come into the station. I have devised an automatic way of lighting these and it would cost but a small amount to make them.

About a foot above the rails from the beginning of the station to the end I would run several copper strips a few inches above each other. On the train would be a metal wedge fastened to a rod which runs up on the car, and say the lowest strip was to operate the sign reading "This train for Van Cortlandt Park." The conductor would then move the rod to where on the dial it said the above station (or to some other station) and when the train would come into the station the wedge would connect the circuit and the sign would light. There are also some other features, but this is the principle.

A. There is nothing fundamentally new in a device of this kind, and there have been ingenious patents issued along similar lines before, but somehow or other traction companies have never been kindly disposed toward such devices.

Cold Air Device.

(352) Irving Simpson, Brooklyn, N. Y., advises us:

I enclose a drawing of an idea which occurred to me while thinking of the methods of cooling the atmosphere in the home and elsewhere during the hot days of summer. The common electric fan does not cool but merely "stirs up" the air.

It is a well-known fact to scientists that when a current of electricity is passed thru a bar of Bismuth and a bar of Antimony and both bars touched to each other, the temperature at the points at which the bars touch is sufficiently low to freeze water. This "cold" generated is the principle of my idea.

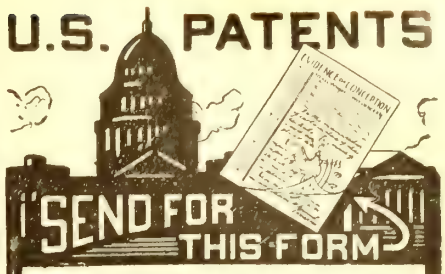
A sheet of Bismuth and a sheet of Antimony (which are specially prepared so that they are perforated and that the space between the perforations are raised to points), are placed in a case so that the points of both plates touch. The current is turned on and a fan is placed in back. The current of air coming from the fan passes out thru the screen into the surrounding air.

A. The idea set forth by our correspondent is certainly worth trying, but we do not know offhand what success it will have. While the Peltier effect is well known and has been described at length in this magazine, very little is known as to what happens when a plurality of contacts are made between the two metals. The experiment is surely worth while trying. We think a patent can be obtained on this device should it work.

Electric Alarm Clock.

(353) George Daniels, Hamilton, Ontario, Canada, writes this Department, with sketch, proposing a novel and simple electric ringing attachment for alarm clocks, and asks our advice as to its patent aspects.

A. Your scheme is certainly very simple, and should work satisfactorily with any standard form of alarm clock on the market. The editor has experimented a great deal with electric alarm clock attachments, and has often considered the commercial possibilities of manufacturing such an attachment, but he has come to the conclusion that very few people will invest in one of these devices unless they can be purchased for a very small sum—certainly less than $1.50 or $2.00, the usual price for the simplest electric alarm clock attachments available.



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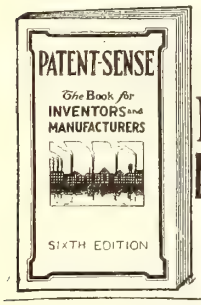
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Patent Advice

(Continued)

However, you might do very well in endeavoring to obtain a patent on your scheme, and to this end you should take the matter up with a patent attorney, a number of reliable ones advertising in these columns. As soon as you place the drawing and specifications of this device in the hands of your patent attorney, he will immediately make a search of the patent office records to ascertain whether or not there are any conflicting patents, and will notify you one way or the other.

In closing, we might suggest that to successfully commercialize this electric alarm attachment, it should be simplified and made as cheap as possible, utilizing a flashlight battery instead of a large size dry cell, and also using as cheap a bell as is available, or even designing a very simple and cheaply manufactured bell for the apparatus.

Electric Motor.

(354) J. P. Morgan, Pliny, W. Va., writes us, showing a sketch of a simple D. C. rotating field motor, as he calls it, and wants to know if it would be worth patenting. It employs oppositely disposed pairs of field poles, which are successively excited so as to drag around a pivoted iron armature.

A. The scheme you show with the motor field composed of a series of electro-magnets, which are excited in pairs successively by direct current in order to drag around a simple iron armature having no windings upon it, is quite old, indeed. You will find such motors of several different and very ingenious types described in many of the books on electric toy making. In fact, the earliest electric motors, dating back 35 to 40 years or more, were constructed on this simple, yet inefficient principle.

Unless you have something novel in mind in regard to the design of this small motor, which you do not disclose in your description of the device, we do not believe you can obtain a patent on it. However, the best thing to do is to take the matter up with a reliable patent attorney, and we can recommend any of those advertising in these columns. The patent attorney will make a search of the U. S. Patent Office Records and ascertain the nearest similar patents which cover ideas identical to or closely resembling your proposal.

Simplified Electric Motors.

(355) C. W. Halligan, Lewisburg, Pa., writes as follows:

"I should like your advice on this idea: It consists essentially in a radically different design of electric motor, and would, no doubt, find its principal application in toy motors.

"Referring to the drawing, Fig. 1 shows an end view of the essential parts. A single magnetic coil is provided with a hollow core. An iron shield surrounds one-half the interior of this space, as shown. The shaft is at the center of the solenoid, and is provided with a cam extending the whole length of the shaft and shaped as shown.

"In Fig. 2 the brush mechanism is shown. The cam, continued beyond the end of the solenoid, provides a means of making and breaking the circuit at the correct time.

"In operation, if the solenoid be energized, the cam will tend to assume the position indicated by the dotted lines in Fig. 1, following a well-known law in physics. At this time the current is broken and is again made after one-half revolution by the brush shown in Fig. 2. In this way rotation is effected.

"In Fig. 3 an alternative construction is indicated. In this case the shield is omitted and the axis of rotation is eccentric to the axis of the solenoid. The principle is the same: The iron will tend to assume a position such that the distribution of magnetic flux is symmetrical, the same as in the magnetic vane type of volt and ammeter. A suitable flywheel must be provided on the shaft to insure an even rotation.

"Please advise me as to the commercial value of the idea and its patentability as soon as convenient."

A. As you suggest, the theory of the operation of this motor is correct, and undoubtedly it will develop quite an appreciable amount of power if a very powerful electro-magnet coil is used. We presume you have done some experimenting already and determined just what proportions the various parts need to have, in order to work most efficiently for a given voltage and amperage.

We do not remember having seen anything just like this in the form of an electric motor for toy purposes, and believe that you can obtain a patent on it. Its simplicity should make it quite worth while for commercial development, so long as the design is confined to a small motor, as, of course, a large motor built on this principle would be very wasteful of energy. We would suggest that you put this in the hands of a patent attorney and have him make a search in the U. S. Patent Office for any conflicting patents. He will notify you directly whether or not there are any such patents which would interfere with the granting of a clear title patent for you on this invention.

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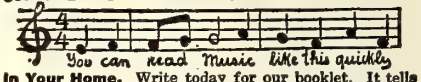
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Sun Signals for Fighting Forest Fires

(Continued from page 628)

est Service to extend heliograph communication to the work of discovering and extinguishing fires.

It is pointed out by Arthur L. Dahl that in order to test the adaptability of the heliograph to the fire patrol conditions some experiments were tried in the California National Forest in the northern part of California. A competent instructor was secured and seven men were chosen from among the rangers to learn the art of signaling. None of these seven men had any previous knowledge of the instrument, but they quickly learned the technical part of their work and became proficient operators in a very short time. When the experiments were begun the only apparatus available was the standard heliograph instrument used by the Signal Corps of the Army.

There are a number of these instruments used by the forest men. The instrument consists of two four-inch square mirrors and adjustable frames, a mirror bar, a sighting rod, a shutter and two hardwood tripods, to the top of which the whole outfit is attached. The equipment is rather bulky and weighs approximately twenty pounds. The principle of the heliograph is the reflection of the sun's rays steadily in a given direction, provision being made for alternately exposing and obscuring the mirror so as to transmit a series of long and short flashes. This device is set up at a point from which can be seen the station to be signaled. By means of the sighting rod and the tangent screws the instrument is sighted on the receiving station. The mirror is then so adjusted that the reflected ray is projected directly toward the station. The circle of illumination created by the mirror has a diameter *which increases approximately fifty feet for every mile of distance from the mirror.* For example: If the receiving station is six miles distant, the space at that spot within which the flash can be seen would be 300 feet wide. As the shutter is placed directly in the path of the reflected rays, flashes are transmitted by opening and closing the shutter. The actual manipulation is very similar to that used in telegraphing. The best code for heliograph communication is the Myer code, used as a standard by the Signal Corps.

It is stated that in some cases the Morse code has been used for this purpose, but since it was created primarily for audible signaling rather than visible signaling, it is not adapted for heliograph work. The Morse alphabet is based on a combination of ones and twos. For instance, the letter A is represented by 22, the letter L by 221, and the letter P by 1211. The one in the Myer code is represented by a short flash. This means holding the shutter open for about one-half second. The two is represented by two shorter flashes in quick succession. Spaces between words are represented by a long flash of about two seconds. It is of the utmost importance that uniformity in the mechanical movement of the shutter be cultivated, as lack of rhythm in the signals of the sender entails unnecessary concentration on the part of the receiver.

It is maintained that it is easier to send than to receive messages, and one of the difficulties to be overcome by the forest rangers was to secure perfect team work between the men, as the men at first sent their messages too fast to enable the "receiver" to decipher them. When the men had been taught the code, and were able to send messages, a definite system was laid out for the forest. There were within the experimental area two prominent peaks al-

To cut down the cost per cut the blade

A Matter of Teeth

The efficiency of a hack saw blade depends almost entirely upon the rake, the "set," and the pitch or number of teeth to the inch.

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Starrett Hack Saws are made in varying pitches or number of teeth to the inch, from 10 to 32, according to the work they are intended for.

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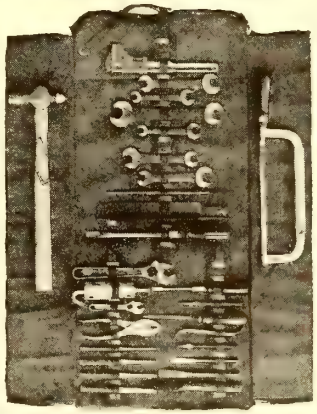
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radio school of the world, and this correspondence course is an extension of our activities, a Post Graduate Course in our Washington School being given you free, if you desire. You see we are not *A RADIO SCHOOL*, but actually and absolutely *THE RADIO SCHOOL*—the top one, the biggest one—the one that *HAS BEEN* and *IS* turning out the *WINNERS* every week. You can't compare us with any other school, because we are head and shoulders above all—the very top. You get the idea? You can't get a better or higher course, we are the final—the finish. Act now. Get a grip on yourself—take the big important step. Settle your career today. Our new catalogue, just out of press, will tell you how. Send for it.

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One box of *Carnotite* and one vial of *Uranium Ore* as described above 50c sent prepaid.

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ready equipt for fire lookout work.

It is noted by Mr. Dahl that both peaks were connected by telephone with the Forest Supervisor's office and with the nearby rangers' cabin. In addition to these two principal peaks, there were five smaller ones, also connected by telephone. The first two points were made the central stations, and two of the best men were stationed there. The other five points were designated as substations. These substations reported to the nearest central station, and since each forest officer was furnished with all locating instruments it was merely necessary for the substation to report the degree angle of the fire from its point and add a short statement of local description.

A typical heliograph message would read: "Smoke bears 26 about seven miles on Rattlesnake Creek, near Bloody Rock. Just started. Burning in bush." If the same fire was discovered by several operators each would send a report. and by plotting the angle lines given in these reports would give the location of the fire, which would be at the point of intersection of those angles. The average speed attained by the operators was four words a minute. It will be noted that as the average message need not exceed twenty words, that after discovering a fire a good heliograph man can notify headquarters within five minutes, whereas under the old conditions he would have to ride for an hour to reach the nearest telephone. The range over which heliograph signaiing may be effected on favorable atmospheric conditions is almost unlimited. By actual test *it was found that perfectly visible messages could be flashed for a distance of 45 miles and read without the a'd of a field glass.*

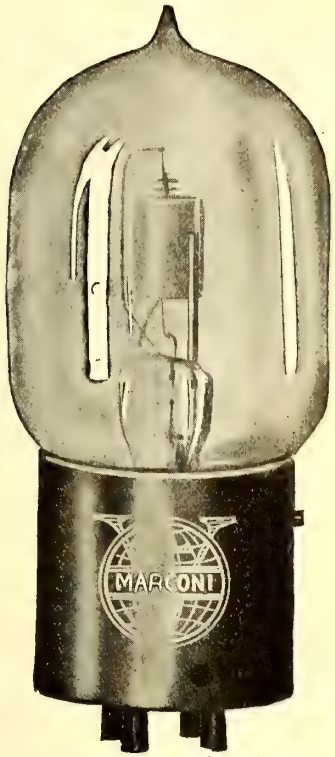
It is held that the only serious drawback to the use of the instrument is that on a cloudy day it is useless. When it had been determined that the heliograph was valuable to the forest officers, the next step was to secure a more portable and less awkward outfit. After much experimenting the ideal instrument for the use of the forest men was designed. The instrument proper is made of aluminum alloy with certain parts of bronze. It fits into a small leather case approximately the size and shape of a 3A kodak case, which very conveniently fits into the saddle bags on the horn of a patrolman's saddle. Instead of two heavy tripods, as in the case of the Army instrument, the new Forest Service instrument fits entirely on the head of one small tripod about 20 inches long 2 inches in diameter.

The entire equipment, including tripod and instrument, weighs about one-fifth of the standard instrument, and in bulk it bears the same relation. It was also found that by reducing the size of the mirror from 4½ inches square to 3 inches square no appreciable difference was made in the brilliancy of the flash. This afforded the opportunity of reducing the size of the whole instrument accordingly. As fast as the rangers on the different California forests can be taught to use the heliograph, they will be furnished with the new instruments, and on their rides through the mountains, if a fire is discovered, they need only proceed to the highest available point and flash their signal to the proper points where the "fire fighters" are notified their services are required.

Chicago has more telephones than all France, and a single office building in New York contains more than there are in the whole of Greece.

Siam's telephone service is owned and operated by the government, and Bangkok, the capital, is the only city with an exchange.

THE HEART OF THE WIRELESS



Fleming Pat. No. 803684
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An Amateur Station Without a Vacuum Tube is Years Behind the Times

MARCONI V.T.

$7.00 each

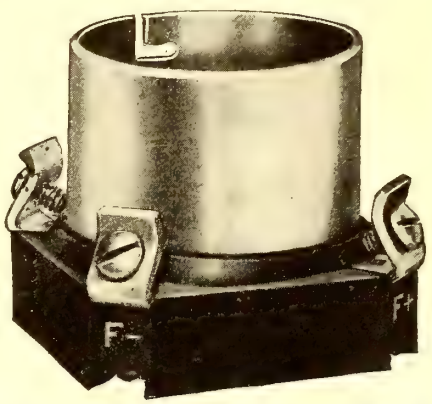
Under agreements recently effected the Marconi V. T. is the only vacuum tube, or audion, which may be sold to amateurs, laboratories, schools of instruction and experimenters.

The approximate operating life of the MARCONI V. T. is 1,500 hours.

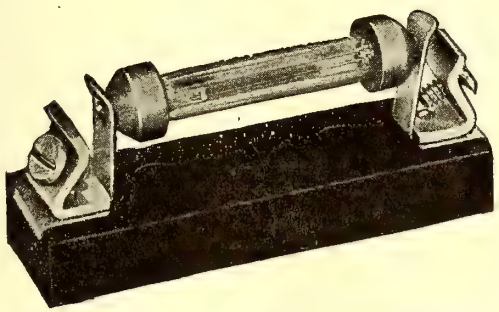
Class I.—Designed for use as a detector; operates with plate potential of 20 to 60 volts.

Class II.—Designed for use as an amplifier; plate potentials from 60 to 110 volts may be applied.

Tubes in either class may be used for detection or amplification, but those of Class I are best as detectors, and Class II tubes are superior as amplifiers.



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Standard Resistance, Complete $1.00

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Tested Ranges { **Telegraph 50 to 75 miles Depending upon aerial**
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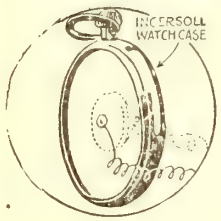


Fig. 1



Fig. 2



Fig. 3

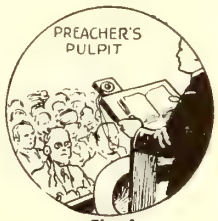


Fig. 4



Fig. 5

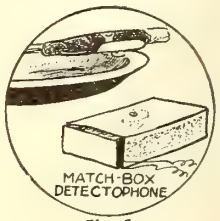


Fig. 6



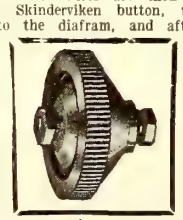
Fig. 7



Fig. 8

THE SKINDERVIKEN TRANSMITTER BUTTON presents the latest advance in microphones and marks a revolution in transmitter construction. It works on an entirely new principle, takes up practically no room, and marks the end of all telephone transmitter troubles.

The **SKINDERVIKEN TRANSMITTER BUTTON** can be placed in any position and it will talk loudly and distinctly and is at the same time extraordinarily sensitive. It was primarily designed to replace the old damaged or burnt out transmitter. Simply unscrew and remove the telephone transmitter front, disconnect the two inside wires, unscrew and remove the bridge and the old electrode. There remains only the diafram. These wires are then connected with the Skinderviken button, the latter screwed to the diafram, and after screwing the old transmitter housing together again the telephone is ready for work.



ELETRICAL EXPERIMENTER readers will be particularly interested in all the different experiments that can be performed with the Skinderviken Button. Fig. 1 shows the Skinderviken button attached to the back of an Ingersol watch case. When speaking towards the inside of the case, it will be found that the voice is reproduced clearly and loudly. Fig. 2 shows another interesting stunt. By attaching the button to a tin diafram about the size of half a dollar, and by holding the diafram at the side of the throat, as shown, speech can be transmitted with surprising clarity. Fig. 3 illustrates the same arrangemnt placed on the chest as shown. In this position the transmitter will talk clearly and loudly. Fig. 4 shows an arrangement whereby the Skinderviken button is attached on a thin wood board at the preacher's pulpit. His voice is clearly transmitted so that people hard of hearing can readily hear the sermon. Fig. 5 shows an interesting stunt, whereby a hole is drilled in the side of a thin glass water-tumbler; the sides of the glass thus acting as a diafram, the voice is clearly transmitted. Fig. 6 shows a simple match box Detectophone. The Skinderviken button is concealed inside of a box, only the small brass nut showing on the outside. This can be camouflaged as well. This device talks well. Fig. 7 shows how to transmit phonograph music at a distance merely by drilling a small hole in the phonograph arm and attaching the Skinderviken button; a very favorite experiment with all experimenters. Fig. 8. shows how a very sensitive Detectophone can be made by placing one of the buttons in the center of a lithographed cardboard picture, so that only the small brass nut shows. The large surface of the picture acts as a big diafram, and the voice is well reproduced.

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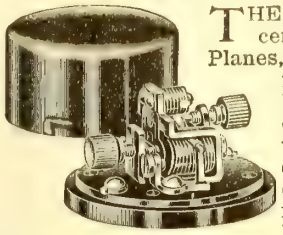
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Mesco Radio Buzzer

With Shunt Resistance
U. S. Navy and U. S. Army Standard



THE Radio Officers of the NC Planes, after testing all other buzzers, decided to use the "Mesco" on their radio equipment. The R-34 was equipped with two Mesco Radio Buzzers.

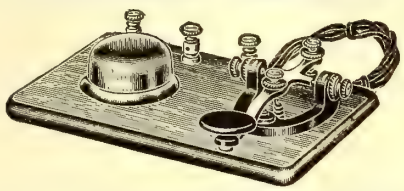
Why? Because of its reliability and constancy in operation; greater output efficiency; ease of adjustment; unaffected by extreme variations in weather conditions; exposed wires eliminated.

Sparking is almost entirely eliminated, so that the energy lost in light and heat in the operation of other buzzers is here conserved and radiated in the form of oscillating energy.

This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

List No. 55, Mesco Radio Buzzer
Price $2.05

MESCO WIRELESS PRACTICE SET

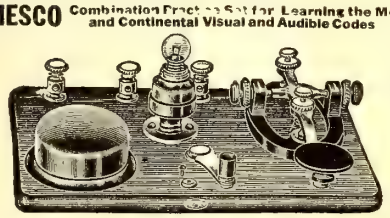


The Practice Set comprises a regular telegraph key without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

List No. Price
342 Telegraph Practice Set, with Battery and cord.....$3.24
Weighs 4 lbs. packed.
Price does not include postage.

MESCO Combination Practice Set for Learning the Morse and Continental Visual and Audible Codes



This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.

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Radio Links Airplane and Submarine

(Continued from page 661)

Wire.—Seven strands of No. 14 B. & S. phosphor bronze wire, covered with 40 per cent Para rubber, to a total outside diameter of ½".

Supports.—Two substantial masts, triangular or oval in cross-section, 3 feet high with insulators at the top, erected at either end of the boat and braced to withstand considerable strain.

Stanchions.—Two stanchions insulated at the top placed high enough to support the wire at least 1 foot above the bridge.

Radio Insulators.—An extra radio insulator similar to the one already installed, placed in the space now occupied by the antenna mast (or in any convenient place at least 3 feet away from the other insulator), and extended vertically thru the hull.

Water-tight Sleeves.—(To prevent the sea water from working up under the insulation on wire.) Brass stock 3" long bored to outside dimensions of insulated wire for 2¾" and drilled dimensions of bare wire for ¼". The wire is stript of insulation for a few inches and is slipt thru the sleeve, the insulated portion being smeared with white lead and the stript portion being soldered to the brass.

Grounded Connections.—Lugs on end of wire grounded to hull by bolts.

Lead-in Joints.—Junction of insulated wire and radio conductor is made watertight by marine glue poured in a cylindrical mold.

Wire-tightening Device. — (*a*) Turnbuckles may be placed at the end of each wire next to ground connections; or (*b*) in order to take up slack on both wires equally it is preferable if construction of boat permits to place one insulated turnbuckle between stanchions on bridge.

Receiving Apparatus.—Tuner capable of receiving wave lengths of 300 to 16,000 meters, and oscillation audion detector and three-stage resistance type amplifier of French design. (The Navy standard audion control box type SE 1,000 two-step amplifier cannot be used unless placed in a noise-proof and inductive-proof compartment.)

Transmission Apparatus. — Regular quenched spark set, preferably the 1 KW. size. Terminals of loop antenna are connected to the antenna and ground connections, respectively, with a .0005 microfarad condenser in series with the loop. The ground connection on the set being removed.

Nauen Radio Opened Again

(Continued from page 662)

were captured during the war, of course, and we may presume from those captured, that the bulbs used in practically all the Teutonic radio stations were similar or nearly so, and that if the German experts had devised any wonderful new bulb, that they would have put these bulbs into their field sets, by the very nature of the wartime conditions, and particularly those used in the large base radio stations, several of which were captured during the latter months of the war. In a test with these bulbs as compared with the French vacuum bulbs and the American types, such as the De Forest and Western Electric amplifiers, the German bulbs showed up as good, but not better, under careful tests which were carried out in conformity with U. S. naval specifications for the device. A radio engineer of the U. S. Navy Department recently informed us to this effect, and we also heard the same opinion voiced by officers of the French and British Armies, who had the opportunity of carefully testing a



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Hammond MULTIPLEX

"MANY TYPEWRITERS IN ONE"

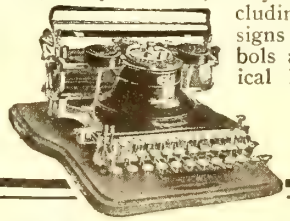
Sounds like an Arabian Knights story but the machine itself is very practical, very real. It is the typewriter President Wilson uses personally — the typewriter he took with him when he visited King George. It's the typewriter King George's mother, Queen Alexandra, and many other Queens and Kings use.

The Multiplex has revolutionized typewriting—has changed it from monotonous commercial work to the beauty of fine printing and engraving.

No Other Typewriter Can Do This:

MULTIPLEX HAMMOND'S
Instantly changeable type
Many styles, many languages
Two types or languages always in the machine
Just Turn the Knob to change

Write for booklet showing the many languages and type sets of the Multiplex—there's a type for every profession, every business, every science, including technical signs and symbols and chemical keyboard.



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Gentlemen—Please send your **Free Book** and pamphlet, **"The President and His Typewriter."**

Name.....
Address.....
Occupation.....

AMPLIFY YOUR RADIO SIGNALS

With the new DETECTAGRAPH-TRANSMITTER, the amateur can amplify radio signals to such an intensity that he can hear the signals about his station without the need of the telephone head set.

By the addition of a loud talking telephone he is able to hear the messages many feet away from the instrument.

The super-sensitive DETECTAGRAPH-TRANSMITTER herewith shown is two and three-eighths inches in diameter, five-eighths of an inch thick and weighs less than three ounces. It is the most sensitive sound detecting device ever brought before the public.

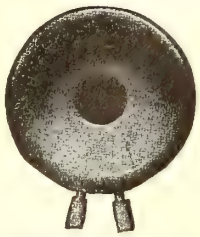
The manner in which the amplifying process is attained is by attaching with tape the DETECTAGRAPH-TRANSMITTER to the regular wireless receiver.

Not only is this instrument applicable for amplifying radio signals, but it can be used with equal satisfaction for magnifying other sounds. Phonograph music can be transmitted from one place to another by means of this instrument, and those who are afflicted with deafness will find enormous benefit by using this transmitter. It is the greatest device for building your own loud talking telephone, detectagraph and other devices. Can be used for any purpose where a sensitive detecting instrument is required.

SUPER-SENSITIVE Detectagraph MICROPHONE DEVICES



Our Super-Sensitive Detectagraph Transmitter. Price, $7.00 Complete



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Super-Sensitive No. 40 Receivers to be used in connection with Detectagraph-transmitters. $10.00



The Detectagraph Junior Deaf-Phone $15

Equal to any $35 instrument made. Outfit consists of Super-Sensitive Transmitter with cord connector; Super-Sensitive Ear Piece with small black cord; Black Single Headband; Black Case and Two Batteries.



Model "B" Horn, with Loud Talking Receiver, Cord Plugs and Desk Stand Base. Price, $12.00 Complete



Model "C" Horn, with loud talking Receiver, Cord Plugs and Wall Base. Price, $12.00 Complete



Detectagraph $15

This detecting instrument of marvelous sensitivity can be used for detecting secret conversations. Outfit consists of Sensitive Transmitter, 25-ft. Black Cord, Receiver, Headband, Case and Battery.

Order direct from ad.

Or write for free descriptive circular.

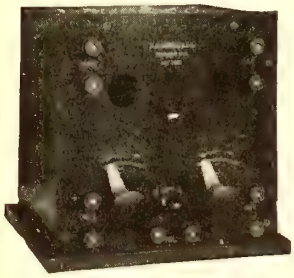
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Makers of Super-Sensitive Microphone Devices

Read All Signals That Reach Your Station

With the ordinary receiver many signals never become audible. Those stations you've wanted to hear can now be brought in with surprising intensity if you connect into circuit a



Type RORB, Price $45

Two-Stage Audio-Frequency Amplifier

This Amplifier is designed to eliminate howling due to resonant feed-backs, without impairing its amplifying efficiency. The cover is hinged, affording accessibility to all parts. The sockets accommodate the standard four-prong tube and perfect contact is secured through strong phosphor-bronze springs.

The wiring and mechanical construction are characteristic of Grebe workmanship. Better be sure *your* Amplifier is a Grebe.

Write for free bulletin describing Grebe Amplifiers; complete catalog sent upon receipt of 10c.

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School established 45 years. Endorsed by wireless, railway and telegraph officials. Low rates. Students can earn living expenses while attending school. **Catalog Free. Write Today.**

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large number of bulbs of all makes, before and after the signing of the Armistice.

Two large antenna systems are provided—the larger being of T-shape, and the smaller in the form of an elevated horizontal triangle with the down leads from the apex, says the *Wireless World*. Simultaneous transmission on two different wavelengths is thus possible. The two main masts, of lattice construction, are 260 meters high, and are bedded on an insulating ball at the base. Additional insulation is provided at 150 meters from the ground. The supply alternator, single phase, can deliver 800 horse-power, and after multiplication of the frequency by static frequency raisers, furnishes 24,000 cycles current to the aerial. The wave-length is thus 12,500 meters. Transmission at 200 letters per minute can be carried on. The overall efficiency is claimed to be 65 per cent from alternator to aerial at 12,000 meters wavelength.

The following table gives an interesting comparison with the installation in use in 1908:

	1908	1918	
		Small Aerial	Large Aerial
Masts	1 of 100 m.	2 of 150 m. 1 of 135 m.	2 of 260 m. 4 of 120 m.
Antenna area sq. metres	31,000	77,500	155,500 sq. m.
Primary ouptut K. W.	50	175	600
Aerial energy K. W.	12	100	400
System	slow spark	quenched spark	H. F. Alternator C. W.
Range Kms.	3,600	8,000	20,000

THREE LAND RADIO STATIONS FOR AIRPLANE MAIL.

The Post Office Department has contracted for the erection of three high-power radio stations, the first of a chain of wireless communicating centers in various cities to be used primarily for the direction of mail-carrying airplanes handicapped by fog, it was announced recently by Emil J. Simon, the well-known New York radio engineer.

Stations will be established at Bellefonte, Pa., and Cleveland, Ohio, with a third at some point on Long Island or Newark, N. J. Appropriations for them already are available. Others will be erected at Washington and Chicago as soon as Congress provides funds.

Each station will be equipt with steel towers 200 feet high and 300 feet apart and will have a range of approximately 400 miles to *mail airplanes* and approximately 700 miles between stations, the difference in range being due to the lesser sending ability of airplane wireless equipment.

The station at Bellefonte were completed about the middle of October, while the other two definitely decided upon were expected to be ready early in December.

Establishment of the radio stations will enable the Post Office Department to maintain communication between cities having air post delivery independent of telegraph and telephone services in the event of a disruption of service by storms or other causes.

Lieutenant Clark A. Edgerton, formerly of the army aviation service, in charge of the air mail experimental work at Washington, will direct the activities of the radio stations.

"Cold Fire"

By H. Gernsback

(Continued from page 633)

(standard 110,000 volt insulator for 60-cycle work, such as is used in electrical power transmission equipment) equipped with a "corona" or flux distributing shield. This flash-over is occuring at 234,000 volts and 51,000 cycles per second. Without the corona shield, corona will form on the metal cap of the insulator and flash-over will occur at voltages slightly less than 100,000 at a frequency of 51,000 cycles per second.

SEVEN ZEPPELINS WERE LURED TO DEATH BY RADIO.

This is the tale of the seven Zeppelins. Do you remember the last big raid over England after which most of the flock of ungainly birds came flopping down into the fields and forests of France, while one met its fate in the Mediterranean?

People in London told one another all manner of tales about frozen motors and gasoline icicles. As well to let it go at that in those days, but now that I know the Germans know all about it, here is what happened, says Gordon Stiles in a press report from Berlin.

A certain French radio officer had been very diligent during the war. When America came in some wireless experts from over there joined forces with him. Among other things they studied the German method of wireless control of aircraft.

The Allies had known for a long time the Zeppelins were guided by instructions sent from powerful wireless stations in Belgium and Germany. When its cargo of bombs had been disposed of the airship would flash back, "Where am I? And what course shall I take to reach home?"

This call would be received by several German stations, indicating the direction from which it came. Thus by using formula which involved mathematical calculation dealing with intersections and the like the position of the Zeppelin could be exactly determined. The rest was easy. The compass course to be taken went thru the ether to the Zeppelin.

By patient work the French radio officer had compiled a vocabulary which embraced more than 400 German code words. With the help of mechanicians he had built a wireless set which had all the characteristics of the German apparatus, even to "flaws."

On the night of the raid in November 1917, this set was read for use. Fate was with the Allies, for when the Zeppelins were floundering at a dizzy height over London, the signaled replies from the German stations did not reach them. Static disturbances prevented the message carrying.

The French stations were very busy. "Come this way." "Take this course." "Steer so many degrees east by south." These were the messages flashed over the new sending apparatus.

From the Zeppelins, one after another came "O. K." And they came. They came so accurately that the French actually telephoned the various anti-aircraft stations the exact minute when they might expect a Zeppelin over their position. Allied night fliers were sent up in swarms to demolish those which the guns did not claim.

We know their success. The big gas bags came tumbling into France or sailed wildly about, damaged and limping, until the airplanes finished them.

Another dent in Fritz's wild war dream.

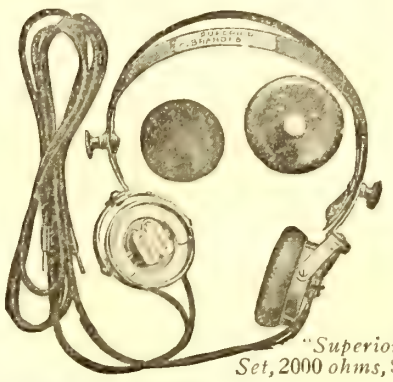
"ASK ANYONE WHO HAS USED IT"

Said Denver, Col. to Valley Stream, L. I.:—

One of our most enthusiastic customers communicates by wireless from his home in Denver to a friend on Long Island. He uses a Brandes Headset—after exhaustive tests and comparisons. (Name on request.)

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CLEAR TONE
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DEPENDABLE SERVICE



"Superior" Set, 2000 ohms, $7

Score 100% efficiency in actual use. Sharp, Unblurred, Readable Signals assured by

"BRANDES MATCHED TONE"—

Exactly matching the tone of both receivers in each set and thus eliminating all confusion due to unmatched harmonics.

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Buy a Brandes Superior Headset and use it critically for ten days. Then, if it doesn't come up to our claims or your expectations, return it and your money will be cheerfully refunded. Test it—compare with others—for sensitiveness, clearness, distance. Prove for yourself the fine quality, the "matched tone." The two diaphrams, toned exactly alike, strengthen the signals and prevent blurring. Used by many U. S. Government experts, and experts abroad; by colleges and technical schools; and by professional and amateurs everywhere.

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The oldest, largest and best equipped radio school in New England. Recommended by Marconi and Government officials. DAY AND EVENING CLASSES. START ANY MONDAY.

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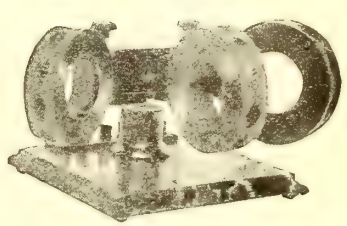
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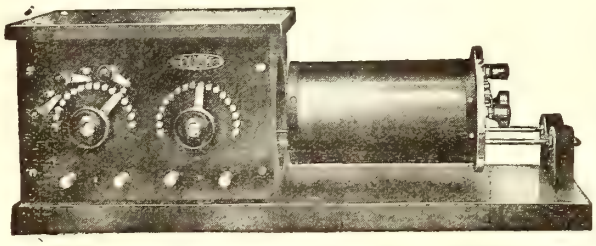
For protection and sport every man and boy should have one. Order at once. Get an American flag FREE. Money refunded if desired. **E. L. LEWIS CO., 1400 B'way, N.Y.C.**



DUCK'S New Big 264-Page Wireless and Electrical Catalog Just Out—Now Ready

It is mailed for 12c in stamps or coin which may be deducted on first order of $1.00. Catalog not sent otherwise.

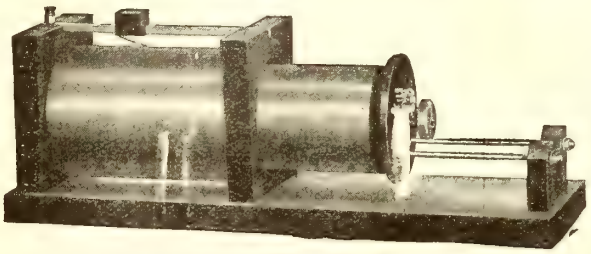
We regard this catalog as our greatest effort. It embraces everything in wireless worth while. 172 pages with no waste space devoted exclusively to wireless instruments. Your amateur friend will tell you that there never has been any wireless catalog to take the place of catalog of this company and above all that you can absolutely depend on our goods. There is no need for any other catalog when you have this big catalog.



NEW MODEL 5BB. NAVY TYPE RECEIVING TRANSFORMER

A big improvement over our former model. Primary divided into two sections, with three dead end switches, greatly improving selectivity.

Secondary divided into three sections, with two dead end switches, eliminating harmonics. By changing the construction of the end piece, there is also greater loose coupling. It is a wonderful improvement over our old model both in performance and appearance. Only $23.50.



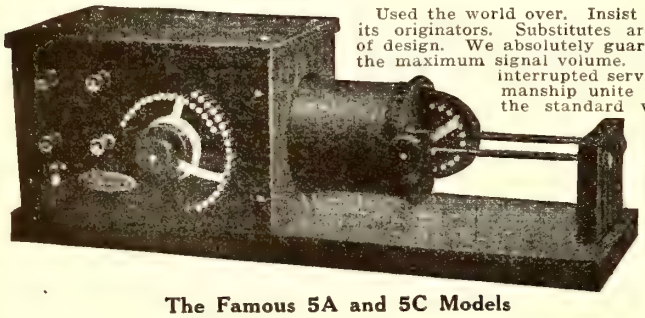
OUR IMPROVED ARLINGTON RECEIVING TRANSFORMER

The secondary on our new type Arlington is divided into three sections with two dead end switches, eliminating dead end effect and harmonic and giving greater selectivity. The end support similar to that on our Navy type permitting of greater loose coupling. It is a beautifully finished instrument and will be sold by us at the same price as the old model. $9.00.

THE WILLIAM B. DUCK CO., 240-242 Superior St., Toledo, Ohio

TRACO QUALITY

RECEIVING TRANSFORMERS



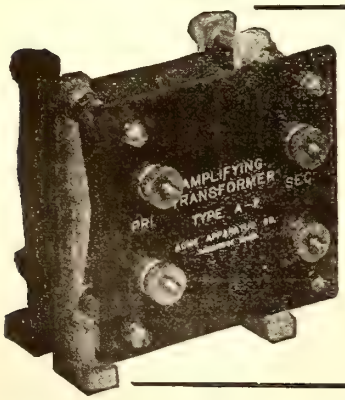
Used the world over. Insist on the genuine, built by its originators. Substitutes are expensive, irrespective of design. We absolutely guarantee our tuners to give the maximum signal volume. Delicate refinement, uninterrupted service and high class workmanship unite to make TRACO tuners the standard whereby all others are judged. If you Dealer does not handle them, order direct from us.

LIBERTY DETECTOR VALVES, RADIO AMPLIFYING PHONES, type used by the **UNITED STATES, BRITISH** and **FRENCH GOVERNMENTS,** now in stock, for sale.

Send stamps for bulletins.

The Famous 5A and 5C Models

THE RADIO APPARATUS CO., Pottstown, Penna., U. S. A.



CHANGE OF PRICES

With Quantity Production and adoption of Automatically Wound Coils, we are glad to announce a Reduction in prices of our Amplifying Transformers as follows:

Type A-2 fully mounted with Aluminum Supports, Engraved Bakelite Dilecto Panel, and Nickel Plated Bind Posts.....$7.00

With Supports, but without Panel and Bind Posts $5.00

Assembled, but Unmounted.....$4.50

Although originally designed for use with VT-1 Tubes, these are now being used extensively and with excellent results with Marconi V. Ts.

ACME APPARATUS CO., 28 Windsor St., Cambridge, Mass.

DENMARK PLANS BIG RADIO STATION

Official announcement that Denmark is making plans to open wireless communication between Copenhagen and the United States was made recently by the Danish Legation. This statement was made public:

"Information to the effect that regular wireless connection has been established between Denmark and Great Britain has just been received by the Danish Legation here. Plans are now being worked out by the Danish Ministry of Traffic for erecting a great transatlantic radio station near Copenhagen which will put Denmark in direct wireless communication with the United States.

"Danish newspapers complain that their telegrams for some time have been greatly delayed because of the crowded cables. The Danish papers express the hope that the still important plan for a great transatlantic station will soon be realized. The Danish press is anxious to get into direct communication with America, so as to be able to obtain news from over here at first hand and at reasonable rates.

"The Danish wireless station at Lyngby is at times able to hear the American station at Arlington talk to Rome, but is not powerful enough to send messages over the Atlantic. The plan now under consideration by the Danish Government call for the erection of a transatlantic wireless station to cost 2,000,000 kroner."

JAPAN WANTS $16,000,000,000 PACIFIC CABLE.

The Marconi Company, it was said, had proposed a wireless system between America and the Far East, at a cost of about $6,000,000. But the members of the council declared that wireless would not be satisfactory owing to static conditions and other disadvantages which would make transmission impracticable for more than seven hours out of twenty-four.

RADIO-CONTROLLED 'PLANES WERE TO BOMB BERLIN, SAYS JACK BINNS.

At the very moment when the armistice was signed a squadron of super-Handley Page bombing airplanes were awaiting orders to bomb Berlin, says Jack R. Binns, the well-known radio expert, late instructor in the wireless school of the Royal Air Force. These giant machines were equipt with wireless in such a way that the German wireless station at Nauen would have unwittingly navigated them in a direct line to Berlin.

It has made inter-communication between airplane and airplane possible over a distance of 400 miles, with less power than is used by a ship at sea to communicate 200 miles.

It has made aerial navigation possible irrespective of weather conditions. It has made the transmission of human speech between the occupants of one plane to the person on another plane possible over a distance of 25 miles.

Of these its effect upon aerial navigation is the most recent and most phenomenal of the developments arising out of the welter of war.

On all the great Handley Page and super-Handley Page airplanes of the British Air Force the so-called Chanffer "direction "finder" has been equipt. This is one of the most closely guarded secret inventions of the war.

With its aid the navigator of one of these giant machines can pin down upon a chart the exact latitude and longitude of the airplane within five minutes of commencing the observation. Moreover, this navigational work can be done while the machine is in a dense fog.

The most remarkable thing about this invention is the fact that the large aerial

which makes a wireless station such a conspicuous landmark is entirely missing. In its place two moderate sized coils of wire are fitted into the nacelle of the machine.

I have located the exact position of a Handley Page while flying above dense clouds over the North Sea in less than ten minutes.

The manner in which these observations are taken is as follows: One of the two coils on the machine is movable thru a complete circle. This coil is moved until it receives signals from some well-known wireless station in Europe. The direction of this coil gives the true bearing of that particular station after allowances have been made for certain well known and charted errors, such as magnetic deviation of the compass and quadrantal error of the airplane.

The angle of the station to the bearing of the machine is then worked out on a chart, and the resulting line drawn clear across the chart. When this is completed the coil is turned around until some other well-known station is heard. The same process is completed, and the point where the two lines cross is the exact location of the airplane in latitude and longitude above the earth. The whole apparatus, with the exception of the coils, can be carried in one hand; and the coils, while bulky, have very little weight.

Another remarkable feature of this invention was its application to the big bomb-dropping airplanes that raided German cities. In this case there was a variation in its utilization. The coils were fixt rigidly in the machines, which then pointed themselves bodily at a wireless station situated at the point where they wished to go.

In other words, German wireless stations directed British bomb-dropping airplanes to their cities without knowing it, and over the shortest possible route. The wireless stations back of the British lines took care of their return.

Next to the direction finder the development of the wireless telephone on aircraft has been the greatest achievement of the radio experts during the war.

All the day and night bombing squadrons were fitted with it. Its utilization brought success to bombing raids by eliminating all confusion and enabling the squadrons to retain their formation under all conditions.

The squadron commander sitting in his machine would issue orders in an ordinary tone that was easily heard above the roar of the powerful engines, while the machines were rushing thru space at the rate of a mile every thirty seconds.

If, thru unforeseen circumstances, a machine got separated from the squadron, it could rejoin by means of instructions given thru the air by the human voice up to any distance within twenty-five miles.

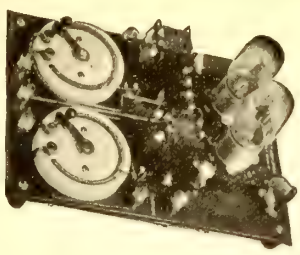
This wonderful invention was also utilized in scout work. All the Bristol scouts were equipt with it.

They would sit above the clouds watchfully waiting. Immediately a German scout appeared the artillery co-operation machine would radio the fact to the aerodrome. The operator on duty at the 'drome would then talk into a telephone transmitter, and ten seconds later the Bristol would swoop down thru the clouds upon its unsuspecting prey.

One of the 1918 developments was the long distance wireless telegraph sets for aircraft. With these machines engaged in patrol work hundreds of miles back of the German lines could communicate instantly with headquarters any distance up to 400 miles. Not only this, but they could receive special instructions instantly from headquarters.

The moment the German command began to move troops in the back areas, the fact was known in all headquarters in the British army.

All this was done from a speck in the sky, from an airplane large enough to carry only two men.



TWO STEP AMPLIFIER

TYPE TRIODE E

This unit was designed to facilitate experimenting by making all wiring and connections visible and accessible It is a compact unit of the resonance low frequency type, and provides a maximum of amplification. The design of this instrument is such that it will not "squeal," "howl," "fry" or "roar," as is the case with so many amplifiers now on the market. Particulars and price on application.

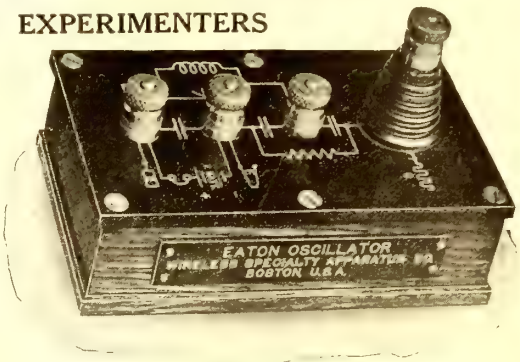
THE EATON OSCILLATOR

FOR EXPERIMENTERS

This instrument, in conjunction with a loose coupler, a single variable condenser and a vacuum tube, makes a complete system for receiving all undamped signals.

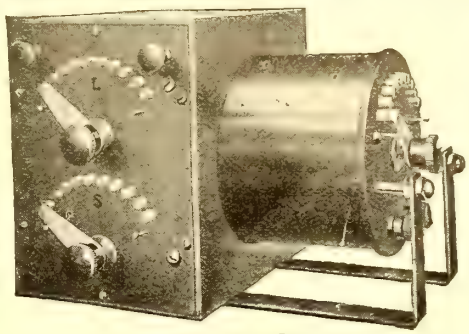
It will oscillate over a wavelength range of 200-25,000 meters, and requires no adjustments of any kind. It employs the Eaton Circuit, standard with all U. S. Navy receiving equipment.

The simplest and cheapest way of receiving undamped signals.



PRICE $14.90 Immediate Delivery

WIRELESS SPECIALTY APPARATUS CO.
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Type-Y673-Coupler

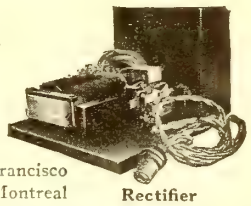
TYPE Y673 Coupler
200 to 3000 meters
Price $12.00

Camb. Rectifier, for storage battery charging
Price $22.00

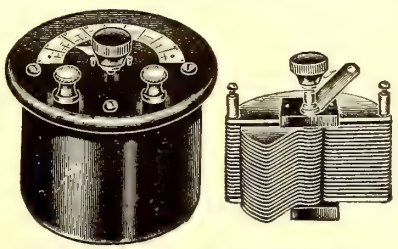
Three-cent stamp brings bulletins of both these instruments

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Just as you have learned to read and write, we can teach you how to draw. Everybody has the ability. True, some have more than others, but that is because that ability has been developed. You start with straight lines—then curves. Then you learn to put them together. Now you begin making pictures. Shading, action, perspective, and all the rest follow in their right order, until you are making pictures that bring you from $50 to $500 or more! Many artists receive as high as $1000 for a single drawing!

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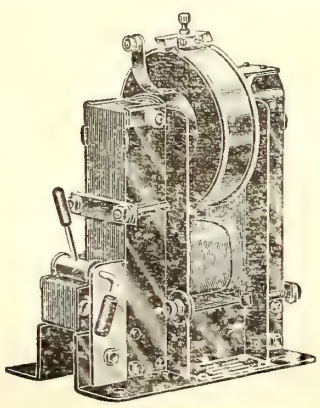
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Will These Perpetual Motion Schemes Work?

By John D. Adams

(Continued from page 649)

be a very marked effect at this distance, but the main thing to note is that there will be no back pressure. From the point "d" the free North pole will then proceed to point "a," as every point along that leg of the triangle is nearer to the attracting South pole than to the repelling North pole of the horseshoe magnet. This completes the path, and, if the reader will now apply the same line of reasoning with the other two horseshoe magnets in place, it will be seen that the operating force is very greatly increased, as each of the three magnets may be considered separately with the same result. As the free North pole leaves the point "a" under the repulsion of the North pole of the left-hand magnet, it is also attracted by the South pole of the right-hand magnet.

The above merely describes the device in its simplest form. If such a machine were to be designed for power purposes, the power could be greatly increased, it would seem, by providing a great many bar magnets, and if they were arranged on a belt at the top and bottom, three similar horseshoe magnets, with polarity reversed, could be applied to the upper or South poles, thus *doubling* the power.

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"PLAN-T"

By John White

(Continued from page 648)

Stevenson's face showed his open disappointment and consternation as the radiogram proved, not a key to the message on hand, but a puzzle; quite as difficult, if not more so, than the "personal."

However, on pondering the matter, he wondered if it were not probable for this message to have a direct bearing upon the newspaper excerpt. It was decidedly possible, else why should Larnelle have postponed this message last evening when by an obvious mistake a duplicate of the "personal" had been transmitted, unless he feared that the uninitiated receiving the two with such proximity should discover the relation between them. This being the case, the solution must be of the utmost simplicity.

Crossing the room, he compared the message just received with the personal. The truth dawned upon him! The message and the personal were but the alternate words of a complete communication! *A code impossible to solve except for the slight, very slight, chance of one stumbling upon the two halves, each transmitted thru radically different mediums.*

Quickly and methodically Stevenson matched up the communication, one word from the "personal" and the next from the radio message, translating as he proceeded, until the deciphered code was before him in full.

It read, capitalized and punctuated:

"Larnelle:—Watkins and Short have delivery ready. Send all four on the fifth. Danger and directions taken up here. S. S. Unsuspecting. Bordinage."

It was evident that a "Larnelle" and "Bordinage" were the *recipient* and *sender* of the message, respectively. Stevenson plausibly assumed that "Send all four on the fifth" was a conveyance in which to transport the "delivery." The "danger and directions" gave the idea that the work was illegitimate. His interpretation of "S. S." varied. It might well be intended for steamship, but from the context he was of the opinion that it was more appropriately "Secret Service."

Stevenson, with his former experience as a government detective, considered that there were plans being formulated, if not already complete, which would culminate in illegitimate business. His ignorance of the kind of work and lack of sufficient evidence prevented his informing the proper authorities. He decided that it would be impossible for him to do other than await developments.

Stevenson unhooked the telephone book from his desk and ran his forefinger down the 's.....Warlick, Washburne," and then his search was rewarded with...."Watkins and Short, paper manufacturers, 36 East Cliff Street."

"Paper manufacturers," thought Stevenson, "that apparently is above board, unless—"

For the next month the air gave no sign of Larnelle, nor was his activity displayed in the personal columns.

Stevenson decided that the transaction, of which he had but the faintest conjecture, were being directed by one Bordinage in the very safe manner described. The complete message was doubtless written out in full, and, on two separate sheets divided into alternate words, a copy of one being sent to the publication while the other was transmitted by radio. By mistake or absentmindedness on the first evening, Bordinage had sent the wrong half.

Some five weeks after the first insertion, Stevenson again found reference to Larnelle in the personal columns. It ran:

"Larnelle: fast with s. wary on may shortly. Bordinage."

The same evening, Stevenson, intent upon his instruments, threw in two-thousand, five-hundred meters wave length.

Occasionally, a high-powered station would chime in, but he was far too high for the common gossip. As ten o'clock approached he feared that Bordinage and Larnelle had varied their wave, but shortly his anxiety was put to nought by the strident screech ...."Larnelle Larnelle Larnelle..."

"....work but caution s. direction removal follow Bordinage," it continued in the clear-cut notes of the experienced operator.

There was silence and Arlington ticked out ten o'clock. Stevenson, with receivers still clasped to his ears, compared the message with the "personal."

When pieced together the communication read:

"Larnelle:—Work fast but with caution. S. S. wary. Directions on removal may follow shortly. Bordinage."

Again, and with more certainty, he interpreted, "Secret Service wary." It was also apparent that Bordinage, Larnelle and Co. were contemplating a change of base of operations if the danger increased.

Removing the headset he walked to the desk 'phone and called Washington by Long Distance.

"Hello, Secret Service?.....Chief Langford, please.....Lang.....How's the boy? Stevenson speaking....Hope to be with you again soon. Say, is there any 'queer' in circulation now?"

"Yes, some. In fact, to you, Steve, I'll confess there's quite a bit."

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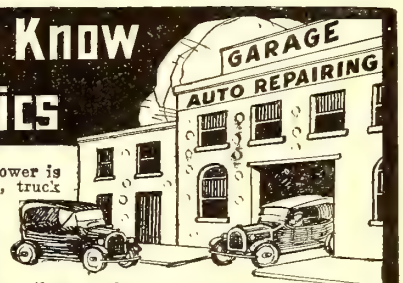
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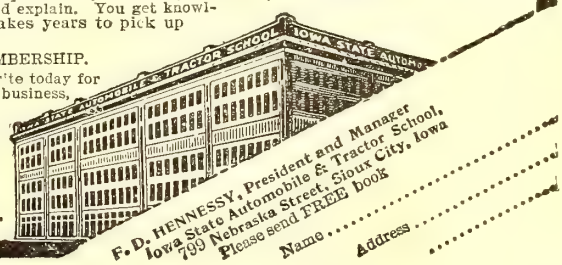
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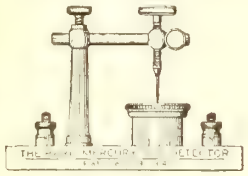
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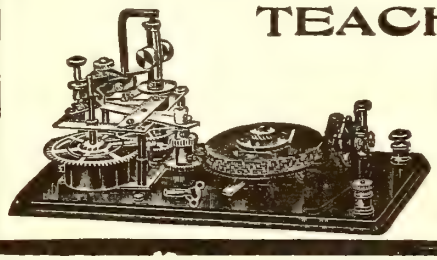
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"Source New York?"

"I have an idea that it is. But it is being distributed rather widely by agents. But what's the idea. How'd you....?"

"Have you got Watkins and Short under suspicion?" broke in Stevenson.

"Yes, but how the devil'd you know. Is there a leak?"

"No, your department's O. K. But I think I'll have a bit of information for you shortly. Well, so long for the time, and remember me to the boys."

Then again followed weeks of silence between Bordinage and Larnelle. Stevenson experienced fears that they had intercommunicated thru other channeds and that, whoever they were, they had fled.

However, his fears w s dispelled when a few days later, amid the agony columns, appeared the following code to Larnelle:

"Larnelle to ignorant to of Europe possible plan followed at with goods nine tomorrow arranged. Bordinage."

Stevenson decided that the "S" was the first part of a reference to the Secret Service, and with his knowledge that the law was closing in upon the probable counterfeiters, it was doubtless to enlighten Larnelle of the increasing danger. "Europe possible plan followed," if the foregoing were true, tended to show the contemplated method of escape. The completion of the message in the evening would, of course, verify his conjecture, but if the conspirators were then told to disembark by a previously arranged plan designated by a letter or numeral, it would be impossible to intercept them.

Again calling up Washington the ex-secret service man communicated with Chief Langford.

"Hello, Lang, old boy? How about that 'queer' you and I talked about. Contemplating arrests, aren't you?"

"Yes, but we can't find exactly where under the sun they're working from. It also seems that somehow or another they're on to us. I haven't the slightest idea where they get their information. But where'd you get yours? How the deuce!"

"How are your directions sent to your deputies in this city?" inquired Stevenson.

"Special delivery and wireless; but that's not it; it's all in code."

"Oh," murmured the radio man, comprehensibly. "Well, have a squad of men up here at nine P. M. to-morrow and I think you'll get them all with the possible exception of the leader. But you'll have to get me permission to use the Brooklyn Navy Station this evening. It is the only way you can get any of them. They'll be gone by to-morrow. Can't explain any more on the 'phone."

"What! Well, I'll take your word for it, but it is beyond me. No mistakes now, Steve. The permit'll be there before you. And, say, I'll be in the city myself."

Stevenson hung up, and with pencil and paper worked long and zealously at the "personal." When he raised his pencil an hour later, there was before him a supplement similar to that sent by Bordinage *via* the aid, but *one, which, when placed with the personal, would convey Stevenson's orders to Larnelle.*

The same evening his face glowed with appreciation as his fingers clasped the key at the Navy Yard's station, to which Langfords' permit had gained him quick admittance.

A half-hour before the usual time of the Bordinage messages, he called "Larnelle Larnelle Larnelle." His wave length was two-thousand, five-hundred meters—that previously employed by Larnelle—and the slightly subdued quenched tone of the navy's roar was so similar to that of Bordinage's that anyone but a professional operator would fail to detect the difference.

"Bordinage Bordinage," he signed, and shortly came the amateurish reply from Larnelle.

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With the wave as short as the present one, the danger of Bordinage's receiving the following message from Stevenson was nil, and it would be equally impossible for Larnelle to copy the *bona fide* communication from Bordinage in the old wave length.

Stevenson tapt out:

"S. on doings as method communication not now as be 840 w. 80 at P. M. all Bordinage." The "840 W. 80" being the residence of Stevenson.

When combined with the personal of that day, the full message read:

"Larnelle: S. S. onto doings. Ignorant as to method of communication. Europe not possible now. Plan as followed: Be at 840 W. 80 with all goods at nine P. M. All arranged. Bordinage."

As he threw in his switch for receiving, the "O. K. Larnelle" ticked in his ears, followed, as he returned to the former meterage, by a crashing, high-pitched call for the Brooklyn Navy Yard from a Canadian Station at Q——. In the midst of the communication the sender quit abruptly and apparently from the same station came the call, "Larnelle Larnelle, Bordinage."

Stevenson switched to a rotary gap, and, running it slowly, answered in the uncertain manner of Larnelle. The message from Bordinage followed:

"....s. on business as method communication only safety T be landing all at A. M. as Bordinage."

When Stevenson O.K.'d the message as Larnelle had done in previous times, the Canadian station returned and continued the message where it had left off. Its tone and wave length were identical with that of the Bordinage station.

At the completion of the communication, Stevenson handed the 'phones to the regular operator and compared the Bordinage message with the personal. Decoded it read:

"Larnelle: S. S. onto business. Ignorant as to method of communication. Europe only possible safety. Plan "T" followed: Be at landing with all goods at nine A. M. as arranged. Bordinage."

His conjecture was correct; they intended to flee.

As Stevenson made his way homeward, a possible explanation for the interruption of the Canadian station occurred to him. Upon reaching his quarters he immediately got in touch with the New York Branch of the U. S. Secret Service.

"Hello...Langford arrive yet?...No?... Well, as soon as he gets in, send him over to Stevenson's.... yes, important."

Early that morning, Langford, tired from a sleepless journey on the Washington flier, arrived at Stevenson's dwelling.

The friends shook hands and Stevenson inquired:

"The men, will they get here this evening?"

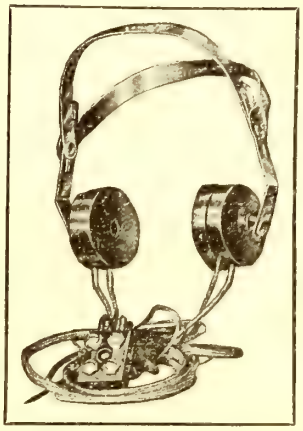
"Sure, they'll all be here, but what's this something 'important' you want and then me for your bed."

"This is it: I think that we can get hold of the leader also. Here is my whole plan...." and he recounted to the amazed Langford how he had first caught on to the drift of things.

"But how under the sun could they have deciphered our codes?" demanded the secret service man. ..

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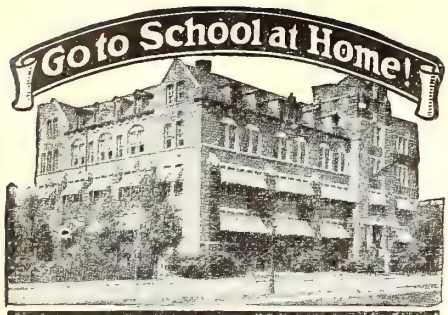
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from Canada for one Bordinage, and also a squad of Canadian plain-clothes men watching the wireless operator at Q—— ready to arrest him the minute you telephone the word. Of course, I'm not sure he's the man; but if so, by to-night I'll get hold of sufficient evidence to demand his arrest."

"Why not, after the capture of the criminals, get the men themselves to tell the whereabouts of Bordinage? That seems the simplest way," argued Langford.

"Because," returned the radio man, "I doubt if they really know who or where he is. He has played one of the safest games in the annals of crime. And also I will require the use of the Brooklyn Navy Yard station for the whole day. You remain here to direct the capture of the men."

Before noon, Stevenson again journeyed to the Navy Yard, where Langford's influence gained him control of the key.

He had scarcely seated himself, when the operator at the Canadian station at Q—— signaled an outgoing ship. Stevenson threw on his sending apparatus and called "Bordinage, Bordinage, Bordinage, Larnelle." There was no danger of Larnelle hearing for the wave was in the upper hundreds and Larnelle, in obedience to the orders of apparently, Bordinage, had reduced to two-hundred.

There was no response to his call of "Bordinage."

A few minutes later the same Canadian operator transmitted the weather reports relayed from the astronomical station at St. Johns. Again Stevenson made a futile attempt to call Bordinage.

Thruout the afternoon and evening, except when the navy station was operated for government use, and *only when the Canadian operator was busy*, the hobbyist vainly endeavored to reach Bordinage.

Shortly after nine, Langford entered and announced that the active members of the gang, including Larnelle, coming to Stevenson's home, had been arrested with little difficulty. They had brought the "goods," *five boxes of tightly packed ten-dollar bills.* Stevenson had been correct. They profest ignorance as to the whereabouts of their leader.

The radio man motioned for quiet and again listened to the Canadian operator in communication with an Atlantic vessel.

"How about this Bordinage," broke in Langford.

"I'm going to get him now," responded Stevenson.

A moment after the man at Q—— had completed his orders to the ship, Stevenson prest the key with:

"Bordinage, Bordinage, Bordinage."

It was the first time he had flashed the call *when the Canadian operator had not been transmitting.* "Larnelle Larnelle" he signed.

Silence for the moment.

Then back crashed the acknowledgment in the high-pitched tone of the Q—— station. "Larnelle Larnelle, Bordinage."

A coincidence was impossible! By a process of elimination the operator at Q—— and Bordinage *were the same!*

The light from the powerful nitrogen bulbs flooded the trans-Atlantic station at Q——, and, reflected from the polished instruments, dimmed the pale glow of the Audions into almost obliteration.

One of the two men in the outer office noiselessly replaced the Long Distance 'phone upon the desk.

The radio man moved nervously in a swivel chair, as for the fifth time in half as many minutes, he had screeched out to the unresponsive Larnelle.

Feeling a hand on his shoulder, he whirled in his seat and faced—a representative of the Canadian Secret Service.

(The End.)

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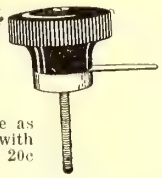
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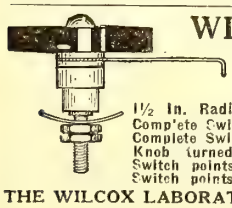
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The following table compares the Liberty 12 and experimental Liberty 24:

HORSE POWER (NORMAL).

Liberty....24 673 Liberty....12 400

POUNDS PER H. P. (DRY).

Liberty....24 1.97 Liberty....12 2.11

GAS CONSUMPTION (POUND) PER H. P. AN HOUR.

Liberty....24 .55 Liberty....12 .51

The experimental Liberty 24 compares favorably with successful tests of foreign motors of approximately the same power. An engine of this power, if run at the normal speed, would enable the use of a comparatively large slow-speed propeller without gear reduction, thus increasing propeller efficiency.

The following table compares the Liberty 24 and various high-powered foreign motors:

Motor and Country of Mfg.	H.P.
Dedion, France	800
Liberty 24, United States	*673-738
Fiat A-14, Italy	600
Rolls-Royce "Candor," England	600
Anzani 20, France	600
Renault 12-M, France	550
Salmson 18-Z, France	500
Napier "Lion," England	450

*Experimental, not rated.

The Electrical Machinist

By H. Winfield Secor.

(Continued from page 658.)

down operation is not carefully watched, the tool is liable to "hog-in," and before you know what has happened, there is one grand bang, and there are commutator segments in sixty-four different parts of the machine shop. Practical experience has proven that the best tool for all ordinary commutator work up to 6 to 8 inches in diameter, is a ¼-inch to $\frac{5}{16}$-inch piece of self-hardening steel, ground carefully to a diamond point with a good clearance. This tool should measure about 1½ to 2 inches long, being supported in an Armstrong or other patent tool holder of the clamping type. A left-hand tool holder should be used in turning a commutator. If the commutator is to be machined, then the armature is invariably placed in the lathe with the commutator facing the tail-stock center. This means that the tool will be fed from right to left across the commutator, taking a fine cut, the depth of which can best be judged by actual experience in turning a few commutators of different sizes. As will be readily appreciated, great care must be exercised to quickly release the tool carriage *feed*, as the tool approaches the rear end of the commutator where the connecting lugs are, or it will "hog in" with disastrous results so far as the mechanical job is concerned. On small commutators it is the best practice unless you are a skilled Electrical Machinist, and used to turning commutators, not to use the automatic feed on the lathe carriage and screw, but to traverse the carriage and tool along

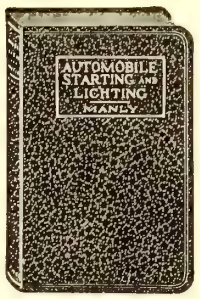
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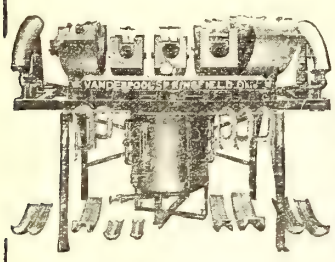
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the commutator by hand. The commutator should revolve at medium speed, it usually proving t' best practice to shift the belt on the lathe to the center cone on the stept pulley. Be sure to oil the tail-stock center, or both centers, if the armature or shaft supporting the commutator is supported at two centers instead of gripping the rear end of the shaft in the live chuck; also watch the tail-center closely, making sure that it is kept tight, and does not slowly loosen, or the armature may fly out of the lathe and be badly damaged. There are two ways of supporting the armature or shaft in the lathe;—in the *first* method a *dog* is secured to the rear end of the shaft which engages with one of the slots in the face plate mounted on the lathe spindle. In the *second* method, the commutator end of the shaft, as shown at Fig. 2, is supported on the tail center, while the rear or pulley end of the shaft is gript in the lathe chuck. Care must be taken to accurately center the shaft in the chuck if it is an independent 3 or 4-inch jaw chuck, and of course, if it is an automatic self-centering chuck, then the shaft will be centered without trouble, at once. Do not under any consideration, allow the chuck jaws to close down on the shaft directly; a piece of thin brass or copper is placed around the shaft and the jaws of the chuck are allowed to press on this, so as not to damage the shaft.

Finishing the commutator: After the commutator has been turned down, until all of the burnt spots or *low areas* have been cleared up and a new even surface is seen all around the commutator, it is ready to be finished or polished. It is good practice to start finishing the commutator (the tool of course being backed away from the commutator, or in fact removed from the tool post), by gently applying a fine cut file. This means a single cut file and not a double cut one, and also one having a fine pitch. After the rough surface has been pretty well drest down by a light application of the file applied over the rotating commutator as evenly as possible, it can then be finished with fine sand paper. Some machinists use first a medium coarse sand paper, and then finish with a fine sand paper. *Emery cloth must never be used on any commutator, under any condition whatsoever.* Particles of emery lodge in the mica between the commutator bars, and tend to conduct the current, thus short-circuting the bars. Sometimes bad spots will develop in the mica; thoroly clean out this spot until the white mica is seen, and all charred portions removed; this hole is then filled with a few drops of water glass (sodium and potassium silicate) and this is allowed to harden. This is a very good insulator, and has saved many commutators from breaking down electrically.

Such holes or grooves can be easily cleaned out by means of the small steel tool shown at Fig 3 D. These tools are carried by all electrical and motor men, and they are usually constructed from the ends of broken hack-saw blades, taped up along the handle portion.

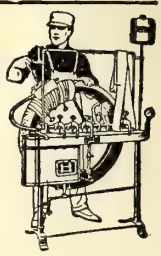
At Fig. 3, several interesting wrinkles in commutator machine work are shown. At A, the position of the diamond point tool is illustrated from above. This tool should be placed at an angular position as shown, and so ground that when it comes up in line with the lugs on the commutator bars, the side of the tool will not touch before the point does. Sometimes it is necessary to take a cut or two over the radial face of the commutator segment lugs, and even the edges of these lugs are frequently turned down. The usual surfaces finished on a commutator are shown at 3-F, and marked F. All narrow edges

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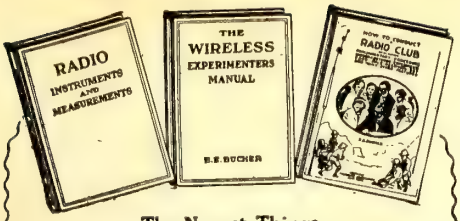
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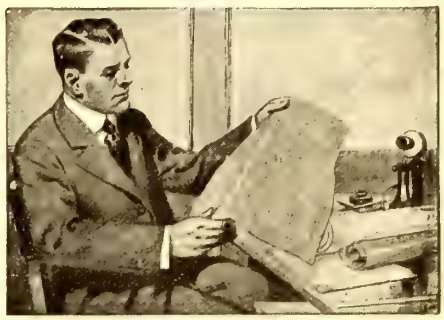
or surfaces are invariably machined off with the hand-feed of the tool rest and carriage. At Fig. 3-B, there is shown the proper position of the diamond point tool turning the commutator, and the point of the tool is best placed a *slight distance* above the center line of the shaft. A handy sand paper block, several sizes of which can be made where much commutator work is done, is shown at Fig 3-C. The curvature of the wooden block over which the sand paper is stretched, should approximate that of the perifery of the commutator. These blocks are extensively used in cleaning the commutator on motors and generators in actual operation in factories, etc. The sand paper is secured in two slots or by screw clamps on the rear of the block.

At Fig. 4 the operation of boring out a commutator to fit a shaft is shown, as well as the detail of the boring out tool. Tools for this purpose are available in the Armstrong or other style of patent clamping tool, in which a short nib of self-hardening steel properly sharpened may be placed, but it is common practice to forge a tool for this purpose of the pattern shown. The cutting edge of the tool may be ground to a diamond point on the emery wheel, as shown. In some cases it may expedite the work to use a drill somewhat smaller than the size of the shaft, for which the commutator is to be bored out to fit, placing the drill in a chuck held in the tail-stock sleeve. It is best to have the point of the boring-out tool slightly above center as before mentioned in the use of the turning tool. The automatic carriage feed, which traverses the tool either way along the lathe, may be used and time gained by increasing the *cut* a thousandth of an inch or two on the cross-feed handle. When the tool has progrest thru the commutator one way; thus a new cut will be taken by the boring-out tool when the carriage is being traversed back toward the tail-stock. It is presumed in this case that the commutator has been accurately centered as regards the outside perifery in the lathe chuck; also the commutator should not be gript by the chuck jaws directly, but a piece of $\frac{1}{16}$-inch brass or copper for small commutators, should be placed around the segments in the manner shown, and the jaws clamped down.

Inside and outside calipers are necessary to correctly carry out this machine operation, the outside calipers being first used to accurately determine the diameter of the shaft, and the inside calipers are then set from the other calipers. From time to time the inside calipers are then tried in the opening being bored out at the center of the commutator, and very light cuts taken toward the last, until the bore is of the right size to permit the commutator fitting on to the shaft. In some cases the commutator has to be bored out so that it will just fit on the shaft with a little urging, and it is then held in place by a key on the shaft. Very small commutators are usually made to have a driving fit. In other words, the hole bored out in the commutator in this case must be a few thousandths of an inch smaller than the diameter of the shaft. It is frequently necessary to apply ice to the shaft, and heat to the commutator, in order to *contract* the former and *expand* the latter, so as to allow the commutator to fit over the shaft. It may even then require a little urging with a mallet and a piece of pipe in order to drive it into place, depending upon how accurately the commutator has been bored out. In a short time the shaft will expand and the commutator will contract, thus providing a very firm juncture, and holding the commutator rigidly in position on the shaft.

(Next installment will appear in the December issue.)

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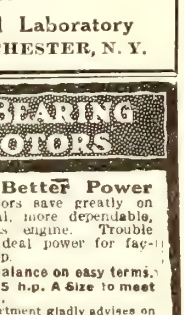


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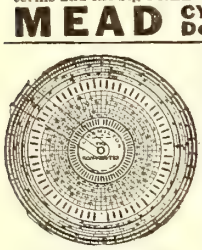
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Sir Charles Parsons on War Inventions.

(Continued from page 640)

Another device, used first by the Germans and afterward by the Allies, consisted of an insulated cable laid on the bottom of the sea, mark a passage thru a mine field or other intricate channel. One end of it was earthed and an alternating current was past along it. Delicate devices were then installed on the vessel, and these enabled it to follow the cable accurately. Sir Charles said that by this means ships were guided for a distance of fifty miles and followed the cable with as much precision as a railless electric street car follows a trolley wire.

BORING INTO THE EARTH FOR POWER.

Sir Charles also discust what England could do when its coal supplies began to give out, saying:

"One cannot but realize that, failing new and unexpected discoveries in science, such as harnessing molecular and atomic energy in matter, the great position of England cannot be maintained for an indefinite period. At some time more or less remote, long before the exhaustion of our coal, population will gradually migrate to those countries where natural sources of energy are most abundant."

He suggested that a new form of energy might be discovered by sinking a shaft twelve miles deep, * that is, about ten times as deep as any in existence. It would cost $25,000,000 and take about eighty-five years, but not only would much useful knowledge concerning the internal constitution of the earth in relation to minerals of high specific gravity be gained from it, but it might also solve the problem of obtaining power.

"In Italy, at Lardarello," Sir Charles said, "boreholes have been sunk which discharge large volumes of high pressure of steam which is being utilized to generate about 10,000 horse power by turbines. At Sol Fatara, near Naples, a similar project is on foot to supply power to the great works in the district. It seems, indeed, probable that in volcanic regions a very large amount of power may be in future obtained directly or indirectly by boring into the earth."

Sir Charles also spoke of the intense pressure produced by moderate forces closing up cavities in water. A committee appointed by the Admiralty investigated during the war the rapid corrosion of propeller blades of some ships performing arduous duties. It was "found that the corrosion was due to the intense blows struck upon the blades of the propellers by the nuclei of vacuous cavities closing up against them. Tho the pressure bringing the water together was only that of one atmosphere, yet it was proved that a nucleus of 20,000 atmosphere might be produced." Sir Charles said this great pressure might be generated under some conditions in rivers and waterfalls when the velocity in river current exceeded fifty feet per second, and was probably as great a source of corrosion as the washing down of boulders and pebbles.

*This scheme was fully described in Mr. Gernsback's editorial. "Tapping the Earth's Heat," in the March, 1919, issue of the "Electrical Experimenter."

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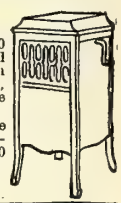


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Popular Astronomy Questions and Answers

By Isabel M. Lewis

(Continued from page 638)

of the sun and that cepheids of longest period have ten thousand times the luminosity of the sun and are rarely surpassed in size by other stars.

Knowing the light-giving power of these stars at a standard distance from the periods of their fluctuations, it is easily possible to find the distance of the clusters in which they appear by the simple relationship connecting apparent with absolute brightness for the apparent brightness of stars of a given magnitude varies inversely as the square of their distance from us.

This simple method founded on the peculiarities of the cepheid variables has yielded wonderful results and made it possible to find the distances of objects so far away that *their light takes two hundred thousand years to reach us,* as easily as the distance of a star ten or fifteen light years away can be found by direct trigonometric measurements of the parallax.

There are many theories to explain the puzzling cause of the fluctuations of light of the cepheids. It is doubtful if two stars are concerned as in the case of eclipsing variables, and it is generally believed that the light variations arise from some change within the masses of isolated stars, such as periodic pulsations or internal oscillations whose course is unknown.

FINDS ANOTHER NEW COMET.

Discovery of a second new comet in three days by the Rev. Joel H. Metcalf was announced August 20 by the Harvard College Observatory. After picking up in the eastern sky on August 20 the first of the year's new stray stars, Mr. Metcalf reported that on the night of the 22d at 11 o'clock he found in Bootes constellation in the western sky another uncharted body, more conspicuous th the first. The discoverer said it could be seen with a small telescope.

Verification of Mr. Metcalf's latest find came in an announcement from Paris of the independent discovery of the same body by M. Morielly of Marseilles the night after Mr. Metcalf found it. The Harvard Observatory also verified it by visual and photographic observation.

The two discoveries of Mr. Metcalf, which are the latest of many he has made, occurred at South Hero, Vermont.

AURORA BOREALIS TIES UP PHONE SERVICE.

Aurora Borealis or "Northern Lights" tied up the telephone and telegraph lines of Canada and the United States as far south as Kansas City and clear across the continent at intervals during the middle of August. The longest interruption was from noon until 12:30 the following day, when the peak load of both telephone and telegraph companies is always felt.

Measuring instruments showed that the "foreign" current had broken all known previous records when it touched 120 volts at times. Previously, when the effect has been felt, five volts was enough to cause trouble, but the record voltage this time exceeded all scientific records. The worst previous disturbance from this cause was in 1914.

According to officials of the Western Union Telegraph Company the disturbance paralyzed the New York City service at intervals.

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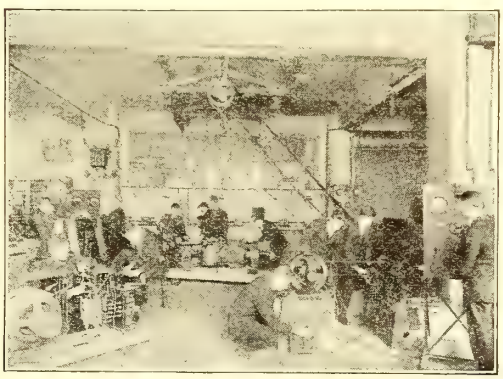
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Health In A Glass Tube

The interesting story of a man "too busy to bother" who appreciated perfect health, energy and vitality only after he lost it—and how he won it back in a startling way

By FRANK HARTLE

YOU probably know dozens of people like my friend John Brainard. Strong, robust, a human dynamo for work, a real bull-dog for stamina, and a very likeable fellow in spite of his entire lack of sympathy for sickness and sick people. He regarded sickness as a mild sort of a crime and had such faith in his own excellent health that he had about as much sympathy for sick people as, according to Mark Twain, David had for Goliath. If you happened to mention that you didn't feel extra well, Brainard would say, as courteously as was absloutely necessary, "T'bad, very sorry"—and you could almost *see* the entire matter sail out of his other ear. Sickness and suffering were foreign to John Brainard and he couldn't understand it in other people, that was all.

But as Josh Billings once said, "Health is like munny. We never have a true idee uv its value until we lose it." And quite suddenly John Brainard realized what ill-health is. Too much overwork, inconsiderate hours, immoderate meals, and general inattention to his health finally "told on him." One day I went to his apartments and found him in bed with a severe attack of sciatica, but fuming with rage in spite of the intense pain. "Why should I have this?—I've been as healthy as a horse all my life. Why should *I* be sick?—hang it, I won't be sick," and he jerked himself to a sitting posture only to fall back in pain upon the pillow.

For a week John Brainard lay in bed in intense agony. Those of you who have suffered from acute sciatica or rheumatism know what it is. The doctor came and went, but Tuesday and Friday when I called, John only said, with a weak attempt at his former cheerfulness, "Nothing doing, Frank. They haven't pushed the right health button yet. Who was that fellow, anyway, who said something about 'a man too busy to take care of his health is like a mechanic too busy to take care of his tools."

Next day while at lunch with George Conrad, our mutual friend, I mentioned about John's still being so very ill. "Listen, Frank, old boy," he said, "I don't want to be presumptuous or anything like that and I certainly believe that the Doc will fix John up fine, but there's a treatment which entirely cured my wife of chronic neuralgia, and now it's bringing total cure to my cousin, another sciatic sufferer. I think if John would give it a trial it might help him some." Ten minutes further conversation with Conrad convinced me and I went right over to John's home to "spring it."

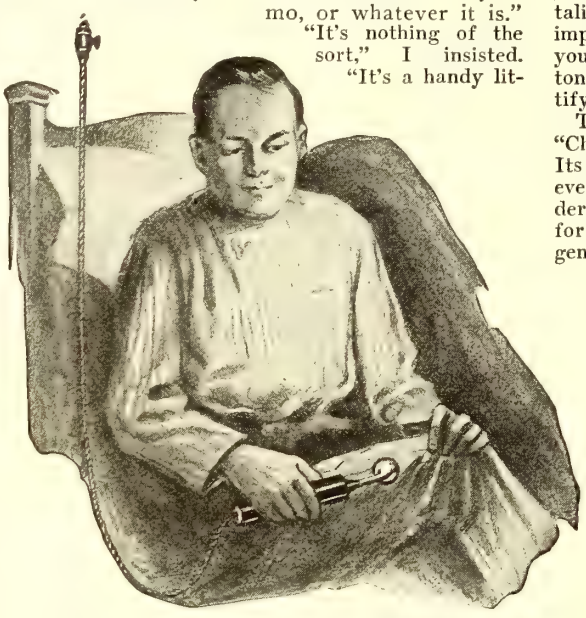
"John," I said quietly, as I tip-toed into his bedroom, "I've got the very thing. Conrad has given me some real facts about what electric violet rays are doing for people and I think—"

"Oh," he interrupted, "I don't know, I don't imagine it can help me."

"Of course you don't know. And you never *will* until you try. Now don't talk foolish, Johnny, old scout. Won't you even believe your friends? This violet ray treatment has *proved* what it is."

And then I went on to tell him all I had learned about violet ray treatment—how it had been invented by the great Tesla in 1890, how it was being used with wonderful success by eminent physicians all over the world, how he could use it on himself and it wouldn't shock him like electricity in other forms, how it would surely at least *help* his own sciatica when it had *cured* other folks' sciatica, neuralgia, hay fever, asthma, neuritis and dozens of other diseases, and finally I told him how it would bring back to him his old "pep," vigor, and "knock-'em-dead" vitality. Then John rolled over and said, "Alright, if it brings me out of this blamed bed a well man I'll swear by it for life. Cart in the dynamo, or whatever it is."

"It's nothing of the sort," I insisted. "It's a handy little tube-shaped thing that attaches to that electric socket right over your head. And you can apply it yourself right to your 'hide' without feeling a bit of a shock."



"When I ran that glass tube over my hide'," said John, "it felt just like a local anasthetic on a wild tooth."

Three days late I had gotten a violet ray instrument from Chicago and John used it on his legs and thighs. "Say," he cried, after the first treatment, "I thought electricity always shocked a fellow. "Why, when I ran that glass tube over me and the violet rays fished around, it just felt like a local anaesthetic on a wild tooth. If this keeps up—oh, boy!"

John Brainard got up for good three days ago for the first time in over two weeks. Five days' treatment with the violet rays put him on his feet.

"Where is your 'rheumatiz,' John," I remarked yesterday.

"Dunno, Frank, I can't find it anywhere. It just 'violet-rayed' itself away, I guess," he said, pointing to the instrument in the bathroom.

"I see you keep it attached."

"Yes, you see my wife discovered that the best beauty specialists in town used it, and she—well, my wife's a woman you know."

* * * *

Violet rays have brought *good results* in almost every disease and Violetta, being the most advanced instrument produced and selling many thousands ahead of all others, is certain to bring you the health-giving results you have always wished. But we do not want you to take our word for it. Judge for yourself—try it for ten days in your home before you decide one way or the other.

Now, through the Violetta, you can have in your own home, the wonderful violet-ray treatments exactly as given by eminent physicians and beauty specialists throughout the country. Now you can rid yourself of Chilblains, Colds, Corns, Constipation, Dandruff, Deafness, Eczema, Eye Diseases, Hay Fever, Headache, Goitre, Insomnia, Lumbago, Nervousness, Neuritis, Obesity, Paralysis, Piles, Pimples, Pyorrhea, Rheumatism, Skin Diseases, Sore Throat, and many other ailments.

Multiply your bodily health—vitalize your nerves—double or treble your energy and vitality. Sleep better, increase your strength, improve your appetite and digestion. Soothe your nerves, reduce or increase your flesh, tone and strengthen the entire system, beautify your complexion. All with the Violetta.

Trixie Friganza, the famous actress, says, "Cheerfully will I add my praise for Violetta. Its the best 'pain chaser and 'soother' I've ever had the good fortune to find. It's wonderful. It cured my brother of neuritis. As for myself, I use it for facial treatment and general massage. I cannot say too much for it." Frank Borzone, of Seattle, Washington, says: "I purchased the Violetta for my wife who was suffering from an acute attack of sciatica. From the very first treatment it induced peaceful rest and she is entirely well now." Scores of letters like these are received each day.

The Violetta is not a vibrator. It is not a machine that contracts the muscles—it does not shock—it does not pound the muscles—it is absolutely painless.

Eminent physicians from all over the country apply the Violetta with wonderful results. Dr. Bert H. Rice, of Vinton, Iowa, says: "I have good results with the Violetta. Almost instant relief in Facial Neuralgia." Dr. Daniels, Lisbon, North Dakota, says: "Have used the Violetta in such cases as Goitre, Bronchitis, Pleurisy, Neuritis, Neuralgia and Lumbago, and find it very beneficial. In fact, I would not be without it in my office." Dr. G. B. Duncan, Kewanee, Ill., says: "The Violetta is the finest thing I ever used to relieve congestion in any part of the body; and to relieve pain. Treatments are so pleasant that all of my patients like it."

Write today for a very interesting little booklet explaining fully about the Violetta and how you can try it for ten days before you decide. Read some of the amazing results produced in almost every disease. Read how the Violetta can be attached to any electric socket and also used where there is no electric light. Read how this little instrument, shaped somewhat like a thermos bottle with a glass tube and bulb at the end, pours electric energy and vigor into every muscle, fibre, cell, and pore of your body. Read how you do not have to obligate yourself in any way until the Violetta has proven its value in your particular case.

Write for this interesting booklet now. Fill out the coupon printed below for your further convenience, *and mail at once.* Address Bleadon-Dun Company, Dept. 2-J, 326 W. Madison St., Chicago, Ill.

BLEADON-DUN CO., Dept. 2-J, 326 W. Madison St., Chicago—Please send me your free booklet about the Violetta and ten days' trial offer.

Name.....

Address.....

.....

Opportunity Ad-lets

YOU will find many remarkable opportunities and real bargains in these columns. It will pay you to read and investigate the offerings made every month by reliable firms, dealers and amateurs from all over the country. No matter what you may be seeking, whether supplies, automobile accessories, the opportunity to make money, or anything else, you will find listed here the best and most attractive specials of the month.

Advertisements in this section nine cents a word for each insertion. No advertisements for less than 75c accepted. Name and address must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. Ten per cent discount for 6 issues, 20 per cent discount for 12 issues. Objectionable or misleading advertisements not accepted. Advertisements for the January issue must reach us not later than December 12.

The Circulation of the Experimenter is over 123,000 and climbing every month

EXPERIMENTER PUBLISHING CO., INC., 233 Fulton Street, New York, N. Y.

Auto Accessories.

Fords start easy in cold weather. Will run 34 miles per gallon on cheapest gasoline or half kerosene using our 1920 carburetors. Increased power; styles for all motors; can attach them yourself. Big profits to agents; money back guarantee. 30 days trial. Air Friction Carburetor Company, 270 Madison St., Dayton, Ohio.

Wanted—Good live selling agents to sell the Chainless, Clutchless and Gearless "Dayton" Electric Starting, Lighting and Ignition system for Ford Cars. Do not make application unless you can provide a Ford car and buy an outfit for demonstrating purposes, as "Ford owners are from Missouri and must be shown." The Dayton Electric Mfg. Co., Dayton, Ohio.

Battery Charging Pays Big Profits. City current or gas engine operates. Easy terms. Hobart Brothers, Troy, Ohio.

Auto Motors and supplies. Buick, Hupp, Franklin, Michigan, Everett, Hudson, Chalmers. Both water and air cooled motors, $40.00 each and up. Bosch Magnetos, $15.00 each and up. Presto Tanks, $5.00. Coils, Carburetors, Head Lamps, Horns, Air Compressors, Generators, Starters. Write for bargain bulletin second hand auto accessories. Johnston, West End Pittsburg, Pa.

Vulcanize Rubber without heat or tools. Whirlwind seller to every Auto owner. Further particulars free. Muscatine Agency, E. E. 402, Muscatine, Iowa.

Tires—Direct to you prices. Exclusive representatives wanted each locality to use and sell Mellinger Extra Ply Tires. Guarantee Bond 8,000 Miles. Sample sections furnished. Mellinger Tire Company, 980 Oak, Kansas City, Missouri.

Send one dollar for the Tuffley Puncture Detector. A new invention for quickly locating punctures in the inner tubes of automobiles, motorcycles, and bicycles, in a clean and scientific manner without the dirty and sloppy method of using water. Sent postpaid to any address for $1. Phil. W. Tuffley, 1456 E. St., San Diego, Cal.

Equip Your Car With Air Brakes. Upon receipt of $2.00 I will send you Blue prints and full description of my Patented Air Brake. R. E. Welch, 247 Auzerais Ave., San Jose, California.

Agents Wanted.

Next Saturday you can earn any of the following: a five cup detector, two slide tuning coil, telegraph outfit two stations, variable condenser, 1000 ohm wireless receiver, ground switch, 400 feet of copper clad aerial wire, high frequency buzzer, or 8 large aerial insulators for selling two dozen household necessities that go like wildfire because they sell so cheap. Send your order now but no money until you have sold them. Hurry, hustle, grab this chance. Leonard Beck, 1298 Carroll St., Bklyn, N. Y.

500 Agents Wanted at Once for Mitchell's Magic Marvel Washing Compound. 300% Profit. Enormous Repeater. "Washes clothes spotlessly clean in ten to fifteen minutes. One thousand other uses in every home. Astounds and delights every woman. Nothing else like it. Nature's mightiest cleanser. Contains no lye, lime, acid or wax. Free samples furnished to boost sales. We positively guarantee the sale of every package. Exclusive territory. Own your own business. You cannot fail to make big money. Barber, Ohio, made $600 last month. Send for free sample and proof. Hurry, hustle, grab this chance. L. Mitchell & Co., Desk 318, 1312-1314 E. 61st, Chicago.

Agents wanted to sell our high grade specialties. Ivol Supply Co., 703 Stanley St., Schenectady, N. Y. Send stamp for particulars.

Every Woman wants Silvoplate—Magic Cleaner that never fails. Sure easy sales plan; main or sideline; quick profits; prepaid deliveries. Sample, 10c; dogen, $1.60. L. B. Sutton, Manufacturer, D-5, New Canaan, Conn.

Agents—Free Sample Outfit. Greatest Washing Tablet proposition. Enormous profits as much as 18c on 25c sale. B. Thayer, 2140 T Clybourn Ave., Chicago, Ill.

Signs for store and office windows. $50 week easily made. Chicago Sign System, G-326 River St., Chicago.

Send for free catalog. "Golden Opportunities" Typewritten tested formulas. Chemical Analysis trade secrets in every line. No printed trash. Satisfaction guaranteed. Industrial Sales Service, 73 Washington, Memphis, Tenn.

Agents Wanted—Cont'd

$10 Daily refinishing chandeliers, brass beds, automobiles by new method, without capital or experience. Free particulars and proofs. Write today. Gunmetal Co., Ave D, Decatur Ill.

Agents—Here is $50.00 to $200.00 weekly proposition. Permanent and repeat. Every office and home needs Argus Moistener for moistening stamps and envelopes. Argus paper clips and pencil and fountain pen holders sell to every man you show—they are different and better than any on the market. Write for particulars. Argus Mfg. Co., 406 No. Paulina St., Dept. 19, Chicago.

Agents—Something new—fastest sellers and quickest repeaters on earth. Permanent, easy, profitable business. Good for $18 to $36 a week. Address: American Products Co., 1500 American Bldg., Cincinnati, Ohio.

New Windshield Cloth solves baffling problem. One wipe cleans rain-blurred windshield. Stays clear 24 hours. Motorists amazed. Agents getting rich. 300% profit. Exclusive territory. Cabco Co., Toledo, Ohio.

Insyde Tyres, inner armor for Automobile tires. Double mileage and prevent punctures and blowouts. Quickly applied. Cost little. Demand tremendous. Profits unlimited. Details free. American Automobile Accessories Co., Dept. 54, Cincinnati, Ohio.

"Klean-Rite"—Best laundry tablet made. Washes clothes without rubbing. Sells like wildfire. Pays agents biggest profit. Special offer and sample free. Besco. 3253. E. L. Belleplain, Chicago.

Sell me your Sparetime. Every house a sale. People all use it. For full particulars address, The Benninghof Chemical Co., Dept. 552, Hiram, Ohio.

Walk Agents: Men with spare time and speciality venders make $5.00 per day upward canvassing office buildings, banks, and business offices, selling the famous Calumet Piece-Pipe, (three pieces,) genuine French Briar. Put up in attractive individual package. Its sensible construction makes cleaning easy and appeals to everybody. Send for proposition. 10,000 bankers have bought and recommend it. The Calumet Co., Dept Q, Mail Sales Division, Cincinnati, Ohio.

Wonderful Chance. Men's shirts and furnishings at wholesale rates or make $10 daily as agent starting real business. Gooddell Co., 102 Duratex Bldg., New York.

Beginners—Complete "Mail Order System," C-Box, 1005 Atlantic City.

Mexican Diamonds flash like genuine, fool experts, stand tests, yet sell for 1/50 the price. Few live agents wanted to sell from handsome sample case. Big profits, pleasant work. Write today. Mexican Diamond Importing Co., Box F I Las Cruces, N. Mex.

Agents. Big returns, fast office sellers; particulars and samples free. One Dip Pen Co., 12 Daily Record Bldg., Baltimore, Md.

Auctioneers.

Auctioneers—Make big money. Free catalog. Carpenter's Auction School, Kansas City.

Salesmen Wanted.

Side-Line Salesmen—We have an attractive line of premium assortments for live salesmen. Commission from $5.00 to $20.00 per order. If you want an up-to-date line, write today. Canfield Mfg. Co., 4003 Broadway St., Chicago, Ill.

Sell the line that hasn't been worked to death. 25% to 31% more than usual for selling staples. $50 a week easy. $100 a week quite common for those selling our Sanitary Brushes, Dustless Mops and Dusters. Good territory available. Promotion for producers. Modern factory and convenient distributing houses assure good service. North Ridge Brush Co., 114 Clark Ave., Freeport, Ill.

Typewriter Supplies.

Ribnsaver makes dried, pale ribbons like new for one cent. 50c postpaid. Order yours today. Ribnsaver Co., 186 La Salle St., Dept. 2, Chicago. Illinois.

For the Photographer.

Do You Take Pictures? Write for free sample of our big magazine showing how to make better pictures and earn money. American Photography, 465 Pope Building, Boston, Mass.

Business Opportunities.

Abraham Bros., Shanghai, China, Importers and Exporters desire connections.

Breed Canaries—Profitable pastime—particulars free. Bird Farm, Lynnhaven, Virginia.

Chiropractic—The new profession. You can learn and earn your way. Practitioners earning $3,000 a year and upwards. Proficiency quickly acquired. Send card for information. Howard College, 515-25 S. Ashland Blvd., Chicago.

Dollars Yearly in Your Back Yard. No ginseng, mushroom dope. New ideas. Investigate. Particulars free. Metz, 313 East 89, New York.

Money-Talks Magazine. Published for progressive men. Send for sample copy. 70-B Park Place, Newark, New Jersey.

Copper Plating Powder. Free package and my original formula, 25c. Instantly and durably Copper Plates steel, iron, tin, etc., by adding water and applying with a rag. Easily and cheaply made. Material anywhere. No free samples. John T. Pierce, 222 East 42nd Street, Los Angeles, Cal.

Enter a New Business. Earn $3,000 to $5,000 yearly in professional fees making and fitting a foot specialty. Openings everywhere with all the trade you can attend to; easily learned by any one at home in a few weeks, at small expense; no further capital required; no goods to buy; job hunting, soliciting or agency. Address Stephenson Laboratory, 18 Back Bay, Boston, Mass.

$30 a Week. Evenings I made it with a small Mail Order Business; continued my regular job daytime. Free Booklet Tells How, 2c postage. Al Exp. Scott, Cohoes, N. Y.

Start a Business of Your Own. Invest $237. Make from $100 to $200 weekly giving moving picture shows in schools, churches, societies, etc. Pleasant evening work. Write for particulars. W. H. Wade, Dept. 120, 14 N. Michigan Ave., Chicago.

Money Making Farms—19 States. $10 to $100 acre. Stock, tools, crops often included to settle quickly. Write for big illustrated catalog. E. A. Strout Farm Agency, 150 EC Nassau St,, New York.

Substantial manufacturing corporation wants capable men to establish branch and manage salesmen. $300 to $1,500 necessary. You handle own money. Will allow expenses to Baltimore if you will qualify. For particulars address Secretary, 416 N. Howard St., Baltimore, Md.

You Can Start your own business with $10.00 if you get my formulas. Send one dollar and will send you formulas and directions, you can make over $10,000 yearly. Write Gust Perganson, 224 S. Sixth St., Springfield, Ill.

Hurry. New device for indexing. Most wonderful results. Will sell directly to men of means. Rev. Emil Meyer, Route 1, Baker, Kan.

Have You A Proposition To Finance? Does your business need money? Let us solve your problem. Write K. J. O'Conner, Secretary, 1 West Thirty-Fourth Street, New York.

$1 Does It. Texas oil land making holders big money everyday. Bank references furnished. Investigate us thoroughly, that's all we ask. Results count. Our plan $1 down, balance monthly few months gives you Warranty Deed to land. May pay profits $200 or more monthly. Maps, reports, established facts free. Address, Sourlake Texas Old Co., 867 De Menil, St. Louis, Mo.

Amazing Profits Manufacturing "Puffed Crisp." Delicious confection. Begin at home. Machine, instructions complete $6.50. Samples 10 cents. "Besco," 3253-EY Belleplaine, Ave., Chicago.

Quick Action Advertising—How it is Building Business for the Progressive Advertiser of America. A little story of results, told by the advertisers themselves—not the publisher. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates—today. Douglas Wakefield Coutlee, 225 West 39th Street, New York.

(Continued on page 724)

(Continued from page 723)

Exchange.

Two analytical balances chemical apparatus and chemicals. In good shape and cheap. Write for list. George Burr, 71 Cartwright, London, Canada.

For Sale or Exchange—One set Hawkins-Electrical Guides, new. C. C. Cooke, Lewis Hotel, Portsmouth, Va.

Bargain Boehm, System Clarinet. Will take omnigraph as part payment. Herbert Erickson, South Haven, Michigan.

Sell—Electrical set with wooden box, $4.00. Structo auto-builder, $4.00; Chemical Labratory, $4.00; Knapp type S. S. dynamo motor, $4.50; 2 V. 20 A. H storage battery with hydrometer, $2.50; Crystaloi detector, $3.25. Send stamp for descriptions. Raymond Fiedler, 70 Sargent St., Lawrence, Mass.

For Sale—½ K. W. transmitting set, $25, Loose coupler, $5.00 Wm. H. Griffiths, 491 Locust Ave., Washington, Pa.

For Sale—First $4.00 takes new $7.50 Knapp dynamo-motor. John Jones, 257 So. 5 St., Columbia, Pa.

Wanted, bad—January, 1918 Experimenter. Pay 50c. Write Paul Lind, Lenore, Ida.

For Sale or Trade—Electrical and wiresless apparatus. Write for list. What have you? Sam McMaster, Bellefourche, South Dakota.

Wanted—Bicycle motor attachment. Complete description. Harry Nelson, Haverstraw, N. Y.

Sell—Flanders 4 with carburetor, magnets, clutch, tank; telephone; bell ringers; electric fans. Want typewriter. Ralph Oberlin, Ada, Ohio.

Sell—Electrical apparatus. List for stamp. Patterson, 11 Cottage Street, Stamford, Conn.

For Sale—Two nickel-plated unicycles. (One Wheel stage bicycles. Each $25. Pyrene extinguisher, $5. R, Richardson, 1341 Park Rd., Washington, D. C.

Will Trade valuable patent for lighting outfit or small dynamo up to ¼ horsepower. Good reason. State condition, type, strength. F. Schlachter, 95 Liberty Street, Oshkosh, Wis.

Will Exchange ½ H. P. Wagner electric motor either 110 or 220 volts. Cost $65. Want high grade sending or receiving apparatus. Mack Simmons, Van Alstyne, Texas.

For Sale—All kinds of apparatus; Radio included. Send for list. Nathan K. Thon, Box 169, Austin, Minnesota.

Exchange, Buy, Sell. Wireless, electrical goods, etc. Large list 6c. State what you have and want. Zehrbach, Box 250, Hiram, O.

Telescope, $3.00; Hawkins Guides, 1 and 2, $1.75; Astronomy, $1.00; Lowells Mars, $1.75; Howard Garner, Lawrenceburg, Kentucky.

Sell—Cyclopedia Applied Electricity, $12.00; Steven's "Favorite" 22 Rifle, $4.00; Electro Chemical Laboratory, $2.00; Schreyer, 72 Ridgewood, Place Staten Island.

I have some small motors, tools and instruments. Will exchange for rifles or shotgun. J. F. K., P. O. Box 18, Akron, Ohio

For Sale: Switchboard with volt and amp meters auto-cutout, and cell switch, rheostat, volt meter switch, 4 D. P. S. T. 10 A. switches. Good condition. Make offer. Warren Lincoln, North Easton, Mass.

For Sale or Exchange. Shoemakers machine, new, wall telephone. Extra cabinet ringer. Water Motor ⅛ motor. Machinists dies and taps. Hawkins Guides Masonic Library, School & Reference Library. Small Ammeter. Harry Clemmer, 917 Fairfax Ave., N. W., Roanoke, Va.

For Sale. Amateurs complete sending and receiving set. Send for list of same. Cyril W. Hooper, Box 404, Republic, Mich.

For Sale. Hammond Portable Typewriter, new. Write, D. Blodgett, 615 W. Second St., Flint, Michigan.

Trade practically new violet ray for excellent ¼ A. C. Motor, or cash. E. Nihiser, Broadway, Hagerstown, Md.

What is offered collectively or separately? All instruments are guaranteed O. K.—4 sending condensers, $3.50 value each, 2 No. .00002 m. f. Receiving condensers, $10.00 each; 1 $35.00 receiving transformer; 1 K. W. sending transformer, value, $60.00. E. Duskis, 1758 Bergen St., Bklyn., N. Y.

Electrical Blueprints of various kinds. See my ad under "Electrical" this issue. Charles L. Chittenden.

Wanted. Small gasoline motor buy or exchange. B. W. Earl, Edgewater Park, New Jersey.

Murdock 10 Ampere Marble Base Key, $6; Hot-wire ammeter, 0-3 amperes, $3; Murdock three pole antenna switch, $3; Brandes Superior Phones, $4; Moorhead two filament tube, $4; R. C. Hitchcock, Box 550, Middletown, Conn.

Trade. 2½ H. P. Motorgo Marine Engine in perfect condition for 1 K. W. Thordarson flexible transformer in perfect condition. Complete set I. C. S. Civil Engineering books for sale, $30.00. Maurice H. Simmers, 409 So. Campbell St., Macomb, Ill.

Exchange—Cont'd

For Sale. Complete Electrical Labratory. Joseph Saltry, 319 Oak St., Scranton, Pa.

Bargain: Curtiss Biplane, 3 ft., model, $8.50. Guaranteed to fly. Send for photos. 24 Fors spark coils, 50c each, 4 for $1.75. 3000 meter loose coupler, $4.50. Complete arclight. $3.00. Edw. Webb, New London, Ohio.

Jewelry.

Distinctive Jewelry for Driscriminating buyers. Our prices surprisingly low. We guarantee to save you money. Send for our catalog and see why. David Stern Company, "Value, Service, Satisfaction since 1885," Chicago, Ill.

Instruction.

Questions Answered. All subjects. Send for circular 7. Answerall Information Bureau, 51 Cliff St., New York.

Cartooning Comics and Lettering in fourteen easy lessons. Only $3, postpaid. Over 300 illustrations. Order yours now. Ernie's School, Elyria, Ohio.

Learn Dancing; become popular. All dances taught by mail; easy; no music. Thousands taught successfully. Write for special offer. W. C. Peak (Graduate Castle House), Room 227, 821 Crescent Place, Chicago.

Become a leader at social gatherings. Mystify, Amuse, Entertain. Learn mind reading. Complete private instructions, 25 cents. Circular free. Mysto, 633 Prospect Ave., N. Y.

Cornetists—Trombonists: Send for "Free Pointers." Weak Lips-High Tones. Virtuoso Cornet School, Buffalo, N. Y.

Musical Instruments.

Violins. Deep, Mellow, Soulful—on credit. Easy terms for wonderful instrument. Get details today. Gustav Henning, 231 11th St., Miami, Florida.

Old Money Wanted.

We Buy and Sell Old Coins. $2 to $500 each paid. Keep All Old Money; you may have valuable coins. Send 10c for New Ilustrated Coin Value Book, 4x6. Guaranteed prices. Get posted. Clarke Coin Co., Box 110, Le Roy, New York.

Never Sell Old Coins until you see our copyrighted 6 x 9 Illustrated Coin Value Book (New Edition) —showing high prices we pay $100 paid for 1894 dime, S Mint. $5.00 for 1856 Eagle Cent. Send 10c for your copy today. Hundreds of old coins wanted. International Coin Co., Box 151-P, Philadelphia, Pa.

Stamps and Coins.

Free—10 varieties unused stamps. (Fine.) Postage, 2c. Dayton, East Foxboro, Mass.

Premium to approval applicants. Harland Burgett, 419 Spring St., Lima, Ohio.

Stamps—Packet, catalog over $2 for only 25c. 100 from 100 countries, 30c. O. Chartico, Wallingford, Conn.

50 Different Stamps, 3c. 100 different, 10c Buckey, 412-B Bowen St., Dayton, Ohio.

Best one cent approvals in America. F. P. Hand, 1117 S. 60th St., Philadelphia, Pa.

South America. Buy direct. 1000 fine assorted Paraguay, Uruguay, etc., for a $2 bill. Exchange rare stamps with collectors and dealers; lots or on sheets. C. P. Mego, Necochea 193, Lomas Dezamora, Argentine Republic.

100 Different Stamps, 12c; 200 27c. Michaels, 5600 Prairie, Chicago.

300 different stamps, 50c. Fred Onken, 630 79th St., Brooklyn, New York.

Stamps—61 All Different Free. Postage, 3c. Mention paper. Quaker Stamp Co., Toledo, O.

California Gold, quarter size; 27c. Half dollar size; 53c. Columbia Nickel and Catalog, 10c Norman Shultz, King City, Mo.

Health.

Tobacco Habit Conquered. $1 prepaid. Entirely new. Guaranteed. Harrison, 105 Walker, Evansville, Ind.

Pyorrhea, (Bigg's Disease—Bleeding or Swollen Gums.) H. E. Kelty, D. D. S., M. D., pyorrhea specialist for 15 years, has developed a successful home treatment for pyorrhea, purifying, healing, preventative. Full month's treatment, $1 postpaid. Or, write for free booklet. Pyorem Mfg. Co., 439 Seventh Street, Brooklyn, New York.

Cigarette, pipe or chewing habit conquered. Nature's method. Guaranteed. Write for free brochure. Edw. J. Woods, TA-300, Station F, New York.

Goiter—Rid yourself of this terrible disease at home, cure guaranteed or money refunded; formula and full directions for using this wonderful new discovery, sent to all sufferers. Price, $2.00. P. O. or express money order. Address: Wellington Labratories, No. 40 15th St., Detroit, Mich.

Song Poems.

Write the Words for a Song. We write music and guarantee publisher's acceptance. Submit poems on war, love or any subject. Chester Music Co., 920 So. Michigan Ave., Room 265, Chicago, Ill.

Song-writers' Manual and Guide Sent Free! Contains valuable instructions and advice. Submit song-poems for examination. We will furnish music, copyright and facilitate publication or sale. Knickerbocker Studios, 319 Gaiety Bldg., New York.

Write the Words for a Song. We revise poems, write music and guarantee to secure publication. Submit poems on any subject. Broadway Studios, 197C Fitzgerald Bldg, New York.

You Write Words For A Song. We write the music, publish and secure a copyright. Submit Poems on any subject. The Metropolitan Studios, 914 So. Michigan Ave., Room 113, Chicago, Ill.

Song Writers.

Song Writers—You cannot afford to miss our proposition. Reference at any bank for first-class sheet music house. Warner C. Williams & Co., Dept. L, Indianapolis, Ind.

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Short Stories, Poems, Plays Etc., are wanted for publication. Literary Bureau, 165 Hannibal, Mo.

Tricks, Puzzles and Games.

Illusions—Stage Tricks with 500 illustrations, catalogue, 15c. Small catalogue free. Hornmann Magic Company, 304 West 34th Street, New York.

Magic Card Tricks, Sensational Escapes, Jokes, Novelties, everything in the amusement line. Large illustrated catalogue of a thousand tricks, free. Write today. largest amusement manufacturers in the world. Heaney Magic Co., Desk 200, Berlin, Wisconsin.

Black Art Hindoo experiments. 1919 edition. 25c. Invisible ink. Free trick. Catalogue each order. Lindhorst Magic X Shop, St. Louis.

Magic Pictures complete outfit for making, 10c. Greatest fun producer on earth. R. E. McIntyre, General Post Office, New York City.

Magic. Entertain at home. Tricks, puzzles, novelties. Big Catalogue A, 25c. Martinka & Co., Inc., Harry Houdini, President, 493 Sixth Avenue, New York City.

Novelties.

Something New! Have you seen them? Curiously mysterious Wonder Shaving. Novelties imported from Japan. Little wooden pieces, when dropped into water, open up, turning into fish, flowers, orange trees, birds, babies, in all colors. Children laugh while old folks are mystified. Entertaining and amusing to invalids or in sickroom. One dozen assorted, all colors, in pretty package with directions, price 15 cents, 3 packages, 35 cents. Excellent for entertaining dinner parties, used as favors, they create talk. One dozen packages sent prepaid for $1.00. Send now. Be first to have these novelties. Address George P. Heinemann, 1424 Rosemont, Ave., Chicago, Ill.

Here, Boys. Make a toy aeroplane; see our Nifty, ad, page 678.

Pictures—Post Cards.

Rare Real Photos; Bathing beauties, models, the kind you want. Sample Dime. Write, (Artiste,) Auburn, Ind.

Wonders of New York, 25 views, illustrated, 25c, cash. John Notes, 90 Division St., New York.

Real Photos. Handsome girl models. Rare poses. Samples, 25c. Garvey, Dept. E., 20 Perkins Place, Brockton, Mass.

Phonographs.

"Build Your Own Phonographs and manufacture them for profit. Drawing, Instructions, Parts Price List. Blue Print, etc., complete sent free upon request. Write today. Associated Phonograph Co., Dept. EI, Cincinnati."

Build Your Phonograph. "Perfection" high-quality spring and electric motors, tone arms, reproducers. Wonderful results. Big saving. New catalog and building instructions mailed for ten cents. Indiana Phonograph Supply Co., Indianapolis, Ind.

Music For Christmas. Our prices on standard talking machines so low you cannot afford to be without one in your home. Send for our catalog. You'll save money. David Stern Company, "Value, Service, Satisfaction since 1885," Chicago, Ill.

Make Your Own Phonograph. Particulars free. DeSelO-PhonE, P. O. Box 720, Attica, Indiana.

Electrical Supplies and Appliances.

Battery Charging pays big profits with HB equipment. Electric light generators and motors can also be furnished on easy payments. Full information free. Hobart Brothers, Troy, Ohio.

Lava Insulation is not molded but individually sawn, lathe turned, milled, drilled, threaded. No limitation on form, only on size. Kilned at two thousand degrees. Hard, strong, accurate, fire, acid proof. Ask for book. American Lava Insulator Company, Chattanooga, Tenn.

Electrical Blueprints—For connecting A. C. motors, 236, 54 single phase, 42 two phase, 50 three phase star, 40 delta, 12 star-delta. Appendix, 36, changes of voltage, speed, phases, cycles, etc. Prints for connecting D. C. motors, 123, Shows changes of voltage by reconnecting and rewinding. Also various ways of testing. For use on autos as well as large motors. Diagrams for connecting transformers. Ten samples of A. C. motor, or transformer samples 25c. Particulars and other information on request. Charles L. Chittenden, 811 West 18th St., Kansas City, Missouri.

Electrical Workers and All Others who are interested in electrical work in the reconstruction that is taking place to send us their name and receive descriptive literature of our modern blue print chart method of electrical wiring, Souvenir information card included. Electrical Wiring Diagram Co., Box C 173, Altoona, Pa.

Boys—Here is the simplest and cheapest electric telegraph ever devised. With the "K" Applicator you need no batteries. Get electricity free, instantly anywhere at any time. Send thirty cents, (postal money order) for full instructions how to make the "K" Applicator and how to operate an electric telegraph without batteries. Is easier to make and requires less material than you would use in making a kite. Gives constant smoothe even current day and night, never runs down, even upon closed circuit. Works on any metallic line, even barbed wire fence, as no insulators necessary. The "K" Applicator, Missouri Valley, Iowa.

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(Continued on page 726)

(Continued from page 725)

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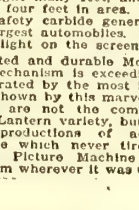
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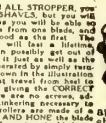


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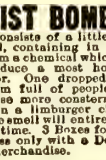


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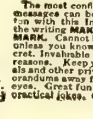
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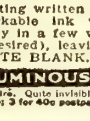
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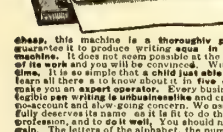
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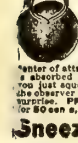
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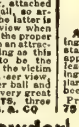
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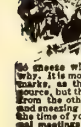
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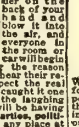
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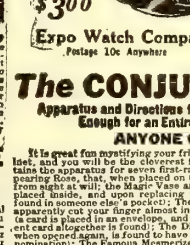
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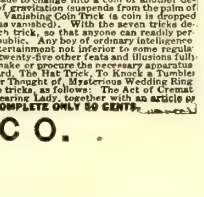
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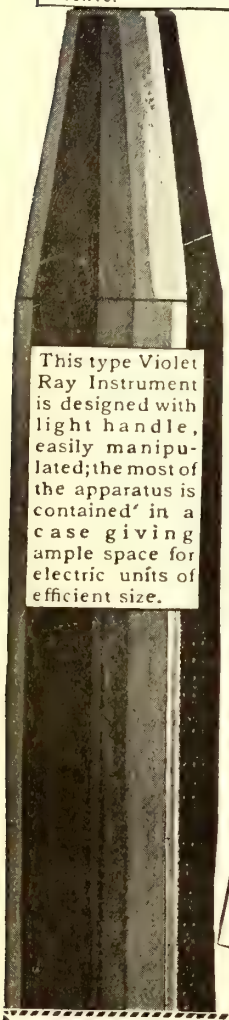
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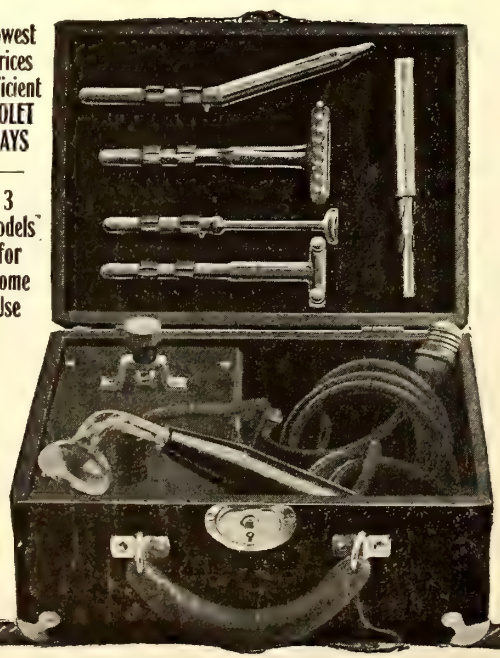
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EDITORIAL

Ether and Space

FOR thousands of years it was an establisht fact that the earth stood still, with the sun, moon and stars revolving around it. All known evidence, visual and otherwise, supported the "fact." But humanity with its deceptive senses had been fooled for generations, until the "establisht fact" was disproved by one Galileo, who brought very convincing proofs that it was the sun that stood still.

Since Euclid, down to a very few years ago, scientists thought that light was always propagated along absolutely straight lines. Einstein, however, showed an astonished world that a ray of light may be curved considerably. Indeed, we appear to have proofs to support him.

Again, for over one hundred years we have accepted unhesitatingly Faraday's teachings that the whole universe is permeated with a very tenuous and exceedingly fine substance, the ether. Faraday and Maxwell, in order to explain the wave theory of light and other electromagnetic waves, invented the ether, as they reasoned that you cannot have waves without a suitable medium in which to vibrate these waves. The ether, accordingly, is a substance so fine, so minute, that it permeates and fills not only the entire universe but all other substances. It fills the space between atoms in metals and all other solids or fluids; in short, it is everywhere. It was reasoned that the ether must have elastic, jelly-like material properties in order to explain many mystifying phenomena, but nothing of the actual structure of the ether is known.

But now Einstein and his followers come along and flatly deny all existence of the ether. In their support it must be said that there are no experimental proofs of the existence of the ether. The ether, in short, is only a theory, which was never proved—but so far also never entirely disproved. If a light ray is material, the ether is no longer required to explain its propagation. Indeed, all recent researches along this line tend to show that light *is* material. We know for instance that the sunlight exerts a pressure of many thousand tons upon the surface of the earth upon which it falls. This is termed the pressure of light. But can you exert pressure upon a body unless the light which exerts it has "body"; in other words, is material? Then, too, if a light ray is deflected in a gravitational field, it certainly must be material.

Once arrived on these premises let us see how space looks to our mental eye, robbed of its hypothetical ether. We will now have a vast vacuum, nothing but a vacuum at a temperature of—273° Fahrenheit. But how can a light ray, or a radio ray (wave) cross this bottomless void? An analogy may perhaps help here. Imagine a man stationed out in space shooting a stream of a non-freezing liquid earthward from a fire-hose. Suppose he vibrates (shakes) the nozzle back and forwards slightly. This would impart to the liquid stream a wave motion the same as we know a light ray has. There being no friction, the wave motion of the liquid stream would persist till the stream reaches the earth's atmosphere, where it would break up into drops.

Now we have seen that given a material stream we need no medium such as the ether to hurl it earthward. If, then, light and other electromagnetic waves are material, we no longer require the ether to explain the wave motion. We can even explain how it comes that the intensity of light diminishes inversely as the square of its distance. If a light ray is material—let us say composed of electrons—we can conceive how, thru its terrific speed of 186,000 miles per second, a certain quantity of electrons are lost continuously in space during its course. These electrons would probably be flipped off from the crests of the wave.

The next decade will no doubt shed further "light" on the question.

H. GERNSBACK.

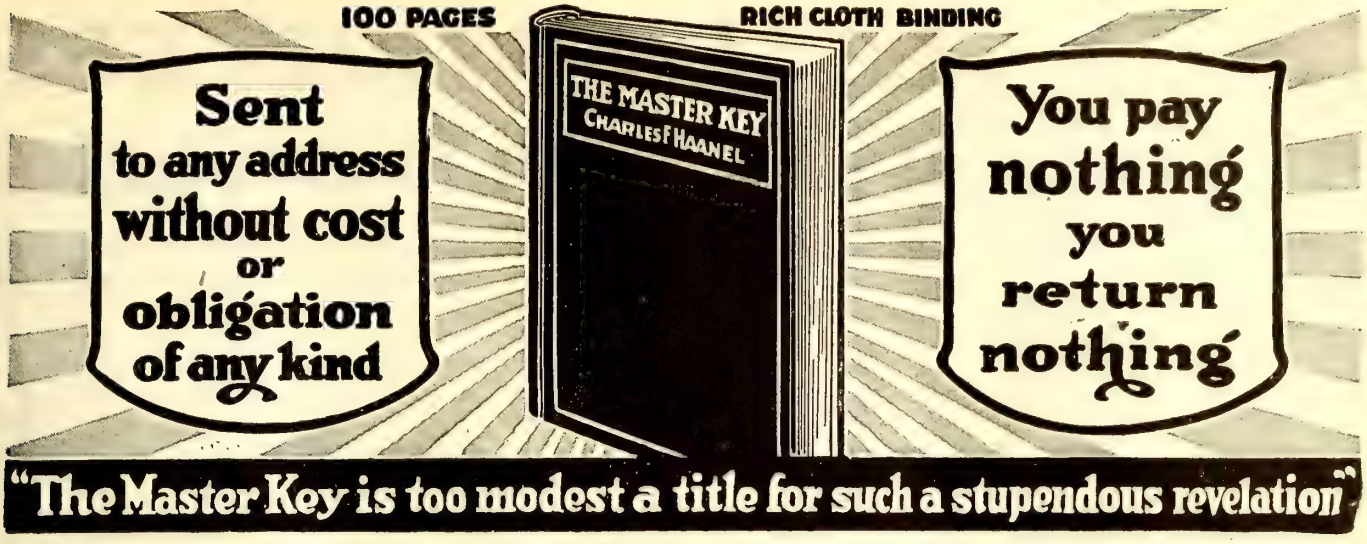
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There's no need to discuss the whys and the wherefores of this "secret." Suffice it to say that *It Works*. That's all we care about—*It Works*. Over 350,000 men and women the world over have proved it for themselves.

Among them are such men as Judge Ben B. Lindsay; Supreme Court Justice Parker; Lieut. Governor McKelvie, of Nebraska; Wu Ting Fang, ex-U. S. Chinese Ambassador; Governor Ferris, of Michigan; and thousands of others of equal prominence.

Some of the things this "secret" has done for people are astounding. I would hardly believe them if I hadn't seen them with my own eyes. Adding ten, twenty, thirty or forty dollars a week to a man's income is a mere nothing. That's merely playing at it. Listen to this:

A young man in the East had an article for which there was a nation-wide demand. For twelve years he "puttered around" with it—barely eking out a living. To-day this young man is worth $200,000. He is building a $25,000 home—and paying cash for it. He has three automobiles. His children go to private schools. He goes hunting, fishing, traveling, whenever the mood strikes him. His income is over a thousand dollars a week.

In a little town in New York lives a man who two years ago was pitied by all who knew him. From the time he was 14 he had worked and slaved—and at sixty he was looked upon as a failure. Without work, in debt to his charitable friends, with an invalid son to support, the outlook was pitchy black. Then he learned the "secret." In two weeks he was in business for himself. In three months his plant was working night and day to fill orders. During 1916 the profits were $20,000. During 1917 the profits ran close to $40,000. And this genial 64-year-young man is enjoying pleasures and comforts he little dreamed would ever be his.

I could tell you thousands of similar instances. But there's no need to do this as I'm willing to tell you the "secret" itself. Then you can put it to work and see what it will do for you. I don't claim I can make you rich over night. Maybe I can—maybe I can't. Sometimes I have failures—everyone has. But I do claim that I can help 90 out of every 100 people if they will let me.

The point of it all, my friend, is that you are using only about one-tenth of that wonderful brain of yours. That's why you haven't won greater success. Throw the unused nine-tenths of your brain into action and you'll be amazed at the almost instantaneous results.

The Will is the motive power of the brain. Without a highly trained, inflexible will, a man has about as much chance of attaining success in life as a railway engine has of crossing the continent without steam. The biggest ideas have no value without will-power to "put them over." Yet the will, altho heretofore entirely neglected, can be trained into wonderful power like the brain or memory and by the very same method—intelligent exercise and use.

If you held your arm in a sling for two years, it would become powerless to lift a feather, from lack of use. The same is true of the Will—it becomes useless from lack of practice. Because we don't use our Wills—because we continually bow to circumstance—we become unable to assert ourselves. What our wills need is practice.

Develop your will-power and money will flow in on you. Rich opportunities will open up for you. Driving energy you never dreamed you had will manifest itself. You will thrill with a new power—a power that nothing can resist. You'll have an influence over people that you never thought possible. Success—in whatever form you want it—will come as easy as failure came before. And those are only a few of the things the "secret" will do for you. The "secret" is fully explained in the wonderful book "Power of Will."

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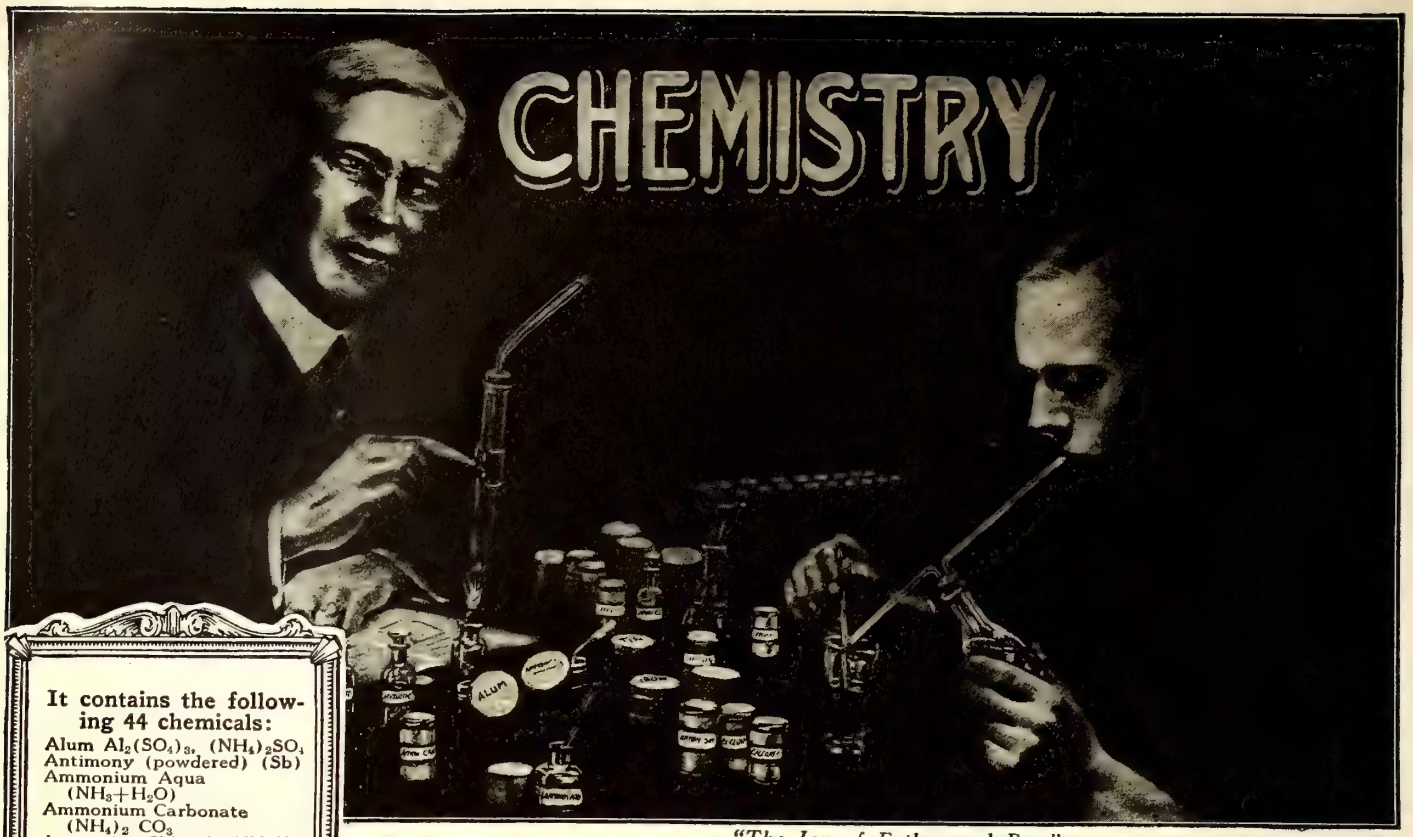
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The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

Among the **100 Experiments** are:

How to make chemical tricks; How to make invisible and magic inks; How to test flour; How to test soil; How to Make Chlorine Gas and smoke (German War Gas); How to bleach cloth and flowers. How to produce Oxygen and Hydrogen; How to make chemical colors; How to test Acids and Alkalies and hundreds of interesting hints and formulas.

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Ammonium Aqua (NH_3+H_2O)
Ammonium Carbonate $(NH_4)_2\ CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride $(BaCl_2)$
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride $(CaCl_2)$
Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_4 2H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate $(MgCO_3)$
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
Sulphate of Nickel $(NiSO_4)$
Sulphate of Zinc $(ZnSO_4)$
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
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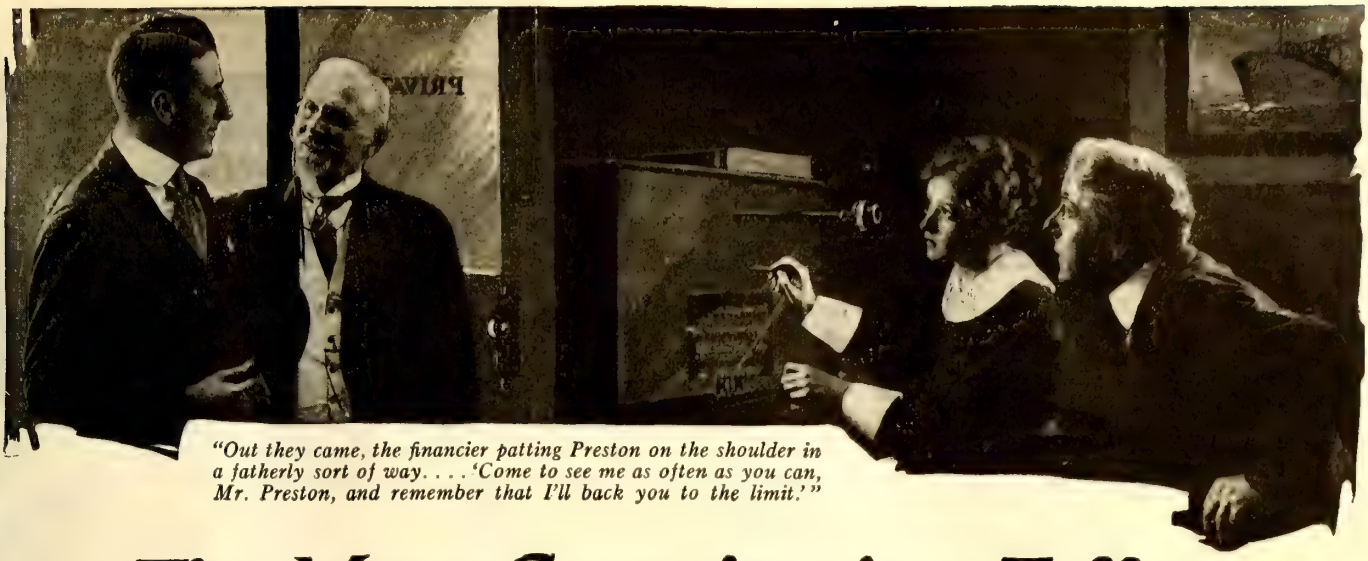
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The Most Convincing Talker I Ever Met

Everywhere this man goes, people shower him with favors and seek his friendship. Things which other people ask for and are refused, he gets instantly. How he does it is told in this amazing story.

LET me ask you this: There is a big business deal to be put through. It involves millions of dollars. Putting it through depends wholly on one thing—getting the backing of a great financier.

But this man is bitterly opposed to your idea and to your associates. Seven of the most able men and women in all America have tried to win over this financier. They failed dismally and completely.

Now, could you, a total stranger to this man, walk in on him unannounced, talk for less than an hour, and then have him take your arm as a token of friendship, and give you a signed letter agreeing to back you to the limit?

Could you?

ASTOUNDING? Yes! But it *W A S* done. And I'll tell you how. Here is the way it all came about. For a long time the directors of our company had felt the handicap of limited capital. We had business in sight running into a million dollars a month. But we couldn't finance this volume of sales. We simply had to get big backing, and that was all there was to it.

Because of trade affiliations, one man—a great financier in New York—controlled the situation. Win him over and the rest was easy. But how to win him?—that was the question. No less than five men and two women—all people of influence and reputation—had tried. They were all repulsed—turned down cold and flat.

You know how a thing of this sort grows on you and how bitter utter defeat is. Well, we were talking it over at a board meeting, when one of our directors announced that he knew of only one man who could possibly put through the deal—a man by the name of Preston.

So it was agreed that Preston was to be sounded out at luncheon the following day. He proved to be a fine type of American. At 34 years of age he had become president and majority stockholder of a thriving manufacturing business rated at three-quarters of a million dollars.

Preston was deeply interested, as anyone would be over the prospect of closing such a big deal. The director in question said casually, "Why don't you run down to New York and take a shot at it, Preston?" Preston looked out of the window for a moment, and then quietly answered, "You're on."

I WENT along with Preston simply as a matter of form to represent our interests. Aboard the 10:25 train out of Chicago we headed for the smoker and got to talking with the crowd there.

Then I noticed something. Preston had dominated them all. Everyone was eagerly hanging on his words, and looking at him with open admiration. No sooner would he stop talking than one of the men would start him up again. And as the men dropped off at stations along the way they gave Preston their cards, with pressing invitations to look them up. No doubt about it, Preston was *T H E* man aboard that car.

The colored porter, too, came under his sway. For that night, when the berths were being made up, the porter came unasked to Preston, told him that his berth was right over the car trucks, and insisted upon changing it to a more comfortable one.

And so it went all the way to New York. Everyone who met Preston took a great liking to him the instant he spoke. They seemed to be eager for his companionship — wanted to be with him every minute, openly admired him, and loaded him with favors.

Even the usual haughty room clerk at the hotel showed a great interest in Preston's welfare. He showered us with attention while a long line of people waited to register.

The next morning we called on the great financier—the man who was so bitterly against us and had flatly turned down seven of our shrewd influential representatives.

I waited in the reception room—nervous, restless, with pins and needles running up and down my spine. Surely Preston would meet the same humiliating fate?

But no! In less than an hour out they came, arm in arm, the financier patting Preston on the shoulder in a fatherly sort of way. And then I heard the surprising words, "Come to see me as often as you can, Mr. Preston, *and remember that I'll back you to the limit!*"

AT the hotel that night sleep wouldn't come. I couldn't get the amazing Preston out of my thoughts. What an irresistible power over men's minds he had. Didn't even have to ask for what he wanted! People actually competed for his attention, anticipated his wishes and eagerly met them. What a man! What power! . . . Then the tremendous possibilities of it all—think what could be done with such power.

What was the secret? For secret there must be. So the first thing next morning I hurried to Preston's room, told him my thoughts, and asked him the secret of his power.

Preston laughed good-naturedly. "Nothing to it—I—well—that—is—" he stalled. "I don't like to talk about myself, but I've simply mastered the knack of talking convincingly, that's all."

"But how did you get the knack?" I persisted.

Preston smiled, and said, "Well, there's an organization in New York that tells you exactly how to do it. *It's amazing!* There's really nothing to study. It's mostly a knack which they tell you. You can learn this knack in a few hours. And in less than a week it will produce definite results in your daily work.

"Write to this organization—the Independent Corporation—and get their method. They send it on free trial. I'll wager that in a few weeks from now you'll have a power over men which you never thought possible . . . . but write and see for yourself." And that was all I could get out of the amazing Preston.

WHEN I returned home I sent for the method Preston told me about. It opened my eyes and astounded me. Just how he had won over the financier was now as clear as day to me. I began to apply the method to my daily work, and soon I was able to wield the same remarkable power over men and women that Preston had. I don't like to talk about my personal achievements any more than Preston does, but I'll say this:

When you have acquired the knack of talking convincingly, it's easy to get people to do anything you want them to do. That's how Preston impressed those people on the train—how he won over the financier—simply by talking convincingly.

This knack of talking convincingly will do wonders for any man or woman. Most people are afraid to express their thoughts; they know the humiliation of talking to people and of being ignored with a casual nod or a "yes" or "no." But when you can talk convincingly, it's different. *When you talk people listen and listen eagerly.* You can get people to do almost anything you want them to do. And the beauty of it all is that they think they are doing it of their own free will.

In committee meetings, or in a crowd of any sort you can rivet the attention of all when you talk. You can force them to accept your ideas. It helps wonderfully in writing business letters—enables you to write sales letters that amaze everyone by the big orders they pull in.

Then again it helps in social life. Interesting and convincing talk is the basis of social success. At social affairs you'll always find that the convincing talker is the centre of attraction, and that people go out of their way to "make up" to him.

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The Couple That Spent Every Cent

WHERE did it all go? Forbes earned a good salary. Neither he nor Mrs. Forbes could be accused of extravagance. But somehow they could never keep more than a few dollars ahead of expenses. Then something happened that gave them a scare—and out of it they found an easy way to get on EASY STREET.

ABOUT six months ago I got the scare of my life. Edith was worried, too. But in the end it was one of the best things that ever happened to us.

I guess I had a pretty close call. The doctor said afterwards that he never expected me to pull through.

But it wasn't my own sickness that gave me my fright—at least, I wasn't alarmed about myself. It was the sick condition of the family finances, and thinking of Edith and the boy that put me in a panic.

There I was, flat on my back in bed; a big doctor's bill running up; a trained nurse to pay every week; and no reserve to fall back on—not a dollar laid by for emergency.

Luckily the firm was good enough to continue my salary without a break, or I don't know what we would have done.

The things that went through my mind during that slow process of getting well made me feel like a criminal. Suppose the worst had happened? No provision for Edith and the boy except a little insurance—the total amount not enough to last more than a year at the rate we had been living.

It hurt like a stab. It seems incredible that two people in their right minds could drift along the way we had been doing, constantly living up to the last cent, constantly on the edge of a slippery precipice. Yet according to statistics, something like 50% of all the men in America over sixty years of age are dependent on relatives or charity for support—including men who had earned princely incomes when in their prime. Think of it! And all because they had failed to look ahead—had never learned how to save. It hit me right between the eyes. For I was nearly thirty-two years old—certainly old enough to know better; yet I wasn't a dollar nearer independence than when I was twenty.

One day, while still in bed, I ran across something in one of the magazines that opened my eyes to our whole trouble.

It said that most people make hard work of saving simply because they don't go at it in the right way. Their money doesn't last long because they have no check on it—no definite system for adjusting their outgo to their income. It said the only practical way is the budget system—split your salary up into proportionate parts; allow so much each week for this, so much for that, and then stick to it.

Then the article told of an almost automatic way for doing this—a new system for managing personal affairs; it was called the Ferrin Money Making Account System.

It struck me that this was just what Edith and I needed if we ever expected to get our feet on solid ground. When I showed my discovery to Edith, she agreed with me, and immediately sent for the complete system.

That little step has proved to be our salvation. It has helped us put nearly $500 in the bank in less than six months—out of the same salary that was formerly never enough. At the same time it helped us to pay a big doctor's bill without ever missing the money.

The Ferrin Money Making Account System has shown us how to cut out all that old haphazard, hit-or-miss kind of spending, how to save money that we formerly frittered away—how to stop the little leaks that were keeping us poor.

The Magic Budget Plan

The Ferrin Money Making Account System is simplifying money matters for thousands upon thousands of people all over the country — helping square up bills and debts—putting money in the bank for people who never before saved a cent. It will help you in the same way. This system, which is simplicity itself, comprises:

The Ferrin Money Making Account Book.
The Ferrin Kitchen Calendar (for the household).
The Ferrin Pocket Account Book.
The Ferrin Investment and Insurance Register.
The Ferrin Household Inventory and Fire Insurance Record.

Compact information is given on Making a Budget, Keeping Expense Accounts, Making Safe Investments, Making an Inventory of Household Goods.

The Pocket Account Book (price when sold separately, 50 cents) contains printed slips so that you have only to jot down the amounts of your daily expenditures. The Kitchen Calendar (price 50 cents) keeps track of household expenses. At the end of each week or month these amounts are transferred to the Money Making Account Book, which contains 112 pages, size 8¼ x 10½ inches, and is bound in half blue Silk Cloth Back—Cadet Blue Cover, Paper Sides—Turned Edges, semi-flexible, stamped in gold on Front Cover. This book has been prepared by an expert to fit any salary from the smallest to the largest. Incorporated in it is a recapitulation for every month of the year, which shows at a glance the Budget and the amounts paid out during the month for the various classified items of expense. It is the only book to our knowledge which has a Budget column for every month. Special columns are provided for items on which an income tax does not have to be paid, so that these amounts may be deducted at the end of the year.



"The things that went through my mind during that slow process of getting well made me feel like a criminal."

One Money Saving Feature

A war tax is now levied on almost every kind of article you buy. Few people know that the amounts so paid on daily purchases may properly be deducted from their income tax report. The following items, for example, are deductable: Interest on personal indebtedness; taxes on land, buildings and household property, war taxes on club dues, theatre tickets, transportation, telephone messages, telegrams, tobacco, etc.; contributions to churches, charitable, scientific or educational institutions which are not conducted for profit. By keeping track of these war taxes on the pages for daily expenditures, and transferring the weekly or monthly totals to the Money Making Account Book, you will effect a saving on your income tax that will surprise you and that will pay the small price of the System many times over.

The Ferrin Investment Insurance Register is designed to keep an accurate record of your investments, insurance policies, etc. Contains 32 pages, size 5 x 8 inches, price separately, 50 cents. The Ferrin Inventory and Fire Insurance Record will enable you to make and keep a complete inventory of every room in the house; also provides for record of your fire insurance policy. It is an absolute necessity in case of fire. It may save you many thousand times the cost, which is 50 cents when sold separately.

READ:

Letter from Head of Financial Department of Largest Corporation of its kind in the United States:

"I consider your account book a remarkable contribution to the people of this country at this time.

In our company we have 5,000 employes and it was a revelation to me, in giving them advice in regard to the making out of their income tax returns to find how few had any intelligent idea of their income and their living expenses.

The simplicity of your plan, which, by comparison with previous methods of account keeping, would seem to be well-nigh automatic, appeals to me strongly.

They say you can't teach an old dog new tricks, but I will say to you that I am going to use the Ferrin Book for my own family expenses, and consider it will make money for me right from the start."

(Signed) D. S. BURTON.

Letter from A. B. Dick, Jr., of the A. B. Dick Company, of Chicago, Manufacturers of the Edison-Dick Mimeograph Machine:

"I can candidly say that all the record books which you have issued are practically invaluable to the man who wishes to handle his personal and household accounts in the proper manner. I have seen several systems to take care of these matters, but yours covers the ground in a more thorough manner than any of them.

"To further show my appreciation, I would like to have three copies of your Investment and Insurance Register, and also one copy of the 'Money Making Account Book,' if these are off the press and available. It would be particularly gratifying to have them in sufficient time for the opening of the new year. If you will forward your bill, I will be very glad to remit."

(Signed) A. B. DICK, JR.

Two Minutes a Day

The Ferrin Money Making Account System takes only two minutes a day. Any grammar school boy or girl can keep the accounts. This method is not a hard task.

Now you need not worry about the money you spend for clothes, food, rent, or the theatre. You will spend it freely because you know how much you can afford to spend.

The Ferrin Money Making Account System is a most practical gift to any newly married couple. Many people use them for Christmas gifts.

Send No Money

See how the Ferrin Money Making Account System works magically, no matter how much or how little your income. We know what you will think of it when you see it. So we are willing to send you the complete System without your sending us any money in advance. Just mail the coupon, and back will come the System by return mail. If you feel that you can afford not to have it, simply send it back, and you will owe nothing.

But when you have seen what big returns the Ferrin System will pay you, you will surely want to keep this wonderful aid to money-making, especially as we are now making a special short-time offer of only $3 for the complete System.

You will appreciate what a remarkable offer this is when you consider that other expense account books are sold for $3 and cover a period of only two years. The Ferrin Money Making Book covers four years, and therefore has twice the value, $6. And in addition you get the Ferrin Kitchen Calendar, the Ferrin Pocket Account Book, the Ferrin Investment and Insurance Register, the Ferrin Household Inventory and Fire Insurance Record, each worth 50 cents, or $2. You have the opportunity, therefore, of securing $8 value for only $3.

But we can make this special combination offer only for a limited time. You are, therefore, urged to mail the coupon now—to do so costs nothing, and does not obligate you in any way, and it may be a revelation to you of how much more you can get out of your income.

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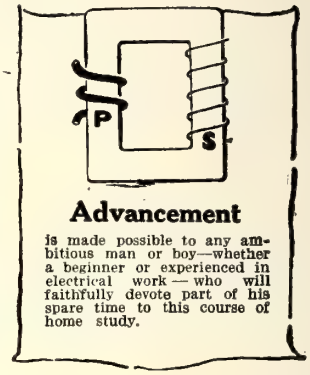
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If you have any fellows who write you about your course and who are not sure it will fit them, send them my name and address, and I shall certainly give you a boost, as I am always glad to do."

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A Startling Memory Feat That You Can Do

How I learned the secret in one evening. It has helped me every day



WHEN my old friend Faulkner invited me to a dinner party at his house, I little thought it would be the direct means of getting me a one-hundred-and-fifty per cent. increase in salary. Yet it was, and and here is the way it all came about.

Toward the close of the evening things began to drag a bit, as they often do at parties. Finally some one suggested the old idea of having everyone do a "stunt." Some sang, others forced weird sounds out of the piano, recited, told stories, and so on.

Then it came to Macdonald's turn. He was a quiet sort of chap, with an air about him that reminded one of the old saying that "still waters run deep." He said he had a simple "stunt" which he hoped we would like. He selected me to assist him. First he asked to be blindfolded securely to prove there was no trickery in it. Those present were to call out twenty-five numbers of three figures each, such as 161, 249, and so on. He asked me to write down the numbers as they were called.

This was done. Macdonald then astounded everyone by repeating the entire list of twenty-five numbers backwards and forwards. Then he asked people to request numbers by positions, such as the eighth number called, the fourth number, and so on. Instantly he repeated back the exact number in the position called. He did this with the entire list—over and over again, without making a single mistake.

Then Macdonald asked that a deck of cards be shuffled and called out to him in their order. This was done. Still blindfolded, he instantly named the cards in their order backwards and forwards. And then to further amaze us, he gave us the number of any card counting from the top, or the card for any number.

You may well imagine our amazement at Macdonald's remarkable feat. You naturally expect to see a thing of this sort on the stage, even then you look upon it as a trick. But to see it done by an everyday business man, in plain view of everyone, blindfolded and under conditions which make trickery impossible, is astonishing, to say the least.

* * * * * *

ON the way home that night I asked Macdonald how it was done. He said there was really nothing to it—simply a memory feat, the key to which anyone could easily learn in one evening. Then he told me that the reason most people have bad memories is because they leave memory development to chance. Anyone could do what he had done, and develop a good memory, he said, by following a few simple rules. And then he told me exactly how to do it. At the time I little thought that evening would prove to be one of the most eventful in my life, but such it proved to be.



"Our president complimented me on always being able to tell him instantly facts he wanted to know."

What Macdonald told me I took to heart. In one evening I made remarkable strides toward improving my memory and it was but a question of days before I learned to do exactly what he had done. At first I amused myself with my new-found ability by amazing people at parties. My "memory feat," as my friends called it, surely made a hit. Every one was talking about it, and I was showered with invitations for all sorts of affairs. If anyone were to ask me how quickly to develop social popularity, I would tell him to learn my memory "feat"—but that is apart from what I want to tell you.

The most gratifying thing about the improvement of my memory was the remarkable way it helped me in business. Much to my surprise I discovered that my memory training had literally put a razor edge on my brain. My brain had become clearer, quicker, keener. I felt that I was fast acquiring that mental grasp and alertness I had so often admired in men who were spoken of as "wonders" and "geniuses."

The next thing I noticed was a marked improvement in my conversational powers. Formerly my talk was halting and disconnected. I never could think of things to say until the conversation was over. And then, when it was too late, I would always think of apt and striking things I "might have said." But now I can think like a flash. When I am talking I never have to hesitate for the right word, the right expression or the right thing to say. It seems that all I have to do is to start to talk, instantly I find myself saying the very thing I want to say to make the greatest impression on people.

It wasn't long before my new-found ability to remember things and to say the right thing at the right time attracted the attention of our president. He got in the habit of calling me in whenever he wanted facts about the business. As he expressed himself to me, "You can always tell me instantly what I want to know, while the other fellows annoy me by dodging out of the office and saying 'I'll look it up.'"

* * * * *

I FOUND that my ability to remember helped me wonderfully in dealing with other people, particularly in committee meetings. When a discussion opens up the man who can back up his statements quickly with a string of definite facts and figures usually dominates the others. Time and time again I have won people to my way of thinking simply because I could instantly recall facts and figures. While I'm proud of my triumphs in this respect, I often feel sorry for the ill-at-ease look of the other men who cannot hold up their end in the argument because they cannot recall facts instantly. It seems as though I never forget anything. Every fact I now put in my mind is as clear and as easy to recall instantly as though it were written before me in plain black and white.

We all hear a lot about the importance of sound judgment. People who ought to know say that a man cannot begin to exercise sound judgment until he is forty to fifty years of age. But I have disproved all that. I have found that sound judgment is nothing more than the ability to weigh and judge facts in their relation to each other. Memory is the basis of sound judgment. I am only thirty-two, but many times I have been complimented on having the judgment of a man of forty-five. I take no personal credit for this—it is all due to the way I trained my memory.

THESE are only a few of the hundreds of ways I have profited by my trained memory. No longer do I suffer the humiliation of meeting men I know and not being able to recall their names. The moment I see a man his name flashes to my mind, together with a string of facts about him. I always liked to read but usually forgot most of it. Now I find it easy to recall what I have read. Another surprising thing is that I can now master a subject in considerably less time than before. Price lists, market quotations, data of all kinds, I can recall in detail almost at will. I rarely make a mistake.

My vocabulary, too, has increased wonderfully. Whenever I see a striking word or expression, I memorize it and use it in my dictation or conversation. This has put a remarkable sparkle and pulling power into my conversation and business letters. And the remarkable part of it all is that I can now do my day's work quicker and with much less effort, simply because my mind works like a flash and I do not have to keep stopping to look things up.

All this is extremely satisfying to me, of course. But the best part of it all is that since my memory power first attracted the attention of our president, my salary has steadily been increased. Today it is many times greater than it was the day Macdonald got me interested in improving my memory.

* * * * * * *

WHAT Macdonald told me that eventful evening was this: "Get the Roth Memory Course." I did. That is how I learned to do all the remarkable things I have told you about. The publishers of the Roth Memory Course—the Independent Corporation—are so confident that it will also show you how to develop a remarkable memory that they will gladly send the Course to you on approval.

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"Underwater Submarine Telegraphy."

"Developing an Audion for the Amateur." By E. T. Jones

"A 170-25000 Meter Receptor." By Francis R. Pray

"Amateur Radio Broadcast de Navy Department."

"Notes on R-34 Return Trip." By R. F. Durrant, Lieut. R. A. F.

"San Diego, Cal., from London." By Alexis J. Hall

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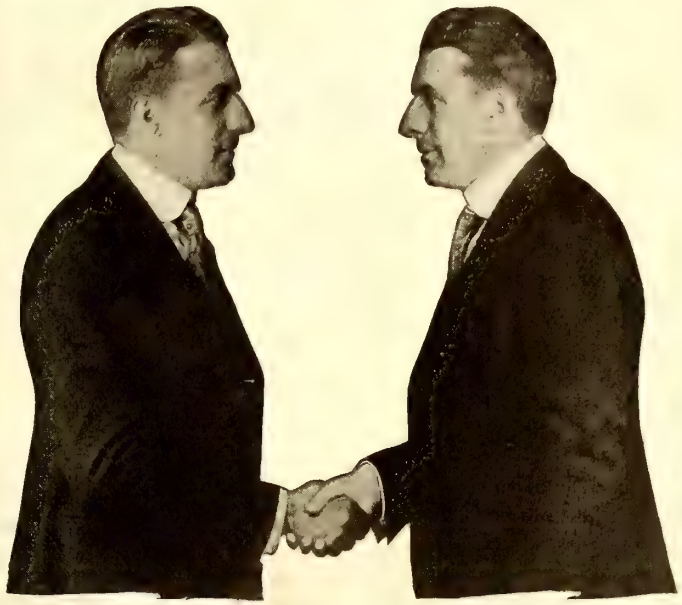
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Shake Hands With Yourself!

Do You Really Know Yourself? Are You in the Line of Work for Which You Are Naturally Best Fitted? Read This Interesting Story of a Man Who First Shook Hands With Himself—and Then With Success.

A CLERK since 1911! Eight long years I had been at the same desk, the same work, and almost the same pay. And, from all signs ahead, 1930 would still find me in the same old grind.

Perhaps you may know just how I felt. At 9:00 every morning I would hang up my hat, settle in my chair and get set to "put in another day." Never a single rush of joy for my work. For some men I knew, each week meant a succession of big deals crowned with big rewards. For me, Monday dragged into Tuesday, which crawled wearily into Wednesday, which finally overlapped into Thursday, and so on—until the welcome oasis of Saturday afternoon and Sunday at home. And then came another week, etc., etc., ad infinitum.



One day, in February of this year, came an incident which was later to mean a great deal to me. While getting together some data for our salesmanager (who had only been there a short time) I overheard part of his conversation with one of his salesmen.

"Willis," I heard him say to the salesman, "I'm *mighty* sorry that you have fallen down on your job. But I really knew when I came here that you would never make a good salesman. I knew it by your face, your carriage, and your manner of speech. Salesmanship isn't written on any part of you. I have given you your chance and you admit that you are misfit in your present position. But I feel sure that you could make an A-1 success in other work. Because a man fails in one line is no reason that he will not make good in another. I believe that you have the capabilities of an excellent office manager and if you wish I will see——"

The door slammed shut but my mind seemed to have been torn loose from its rut. Was *I* a misfit? Was *I* really in the position I was naturally fitted for? I had just drifted into this "clerk's job" eight years ago without studying myself for my biggest capacities. I merely wanted a job—and I got it. I *knew* I had the capacity for big things *in the right line*. But what *was* my right line?

For more than a week I tried to think it out and decide what was best to do. Finally I determined to ask the advice of the salesmanager himself. He had helped Willis and perhaps he would help me. It would do no harm to talk with him and he might be able to help me make a decision.

So I put the whole matter up to him, and asked him to give me the benefit of his opinion.

I felt his keen gaze bore through me as I spoke. Instinctively I knew that his ears were listening to my story but that his eyes were making a sharp estimate of their own.

Finally he spoke. And to my amazement, he solved the whole problem for me. "Henning," he said, "you have been swimming against the current, I do not believe that your *real* work is at a clerk's desk. It might seem that I am hasty but my judgment is usually right. You could, I firmly believe, make a real success as a salesman. I'm willing to give you the chance. If you *don't* succeed, then it will be one of the very few mistakes I have ever made in sizing a man up by his face."

Well, I *did* succeed. I knew it—because money talks and my salary tells me so. I am known as one of the best salesmen in the firm. And now, instead of looking on my work as drudgery, I enjoy it as a great game. Thru my salesmanager's courtesy, I have learned to read character at a glance from the little course he studied and which the publishers sent me for free examination. I find it of immense help to me. Most of us know a few things about character readings. We know that a high forehead indicates the intellectual type—that a receding chin denotes weakness while a pronounced chin means determination. But often these signs are counterbalanced by others which are just as apparent but which the average person doesn't recognize. Consequently we often jump to conclusions about people which later prove incorrect. It's like trying to read a sentence by looking at the first one or two words.

It's all as clear as a book when you know the simple alphabet of signs that spell out a man's character and mental "slants"—an alphabet that is surprisingly easy to learn and of remarkable value to apply. People with whom I had never been able to get along I now number among my best friends. I am popular with my co-workers and receive their hearty co-operation and good-will. In my business dealings, when I approach a prospect I know immediately whether to use tact or sweep him away by enthusiasm—whether to get right down to business or open up in a roundabout way—what angle of talk will make the best appeal to each man and what arguments will clinch him.

I know immediately just how to deal with everyone I meet. I know how to interest them, how to appeal to them most effectively, how to touch their "responsive chord." I can gauge at once their tastes, mental traits, temperament, and personality. Immediately upon meeting a man I know how to make him my friend. At least 40 per cent. of the credit for my success I attribute to my easily-acquired ability to read at sight the character of everyone I meet.

Just as Nature intended that the normal condition of our bodies is perfect health, so the normal condition of everyone is perfect success. We are all meant to be a success at *something*. We all have the capacity within us to achieve big things *in the right line*. If we are not a big success, it is merely because we are in the wrong occupation. Napoleon was a failure at authorship. Florence Nightingale failed as a social favorite. Grant was a failure at everything until he became a soldier. These were their *wrong* occupations. We all have the germ of success within us—the capacity to do big work in some one line. The thing to do is find out what *your* line of work is.

Dr. K. M. H. Blackford has helped thousands of men find out the work for which they were best fitted to achieve big success. This famous character analyst has been retained at record fees by such corporations as the Westinghouse Electric and Manufacturing Company, Scott Paper Company, The Laurentide Co., Ltd., and many other big concerns, to pick and place rightly the men they employ. And 98 per cent. of Dr. Blackford's selections—regardless of their previous experience—made good at the jobs in which they were placed.

Dr. Blackford has helped thousands of others and is now ready to help you. A good many of us are just plugging day in and day out at work we are not naturally fitted to do, work we do not like, work we can never fully succeed at. We swim against the tide, trying to fit our given set of talents to the wrong job. But thru Dr. Blackford, we can now all judge in just what line our biggest success lies. And we can learn the worthwhile secret of knowing, in one quick survey of their features, physique, gestures, and habit of conversation, unerringly the character of every person we meet—of looking *into* people and *through* them, instead of *at* them.

Thru the little course of lessons in "Reading Character at Sight" now being distributed by Dr. Blackford, we can know, the minute we lay eyes on people, how to make them our friends, in either a business or social way—how to talk to them, how to influence them to the best advantage. Thru the secrets given by Dr. Blackford, we can get a better line on the folks we meet than the friends who have known them for years.

Thousands have already benefited thru the course. Some have decided thru it just what their life-work really is. Others have saved themselves from business disaster and unscrupulous partners. Many others have avoided hiring men whom they knew at a glance to be dishonest and unreliable. Many salesmen use the knowledge they have gained to judge and approach their prospects. Executives use it to deal with and judge their employes. Doctors use it in dealing with their patients. Lawyers find it of great help in their court work and in their actions towards clients. Public speakers employ it in judging their audience, and in debate.

And besides its great practical value this course in "Reading Character at Sight" is as fascinating as a game to use in your social life. Written on every man, woman, and child are signs, as clear and distinct as tho they were written in letters a foot high, telling their character. Mouth, nose, chin, eyes, voice, gestures, carriage—each tell a story, which averaged up, give a complete outline of a person's character. And a fascinating pastime it is to be able to tell a person's innermost nature by glancing at him.

Entire Course on Free Examination

This ability to analyze character immediately and without error can easily be yours. It is not a gift. There is no trick or second sight about it. It is not a supernatural mysterious power. It is merely the immutable rules of science, practically applied. You can do it as infallibly as Dr. Blackford. This new course in "Reading Character at Sight" in seven simple and fascinating lessons will be sent to you without cost, for examination. You can judge for yourself just what the course will mean to you before you decide whether or not you want it, return it and forget the matter. Otherwise mail its reasonable cost of $5. The coupon printed below will bring you the entire course for free examination without obligation. Use it.

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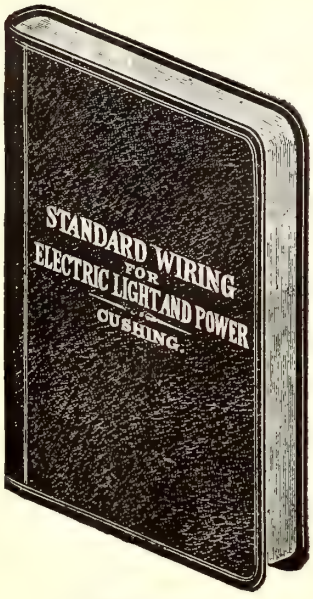
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OUTSIDE WIRING—Pole line construction, line wires, service wires, roof structures, poles and their dimensions and weights, and how to erect and protect them and wires they carry. Insulators, guard arms, guy anchors. Tree wiring, splicing, service and entrance wiring. How to install Lightning arresters. Transformers with diagrams and instructions.

INSIDE WIRING—when and where to use rubber covered, slow burning and weatherproof wire. How to find the proper size of wire to use for lamps, motors or heating devices for any current, voltage and drop, either by formula or by the many tables that are given in this section of the book. How to wire for two-wire or three-wire systems. Direct current, two-phase and three-phase with formulae and tables, with examples worked out for each system and in a simple manner that anyone can understand and use. How to run wires on walls, ceilings, floors, through partitions and walls and in concealed places, damp places and where dangerous surroundings exist. When and where to install Switches, Cut-outs and Circuit Breakers and just how to do it. How to wire for high and low voltage systems and the precautions to be taken. The proper way to install Knife and Snap Switches, Cabinets and Cut-out Boxes, Outlet, Junction and Switch Boxes, Panel Boards, Wooden and Metal Raceways. How to install complete interior conduit jobs either for rigid metal, flexible metal or flexible non-metallic conduit. Concealed knob and tube work or armored cable. How and where to install and wire electric and combination lighting fixtures. How and where to use flexible cord and where not to use it. How to install arc lamps and gas filled lamps and the fixtures and rules required.

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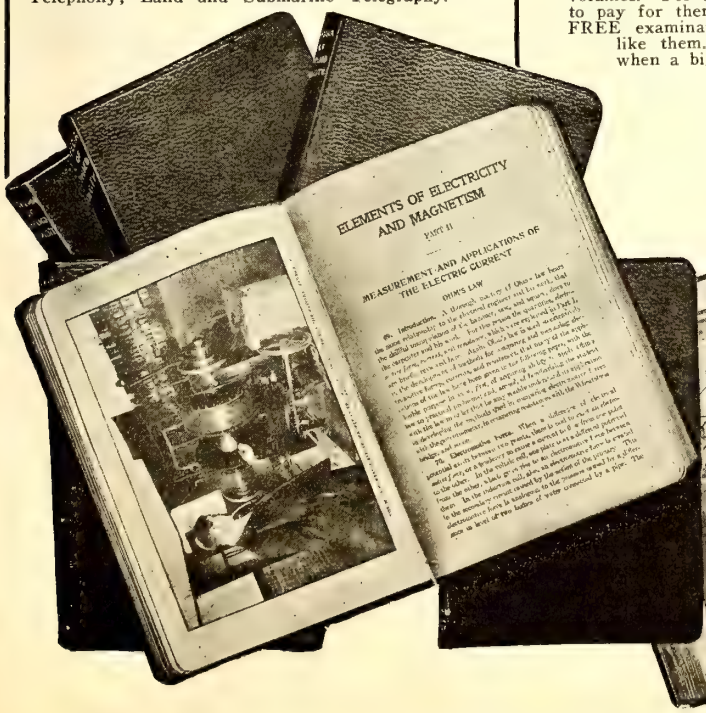
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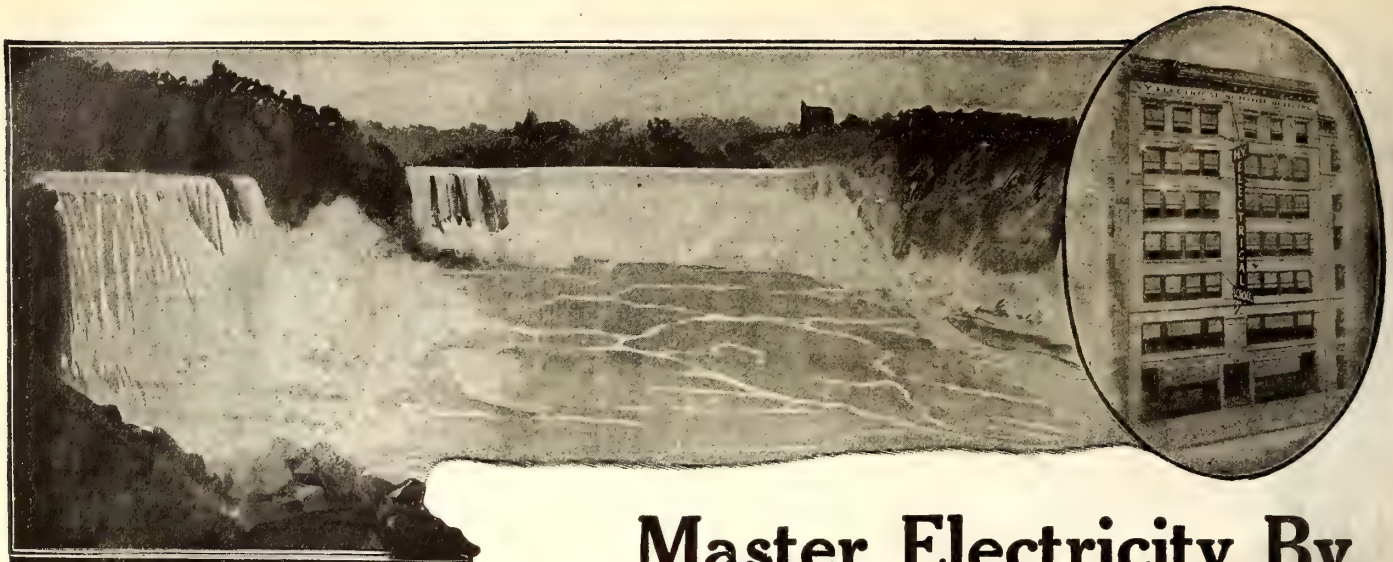
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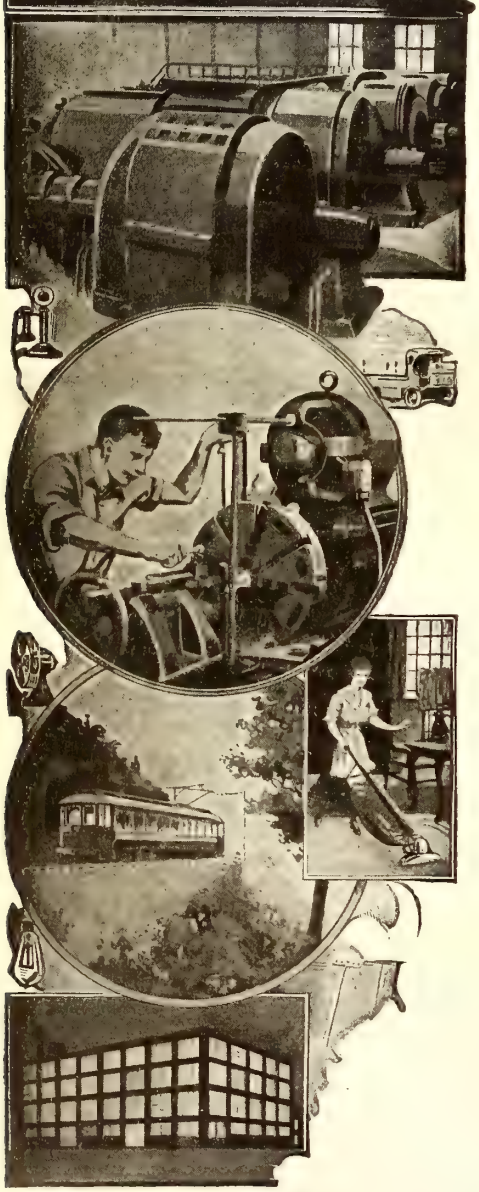
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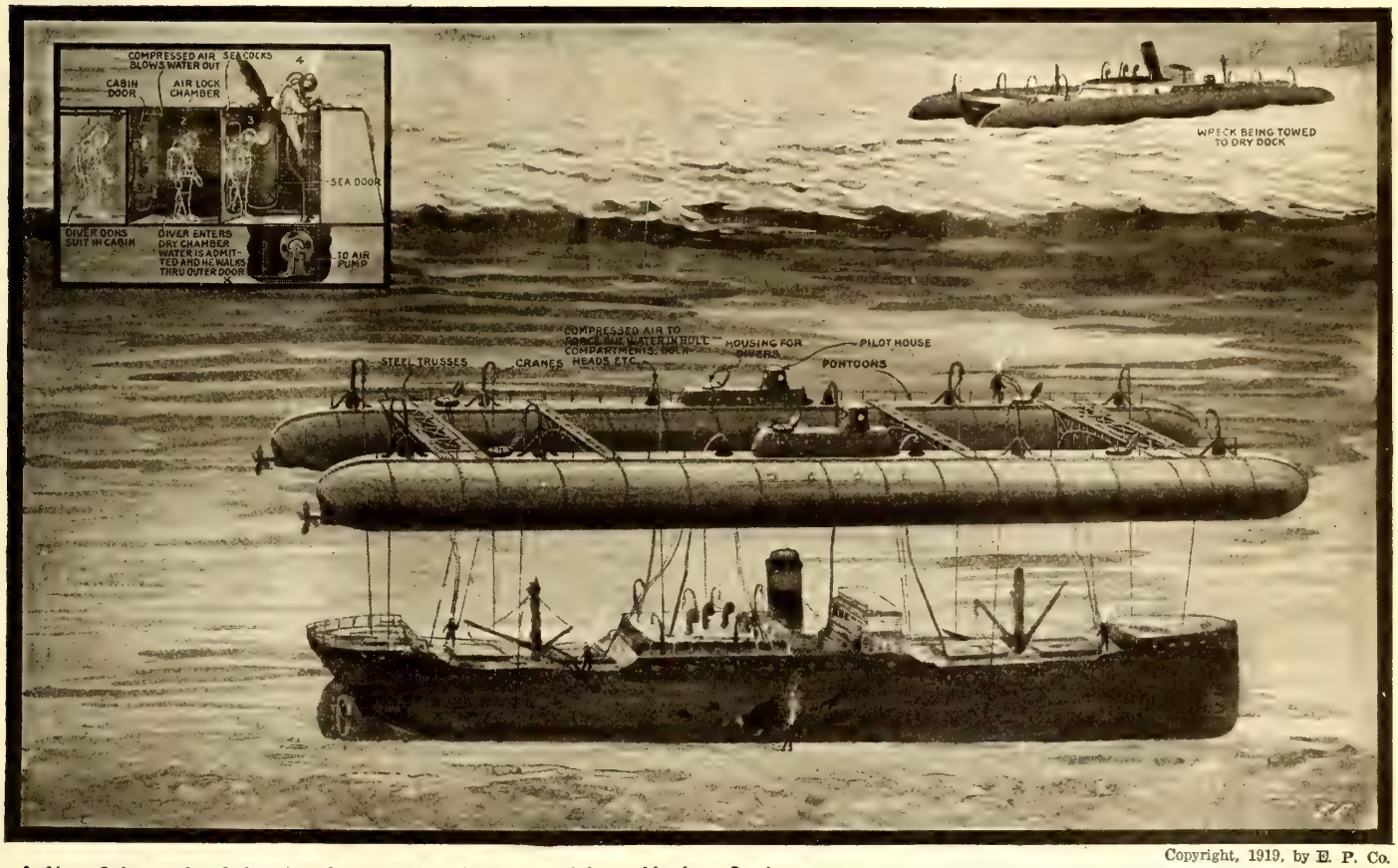
Vol. VII. Whole No. 80 December, 1919 No. 8

DEC 27 1919

Submarines to Salvage Sunken Ships

THE submarine proved to be one of the most effective and formidable sea devices ever conceived during the course of the World War, and now a Yankee genius, Mr. George Wall, comes forward with a peacetime suggestion for utilizing the principle of the submarine to raise some of the thousands of ships sunk during the war.

The accompanying illustration shows Mr. Wall's suggestion in practise. One of the basic principles underlying this new *submerging-pontoon* salvaging craft, is that of the great buoyancy produced when such a large air-tight chamber as a submarine is filled with air while submerged. The lifting power or buoyancy of such a pontoon of the size of a submarine, is tremendous, especially when it may have a length, let us say, of from 500 to 600 feet. These pontoons could be submerged to any depth while seeking the wreck, in the same manner as submarines submerge, i. e., by admitting water into the submerging tanks. When it is desired to rise to the surface, this water is blown out of the ballast tanks by comprest air.



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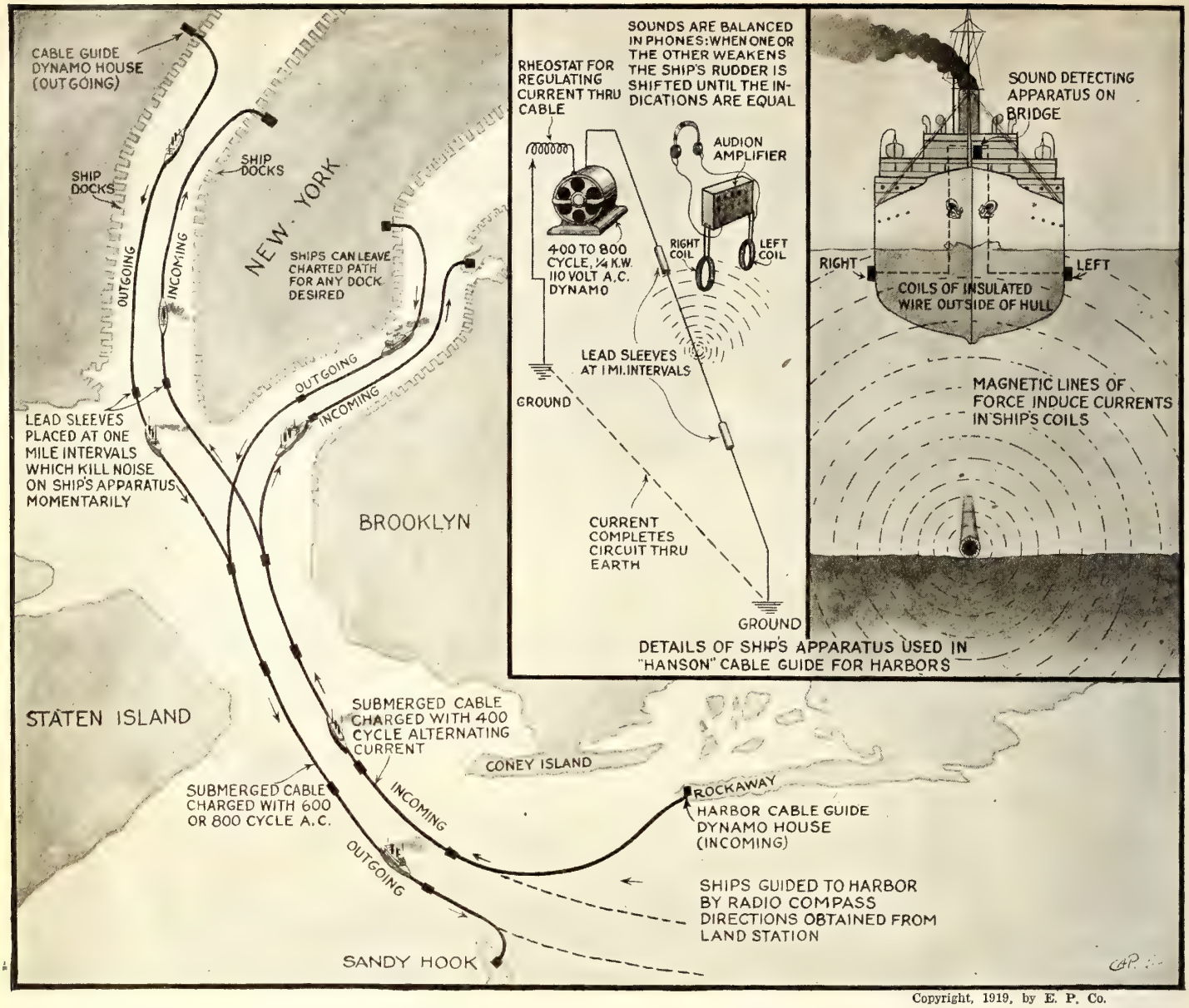
A New Scheme for Salvaging Sunken Vessels Proposed by a Yankee Genius, and Comprising Salvaging Craft Constructed in the Form of Gigantic Submarines, Which Can be Sunk When Desired and Their Immense Buoyancy Utilized in Lifting the Wreck.

TWO SUBMERSIBLE PONTOONS USED

The submarine-pontoon of which two or more may be used in raising an ordinary size vessel, are not tied together mechanically, but may be anchored to each other when desired, by means of steel girders. A number of powerful, motor-operated derricks are placed along the decks of the salvaging pontoons, and from these a series of steel cables depend downward. At the start of the salvaging operation on the wreck, divers are employed to pass cables around under the hull of the boat. The free ends of these cables are caught and brought up to the surface where they are fastened to the lifting derricks of the second pontoon.

Such a salvaging outfit possesses many advantages over the surface type of craft, which cannot submerge, and under many salvaging conditions it is often impracticable to lower a diver down to the scene of the wreck, owing to the long lengths of air-hose, hoisting cables, etc., which have to be used. With the present invention, it is possible whenever necessary, to submerge the pontoons and keep them submerged the same as any ordinary submarine, for several hours. These pontoons may be fitted with powerful electric

(*Continued on page* 809)



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All During the World War There Were Hundreds of New Inventions Developed and Applied. One of These Was the "Hanson" Electrified A.C. Cable, Buried in the Mined Regions Where Our Ships Had to Travel. By a Suitable Listening Device Aboard the Ship the Navigator is Enabled Instantly to Ascertain Whether or Not He is Out of the Proper Course. A Great Stunt for Foggy Weather.

Ships Guided by Electrified Cable

THE marvelous "fog tamer" invented by Earl S. Hanson, a young Los Angeles scientist, is to be thoroly tested by the Navy Department, it is said. The Hanson invention marks an important step to make practical what has been called the greatest development in marine travel since the discovery of the steam turbine.

Mr. Hanson's device makes it possible for steamships to navigate any channel with perfect safety, no matter how winding or treacherous, thru the heaviest ocean fogs or under the most adverse weather conditions. It will prevent the tying up of shipping outside of harbors while vessels wait for the weather to clear so that they can navigate the channel. Steamship service between New York, Liverpool, Brest, Southampton, Cherbourg and other channel ports will be as regular as railroad passenger trains arriving in the giant terminals of New York.

Tests will be made at once at the naval base at New London and later a greater test with some of the biggest liners of the world, such as the *Leviathan,* will be made in Ambrose Channel, New York harbor. Material has been shipt to New London for the first test and men have already been detailed for this work. As soon as the official tests prove satisfactory all the great ports of the United States will be equipt by the navy with the device to defy fog, hail, rain, snow and sleet.

By the use of the new invention in connection with the radio compass which the navy has now perfected, all danger or delay in ocean travel due to weather is absolutely eliminated.

The radio compass brings all shipping in sight of land and the new device, like a friendly hand, reaches out and takes the biggest of ships thru the most tortuous channels safely and quickly to its pier.

The new device is simplicity itself. A cable is laid in the center of the ship channel. Thru it is sent an electric current of low frequency which thru the listening devices on board ship gives off a sound of certain pitch that cannot be mistaken for any other sound. The ship hugs the cable from harbor line to the dock. On the bridge and in the captain's cabin listening devices like telephone receivers are placed and attached by wires to the hull of the ship. The ship follows the course of the cable. Any variation away from the cable is indicated by visible indicators (sensitive galvanometers connected in the receiving coil circuits), which show in feet the distance away from the cable, and the ship is then put back over the cable by the steering rudder in the usual way. By the ear receivers the indicator may be confirmed at all times.

Vessels going into port will use one cable; those coming out another. *The sound on each is different* and there can be no confusion and therefore no collision.

Along the cable, at mile intervals, a section is sheathed with lead. Thru this no sound can come and therefore the man on listening duty can tell instantly how far the ship has progrest, and by the cable chart in front of him, can tell where the cable turns and where the ship must be steered to follow the curve of the cable and the center of the channel. The new device, according

(*Continued on page* 831)

Did the Romans Have "Wireless"?

"WIRELESS telegraphy is new; wireless communication is as old as Biblical times." With this trite statement the National Geographic Society quotes from a communication by John A. Kingman, who sets forth the interesting theory that the island of Capri was an imperial wireless station of ancient Rome.

"We know that the ancients signaled in various ways and over long distances," he says. "They signaled by beacon fires, by beacon smoke, by pigeons, by flags, and by shouting from one sentinel to another.

"Lighthouses are as old as the earliest chapters of the Bible. Beacon fires and beacon smoke were commonly used by the early Greeks, and there was no reason why the more practical Roman should not have employed inproved methods, such as *heliographing.*

HOW ROMANS USED GREAT MIRRORS.

"We do know that at the siege of Syracuse by Marcellus mirrors were employed by Archimedes; and tho we may doubt the burning of vessels from shore by mirrors, as stated on that occasion, we can appreciate the blinding effect of many mirrors on the eyes of the navigators of the attacking vessels. That is what probably happened during that conflict. At any rate, it shows that the great Archimedes, at least, had found some use for mirrors other than the usual one.

"In Imperial times the Romans had mirrors large enough to reflect the entire person; they even had mirrors of glass backed with tin instead of quicksilver.

"Signaling was certainly a common military practise among the ancients, and ancient writers, such as Virgil, Aeschylus, and Herodotus, frequently alluded to it.

"An interesting case of long-distance signaling by relaying is mentioned by Herodotus, in which it appears that certain tidings were sent to Xerxes in Asia by means of a line of beacon fires arranged thru the Greek islands.

"The ancients went further than simply announcing some prearranged message; they had codes and sent long messages. The Greeks signaled on one occasion 100 miles at one jump. This was from Mt. Chigri, 1,698 feet, to Mt. Athos, 6,500 feet.

"Gallup's Hand Book of Military Signaling states that 'under favorable conditions the distance to which messages may be sent and received is only limited by the curvature of the earth'; also, that 'square mirrors are better than round ones only because they contain about one-quarter more reflecting surface for the same packing space.' Round mirrors are used now. Mirror signals have been seen with the unassisted eye at distances of 160 miles. While this is, perhaps, a record, and tho there is no statement as to the size of the mirror, it probably did not exceed twelve inches square.

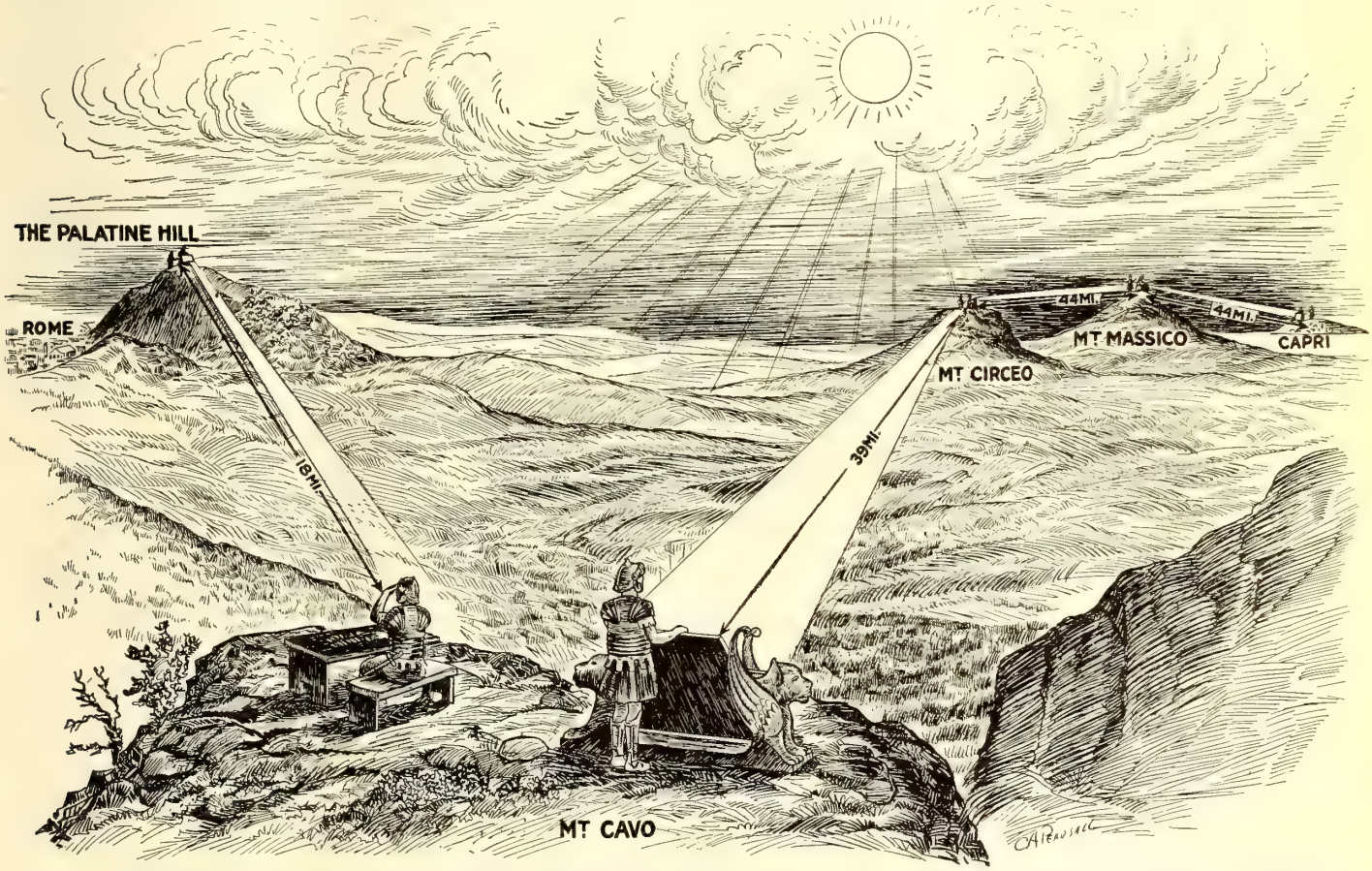
"The reasonableness of the Capri 'wireless' station theory tempts one to speculate as to how much signaling was done and how it was done. It will be remembered that Tiberius, the unpopular successor of Augustus, spent eleven years of his reign on Capri, and without coming to Rome directed most successfully the affairs of the vast empire. He even foiled the conspiracy of his trusted minister, Sejanus who was supposed to have general charge of affairs after Tiberius retired to the island.

"Tho Tiberius went to Capri, an old man, he was the actual ruler—emperor, in fact—and his heavy hand was felt all over the empire until the very end. With regular news bulletins and reports, received daily if need be, containing confidential information, he would be able to issue instructions and manage affairs as thoroly as if he were in Rome.

"Possibly the *Publica acta* (Senate Journal) and the *Diurna acta* (authorized news) were sent to Capri by signal instead of by messenger. We can conceive that such a system, organized most likely under Augustus, must have operated very smoothly after some years of experience and practise. I hazard the theory of mirrors because of its simplicity and convincing character. Signaling by beacon seems too primitive for the wonderful civilization of the empire. Of course, at night-time beacon fires would have to be employed; mirror signaling was a fair-weather method.

"The distance in an air line between Rome and Capri is 130 miles—too long for direct signaling; but if we look along the coast of the Tyrrhenian Sea we find numerous mountains affording points where the signals could be relayed. The frequency of the relaying would depend on the conditions. The highest point on Capri is Monte

(*Continued on page* 832)



There Is Nothing New Under the Sun, Not Even "Wireless." It Now Appears That the Ancient Romans Already Had a System of Sending Messages Over Several Hundred Miles Merely By the Use of Mirrors,—a Sort of Heliograph. This Illustration Shows How It Was Possible to Telegraph from Rome (The Palatine Hill) to Capri, a Total Distance of 145 Miles. Our Illustration Shows How the Flashing of Signals Was Accomplisht During the Day Time. At Night, Fires in Front of the Mirrors No Doubt Were Used.

Thomas A. Edison Speaks to You

By H. Gernsback

MR. EDISON having kindly consented to speak to the readers of the ELECTRICAL EXPERIMENTER, an interview with the illustrious inventor had been arranged for during the latter part of October of this year.

This interview, by the way, has some history attached to it. During the early part of 1917 a similar appointment had been made to interview Mr. Edison on the same subject. But just then the great war broke out and Mr. Edison, who, as is well known, was immediately appointed the head of the Naval Consulting Board, broke off all engagements, devoting himself day and night to the welfare of his country. For this reason the interview only took place a few weeks ago.

THIS is the first interview which Mr. Edison has given out for some years past.

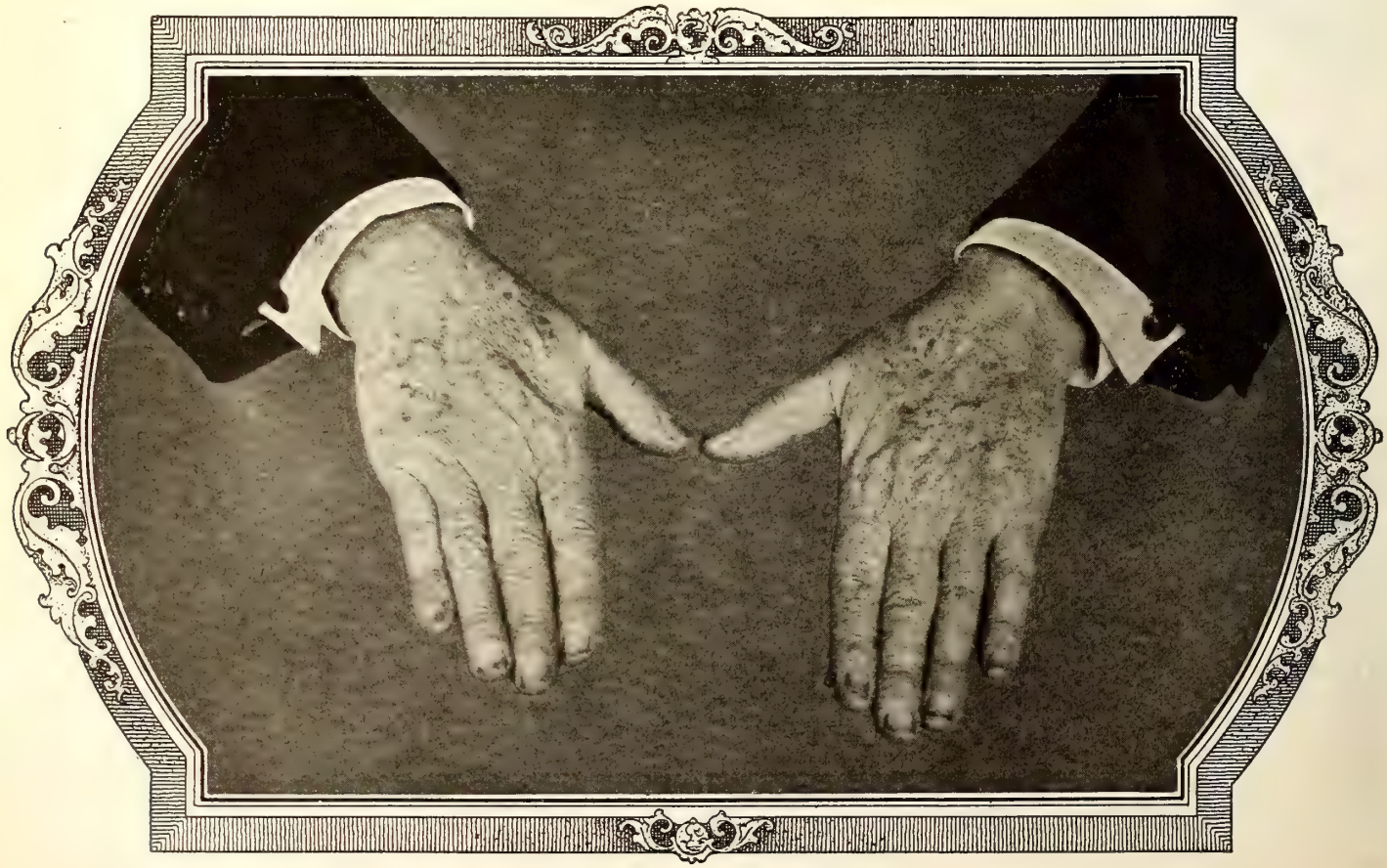
Mr. Edison, who, as is well known, was elected Chairman of the Navy Consulting Board at the outbreak of the world war, was taken up with important duties, refusing to see all visitors. Even several years before this, no general interviews were given out. In this story are covered many points of interest not only to all experimenters and the man interested in science, but to the world at large. Much that is new has been presented here, and it will be noted with satisfaction by all that at the age of seventy-three, Mr. Edison's mind is as keen and clear as ever. We are certain our readers will appreciate this important article. Nearly all of the photographs and illustrations appearing in this story have never been publisht.

I ARRIVE AT MR. EDISON'S LABORATORY.

I arrived at West Orange on a crisp October morning and was soon in the little gate house which protects Mr. Edison from a curious public. Plain and modest as it is, the little red house has past thru its gates hundreds and thousands of the world's most famous men and dignitaries. Few such modest little houses, if any, have held under their roofs such an array of famous people who have come to pay homage to one of the greatest inventors the world has ever known.

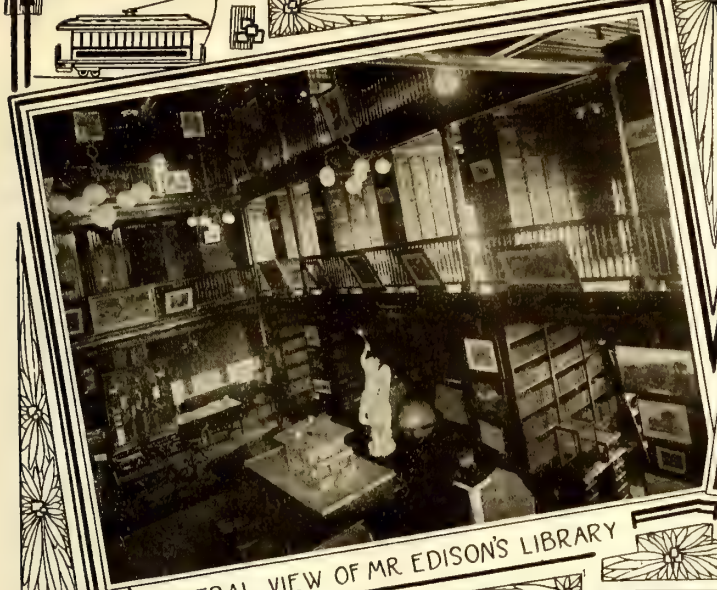
In this little gate house is located the famous time clock on which Mr. Edison rings in his time and rings out every day of the year, many holidays included. An inspection of his week's time card revealed that Mr. Edison had invariably been at the laboratory before 8 o'clock in the morning and had worked as many as eighteen hours for three days at a stretch. Only once did he have a twelve-hour day. Right then and there I wondered how Mr. Edison felt about the now so popular eight or six-hour day, and I meant to ask him about it, but we became so engrossed in other more important questions which are moving the world, that altho we touched upon this subject, the eight-hour day question was never broached by me.

After passing thru the gate house, I made my way to Mr. Edison's library, where I was welcomed by Mr. W. H. Meadowcroft, his trusted and capable friend and secretary. While waiting for Mr. Edison, who was just then engaged with some chemical experiments, Mr. Meadowcroft pointed out all the interesting objects of Mr. Edison's library. This library is a huge affair and, besides containing electrical, chemical and physical reference works printed in almost any imaginable language with English, French and German predominating, many other curiosities are to be found here. There are many dozens of autographed photographs of famous men hanging about the walls, as are famous historic photographs portraying this or that view of an important phase of Mr. Edison's great discoveries, such as the electrical traction, the electric light, the phonograph,



The Only Authentic Photograph of Mr. Edison's Hands Ever Taken Publisht Here for the First Time. The Spots on the Hands Are Chemical Stains Which Could Not Be Washt off at the Time the Picture Was Taken. IF THE WORLD WERE CALLED UPON TO MAKE AN INVENTORY OF WHAT MR. EDISON'S HANDS ACTUALLY WROUGHT IN ENRICHING THIS PLANET, THERE WOULD NOT BE GOLD ENOUGH TO PAY HIM.

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GENERAL VIEW OF MR EDISON'S LIBRARY



MR. EDISON AT HIS DESK. HE DID NOT KNOW THIS PICTURE WAS BEING TAKEN



MR EDISON AND "BLUE DEVILS" SUMMER OF 1918



MR EDISON'S FAVORITE PICTURE TAKEN A SHORT TIME AGO



CUBIC FOOT OF COPPER IN MR. EDISON'S LIBRARY BY TIFFANY



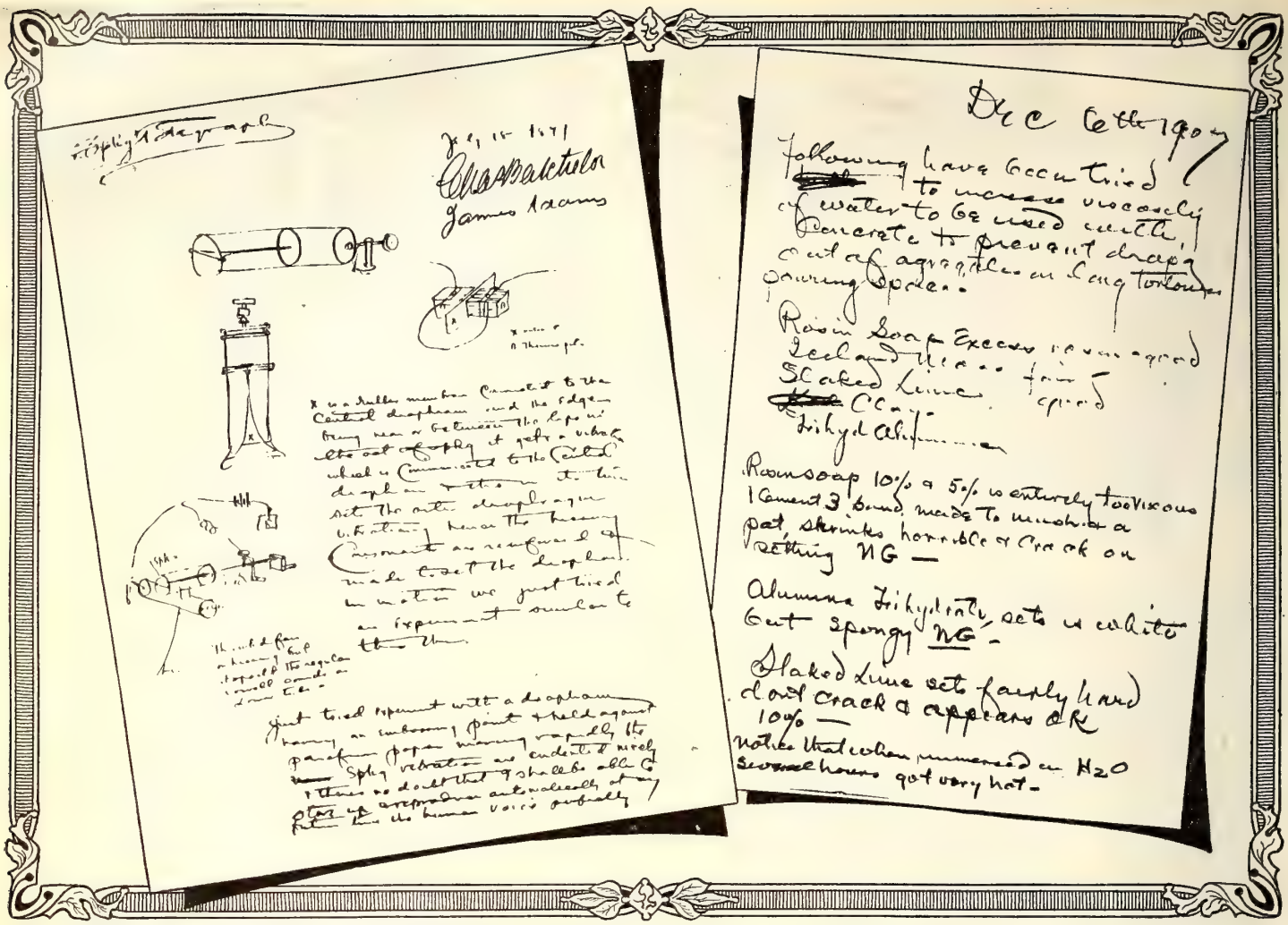
STATUE ON MR. EDISON'S LIBRARY "TRIUMPH OF ELECTRIC LIGHT OVER GAS



MR. EDISON THROWING FIRST BALL AT BASE BALL GAME ON EDISON FIELD DAY



MR. EDISON WITH ASSISTANTS LISTENING TO PHONOGRAPH RECORD



The Illustration at the Left Shows a Photographic Reproduction From One of Mr. Edison's Note Books. It Is Nothing Less Than the Now Historic Proof of the Invention of the Phonograph. It Shows the Conception of the Idea Plainly. On July 18, 1871, Mr. Edison Was Making Some Experiments Which Had Nothing To Do with the Phonograph. As a Matter of Fact It Seemed To Be More or Less Nebulous in His Own Mind, for at the Top of the Page He Wrote "Speaking Telegraph." The Part of Interest to History Is Found in the Foot Note of the Page, Which Reads as Follows:

"Just Tried Experiment with a Diaphragm Having an Embossing Point and Held Against Paraffine Paper Moving Rapidly. The Speaking Vibrations Are Indented Nicely and There Is No Doubt I Shall Be Able to Start Up and Reproduce Automatically at Any Future Time the Human Voice Perfectly."

Note Also the Two Witnesses' Names Under the Date, at Top of Page. The Other Page Shows a More Recent Sample of Mr. Edison's Handwriting. It Is From One of His Memorandum Books and Is Dated December 6, 1907. Note How Much Attention Mr. Edison Pays to Record Even Trivial Experiments, Also His Characteristic "N. G." In Two Places. The Changed Handwriting After an Elapsed Time of Thirty-Six Years Is of Great Interest.

the moving picture and many others. A huge white marble statue immediately catches the eye. Mr. Edison brought this from Paris at the time of the World's Exhibition in 1889, it having caught his fancy. The marble figure represents a boy seated upon a broken gas lantern, holding aloft triumphantly an electric light. Another object of recent dating is a solid cubic foot of copper weighing several hundred pounds mounted upon a mahogany pedestal. This solid piece of copper, made by Tiffany and suitably engraved, was presented to Mr. Edison by the copper interests of this country as a tribute to the great inventor. This symbolic gift can be better understood when it is realized that fully 50 percent of most of this copper is used for lighting purposes, which art was founded by Mr. Edison.

In this library I also inspected the famous "bed" upon which Mr. Edison catches a little sleep when he is engaged in day and night work at the laboratory. This cot is a very prosaic affair, and is located in the corner of the library amidst books and other curios. It is a bed in name only, for it is comprised of nothing but a mattress, pillow and a blanket.

On one of the walls, we also find a complete history of Mr. Edison's Alkaline Storage Battery, exhibited on a large wall board. This is graphically shown by displaying every part, chemicals included, that go into the making of this famous non-lead battery. The thing that most interested me in Mr. Edison's library, however, were his notes, and right here we find one of the pregnant reasons for Mr. Edison's great success.

MR. EDISON'S LABORATORY NOTES.

As is well known, few inventors have made their inventions pay. They are usually "inventors"—and that is all. Mr. Edison, on the other hand, aside from being an inventor, is also an excellent business man. Mr. Edison is systematic and knows the value of notes. He won many a patent suit on account of his notes written dozens of years ago. Early in his career it was brought home to him that when you have an idea, a record should be made *at once!* This was so engrained into his system that it is almost an impossibility for him to make even the most trivial experiment without making a careful record of it. Mr. Edison writes his notes in pencil, and at the end of the day the notes are carefully put away. Each month these notes are bound into a book, where they are kept for further reference. The office staff card-indexes his experiments and cross-indexes them, so at any time Mr. Edison can readily find any one experiment he made during the month, or, for that matter, any experiment that he made 25 years ago, if necessary. The notes are invariably made on yellow paper on ordinary scratch pads, the pages measuring about four by six inches. Being systematic, Mr. Edison always uses the same size pad year after year, and it is therefore refreshing to see the same sized sheets, and the same kind of paper made into bound volumes. While I was still inspecting some of these note books, many of which contain priceless data, Mr. Meadowcroft was informed by telephone that Mr. Edison was ready to receive me.

We walked across an open space separating the library from the chemical laboratory, and Mr. Meadowcroft explained that the building in which Mr. Edison was working that day was known as the chemical laboratory. Mr. Edison, however, does not work in the same laboratory all of the time, but for the past

(*Continued on page* 802)

"Slow Movies" Analyze Motion



THIS camera is known as *Novagraph*, and is an ultra-speed camera According to its inventor, Mr. Charles Watson, it is the result of years of hard study and costly research work, together with intense concentration and experiment. The camera is "cranked" the same as any ordinary motion picture camera, i.e., by hand, and exposes the film to the subject at the rate of 160 *exposures per second*, as compared with the usual *sixteen exposures* of the ordinary motion picture camera taken in the same interval of time. In projecting the film at the normal speed, sixteen pictures per second, the audience views the screened picture *slowed down to one-tenth the usual rate*, thus affording a perfect eye analysis of every motion of the subject. One hundred and sixty exposures per second does not mean that this is the maximum speed at which this camera can be operated. At any time the exposures, if need be, may be speeded up to 200 per second, or even 300, if necessary. In this case, however, the projection would be unduly slow, and quite unnecessary for making the essential analysis of ordinary motion. Needless to say, this camera is of enormous value, and its value lies particularly, perhaps, in its efficiency in scientific work. By means of the Novagraph, wonderful photographs of surgical operations have been taken, and the dexterous manipulation of instruments is made so clear that even an amateur is prompted to attempt the skilled operator's work. The Novagraph recently played an important part in taking photographs of heart actions and medical subjects, at which time Dr Samuel W Lambert, late Dean of the College of Physicians and Surgeons, Columbia University, exprest his highest approval of the wonderful work of this machine and immediately recognized the opportunity of the "slow" motion picture camera in medicine and surgery. At the Convention of Physicians and Surgeons in June at Atlantic City, members from all over the world were tremendously impressed with the above-mentioned motion picture. So much so, that Dr. M. C. McBride stated that never before had the members of the audience broken out into such spontaneous and tremendous applause.

Photographs were taken of the heart and lungs, in which case the movement of the oricles and ventricles of the heart were brought out so clearly that it seemed as tho the heart were being moulded into its various forms. Every little spasmodic contraction was instantly noticeable, and the analysis of its motion rendered complete to the finest detail. Twenty-pound bulldogs were used in conducting these experiments, and as daylight was not powerful enough to enable the camera to attain its best results, 7,200,000 candle-power Sunlight arcs of the new Sperry design were used.

The Advent of the "Slow Movie", as It is Called, Has Clarified for Us Many Hitherto Foggy Scientific Facts. Did You Know That It is Possible for a Running Horse to Get All Four Feet Off the Ground Simultaneously? How Does the Heart Look While Beating? Is a Man or a Woman the Most Graceful Swimmer? All the Views at Right Were Taken by the "Novagraph" Camera Between Two Successive Exposures of the Ordinary Movie Film Shown at Left. The Slow Movie Camera Catches Details Which the Regular Movie Never Shows.

Five hundred feet of film are run thru this camera in forty-nine seconds! Ordinary film traveling thru the camera at this rate would instantly burn up. Hence specially treated film must be used.

In the taking of slow motion pictures it is the general rule of the director to have two cameras placed side by side, the Novagraph and ordinary commercial camera, both cameras trained upon the same subject; the film is then "shot" at the same time. The positives of these films are then cemented end on end. Immediately on projection of the film taken by the ordinary camera, a small sub-title telling of the appearance of the same picture, but taken at the ultra-rapid speed, introduces the Novagraph *detailed analysis* picture on the screen.

In one case a famous billiard artist had photos taken of some very fancy and difficult shots—one in particular being a billiard ball leaping from the table into a wicker basket. When this photograph was taken with the ordinary camera the ball appeared in one frame only. With the Novagraph, however, which was taking pictures of the play at the same time, there were twelve such exposures, depicting the actual flight of the billiard ball into the wicker basket, proving that the Novagraph recorded twelve extremely rapid exposures to one of the ordinary camera. Very interesting pictures were made of the extent of deterioration of steel, and on photographing pictures when a test was being made of its tensile strength one could clearly see the breaking and rending of these steel rods Photographs of high explosives being used to blast rock were so distinct, and the analysis of the cringing movement and the shredding apart of these rocks were so clear as to make the ordinary layman express the greatest surprise that a blasted rock would cause such an intensely interesting scene.

A very peculiar phenomena happened recently in New Jersey. The high-speed camera experts were to take some interior photographs. When it came to the developing of these films it was found that the ordinary camera, which we said before always accompanies the Novagraph camera in the taking of such pictures, produced a most perfect film. In the high-speed camera, however, such was not the case. Every third film was absolute blank. *On inquiring into the cause, it was found that alternating current had been used for the illumination, and this camera had actually photographed the alternations of the current.*

We do not ordinarily perceive any alternations or pulsation in such a current which would be at once indicated by a distinct flick

(*Continued on page* 796)



Mysteries of Stage-craft

How Electricity Makes Possible Modern Stage Wonders

By H. Winfield Secor

IT is a far cry from the present-day theater, with its thousands of electric lamps which can be flashed on and off in the twinkling of an eye, back to the gas-lighted theater of our grandfather's time. The stage electrician of the present generation is king of all he surveys, and a king he truly is, for he can mar or make any theater production. Some of the interesting things which are actually being done on the stage today are described in the following article—electrical and mechanical and stagecraft tricks which the audience never sees.

REVOLVING AND ELEVATING STAGE FLOORS.

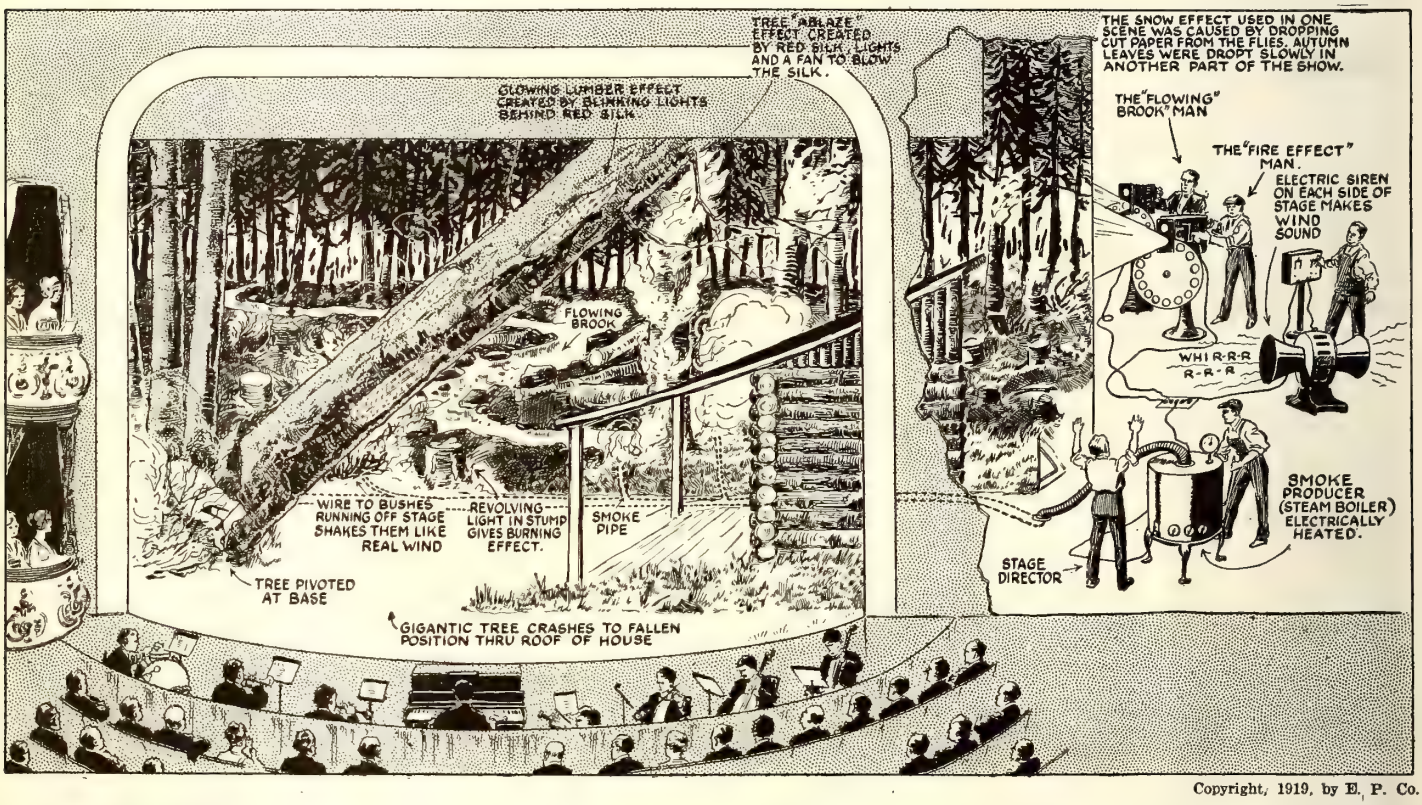
In order to expedite the change of scenes in the more elaborate theatrical productions, especially those having several different scenes to each act, many novel ideas have been developed and installed in several New York theaters, including revolving, as well as rising and falling stage floors. Three different forms of these movable stage floors, which enable several different scenes to be set up at one time, are illustrated at figures one, two, and three. Each of these three ideas, for providing multiple stage floors, have been actually tried out and proven successful.

Figure 1 illustrates a rising and falling stage in use at one theater. Two platforms, each large enough to carry the stage setting as shown, are built in the form of a gigantic elevator; the top platform being separated about 20 feet above the lower platform, with steel girders at the ends and at the rear, where they will not show in the setting. Under the lower platform, which normally is level with the basement floor, there is placed a battery of *hydraulic elevators*, which operate by water under pressure. For the second scene shift, scene No. 1 may be set on either the upper or lower platform, and the second scene brought to the stage level in a few seconds by the hydraulic elevators. That is, considering that a two-act show is being put on. With a three-act show or a production having several acts with many changes of scenes, then at the start, scene No. 1 would be set on the lower platform, while scene No. 2 would be set on the upper platform. When the curtain goes up, scene one appears before the audience, the setting of scene two being 20 feet above the stage. The lights are then winked off for a few seconds, or the front curtain is dropt for a moment and raised again, when, Lo! and behold! the scene has changed! How is it done? Simply by operating the hydraulic elevator cylinders and plungers to lower the platform structure, so that scene No. 2 which was above the stage is now level with it, and the lower platform containing scene No. 1 is level with the basement floor, where the scene shifters immediately get busy and remove the scenery of set No. 1, and dress it with the scenery for scene No. 3.

The revolving stage which is in use in one of the largest New York play-houses, which is necessary as this circular floor is of quite a large diameter, is illustrated in use at figure 2. Two, three, or even four scenes can be set up at one time on this revolving stage. Where an elaborate musical comedy or extravaganza is to be produced with anywhere from 10 to 15 changes of scenery, the convenience and speed with which the different scenes may be changed and the show run off, will be appreciated. The revolving stage is rotated when desired by a throw of a switch, controlling an electric motor which rotates the platform thru a powerful worm gear underneath the floor. The platform rotates on roller bearings.

At figure 3, there is shown the checker-board scheme of quickly changing the scenes in a show. In one scheme now in actual use, the scenes for the three acts are set up on the right, left and rear scene platforms, as shown. These platforms are mounted on substantial rubber-tired wheels, so as to make a minimum amount of noise when the scenes are changed. When act No. 1 has been placed, the curtain is dropt and the platform carrying scenery for this act is rolled to the right, and the platform carrying the scenery for act No. 2, is pulled into place. One of these sets, including the platform, is quite heavy, and while it can be shifted by a number of men, recourse is had to a series of ropes fastened to the platforms and also to a powerful electric motor winch in the basement, whereby any

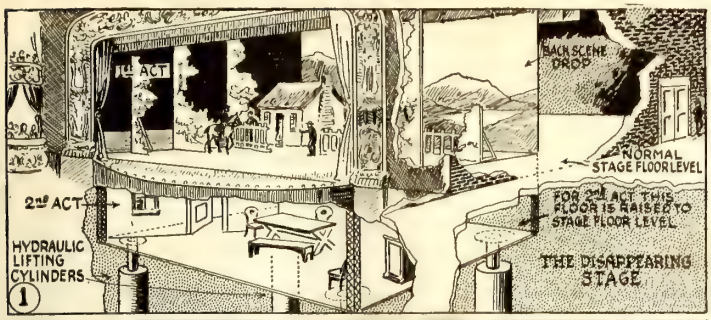
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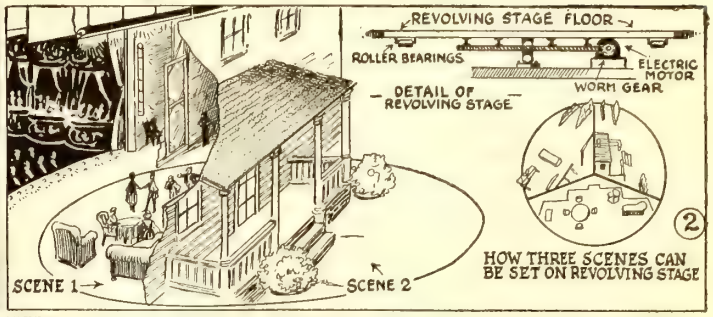


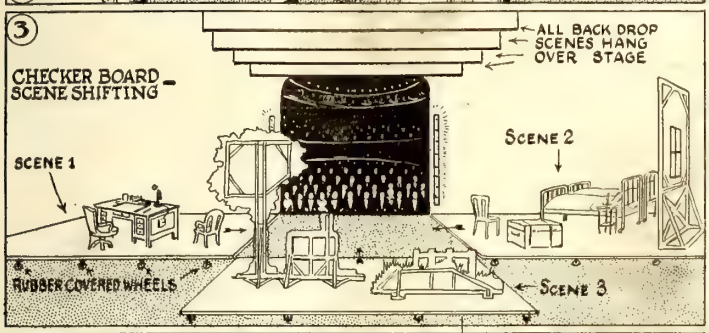
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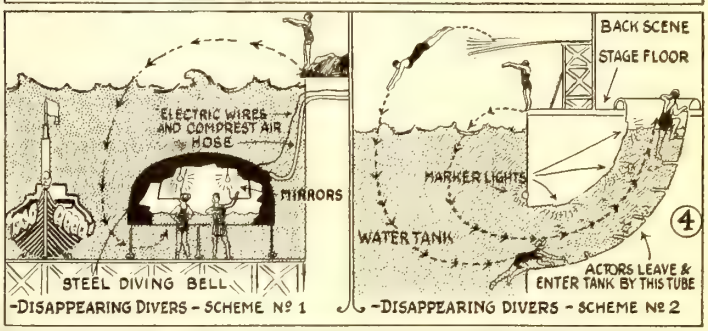
Scene from "The Storm" by Langdon McCormick, a Most Realistic New York Theatrical Production. In the First Act, There Is a Very Good Snow Storm Effect; the Bushes and Trees Swaying in the Wind as it Moans. At the End of the Third Act, the Audience Is Treated to One of the Greatest Masterpieces Ever Produced in Stage Settings,—a Sure-enough "Forest Fire" with Crashing Trees and Howling Wind,—and Not One Speck of Real Fire on the Whole Stage. In This Sensational Scene, the Fire May Be Seen to Creep Slowly Thru the Trees in the Distance. As It Gains Headway the Flames Leap Higher and Higher Until the Whole Stage Is Enveloped in Flames. Trees Fall, the Bushes and Underbrush Sway in the High Wind, and the Largest on the Stage, as Shown Above, Crashes Thru the Cabin Occupied by Burr Winton and David Stewart. The Incandescent or Burning Wood Effect on the Trunk of the Trees, Is Created by Electric Lights, Suitably Camouflaged Behind Colored Silk, Etc. Those Lights, Blinking on and Off, Enhance the Effect. Powerful Electric Sirens Produce the Wind Noise and the Creeping Fire Thru the Trees in the Distance Is Projected From Back Stage on to the Back Drop by Special Lanterns Provided With Moving Colored Discs.

Mysteries of Stage-craft

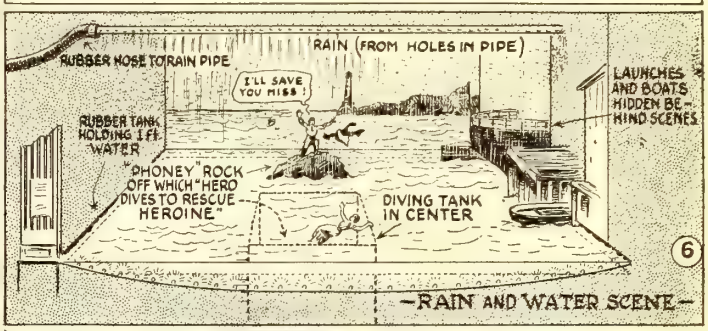


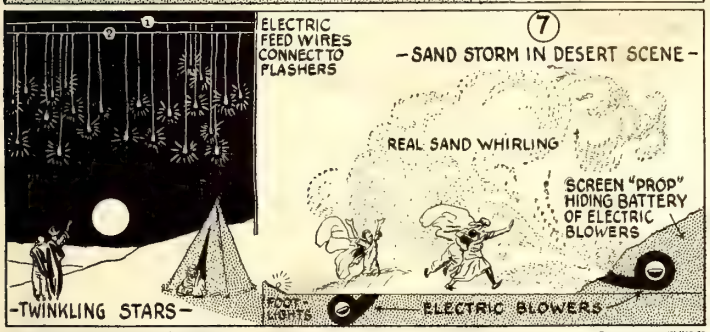


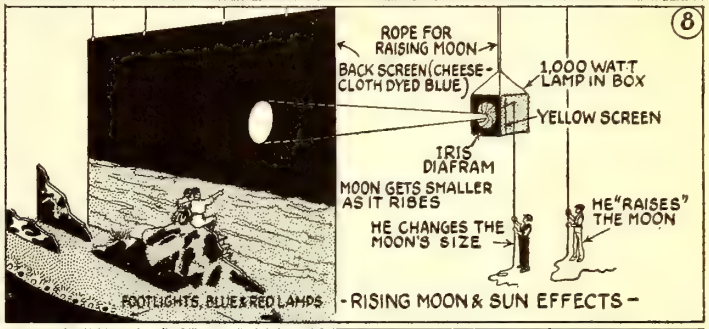


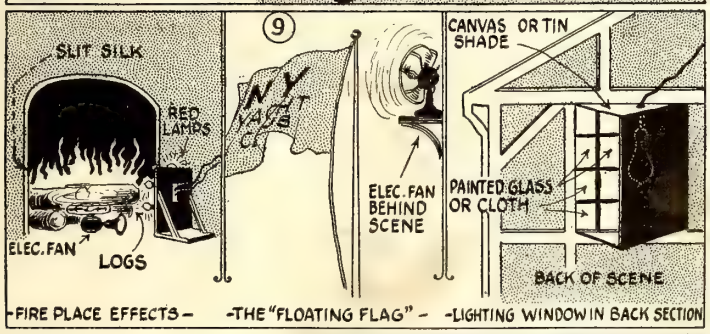


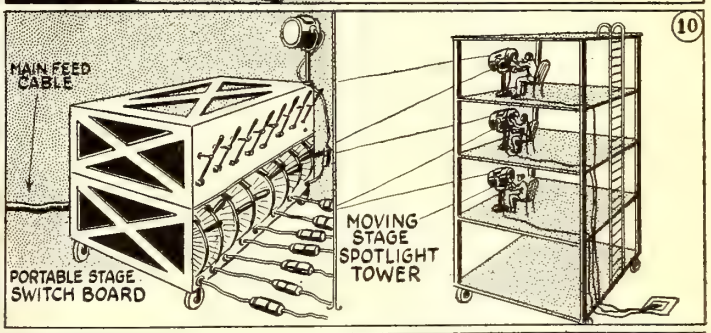


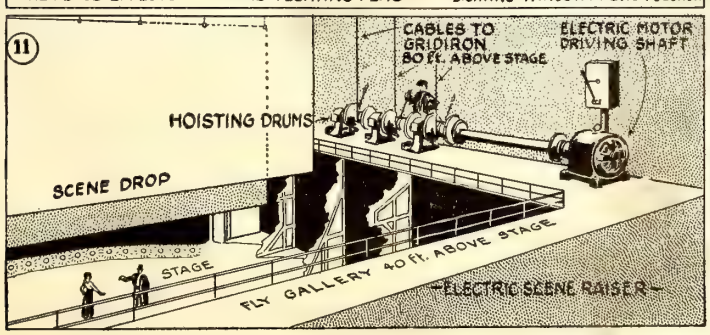


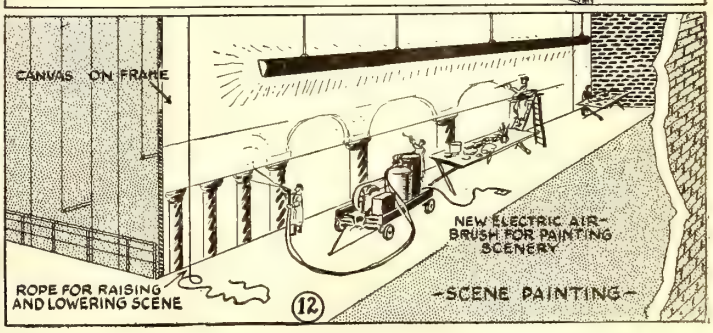












Complete Story on Opposite Page

An Aerial Passenger Rocket

OUR pleasure resorts and summer amusement parks have for many years tried to satisfy the whims of the proverbial "tired business man" and his family, not to mention the millions of others who flock to the great amusement parks at Coney Island and other national play-grounds scattered thruout the country. There are many hair-raising surprises to be found at all of the large amusement parks—such as scenic railways with dizzying inclines down which the passenger-laden cars rush at speeds greatly surpassing those of our fastest express trains, while the passengers proceed to yell and scream their delight as they dash at two-mile-a-minute speed into a pitch dark subterranean cavern made out of papier-maché with the aid of a glue pot, and then decorated by some clever artist to resemble a smaller member of the Rocky Mountain family. But aside from the steel-nerved lady and gent who have in the past few years delighted thousands at the big three-ring circus by looping-the-loop in mid-air in a real automobile or on a bicycle, there haven't been any real hair-raising and startingly new novelties produced in the Amusement World. The illustration here presented, shows a newly proposed amusement-park feature, which smacks decidedly of the essence of war, and while old man Mars and his spiked club, so familiar to our war-time cartoonists, has disappeared from favor in our national family life today, we hope, in fact we know, there is still a small fraction of the war-time spirit burning in the heart of everyone. So those who still think now and then of the war and some of the great deeds performed and the gigantic death-dealing machines developed during that period, will be interested in this new "Aerial Passenger Rocket" amusement device proposed by H. W. Secor and H. Gernsback of New York City.

You board this aerial passenger shell or rocket, on the ground, after which you are "loaded" by a powerful hydraulic plunger into the base of a gigantic comprest-air or electro-magnetic gun, which hurls you skyward with bewildering speed. The next moment you find yourself flying thru space with all the sensations of being imprisoned in one of the ex-Kaiser's dainty ltitle 42 C.M. shells, hurtling thru the upper air strata on its 70-mile journey toward Paris. The greatest pleasure of a trip in the new aerial passenger rocket is yet to come however. The next phase of the journey, all of which occupies the space of but a few seconds, so far, is when the passenger-carrying missile strikes the great mound of water at the top of the race-way or track, shown in the illustration. The water acts as a cushion, and prevents the shell from striking with a disagreeable jolt. All the while you, as a passenger, have been enjoying one of the most novel sensations of your life, thanks to the double-pivoted chair mounted on gimbal rings, and provided with a weight which stabilizes the chair constantly in a vertical position, and now you find yourself dashing earthward with express-train speed down a hollow steel raceway, along which the water discharged from the fountain at the top travels in its journey to the lagoon below. Directly you strike the water in your downward rush, there is a mighty splash as you strike the water and dash thru it, guided by the curved steel rails, until you return around the loop on your journey toward the starting point. As the shore of the lagoon is reached, the pasesnger-laden missile, acting under its own momentum, or else aided by a belt or link conveyor, such as used on scenic railways, is loaded onto electric cars of the type shown, which carry it along the track to the debarking station. Here the aerial rocket is unloaded and new passengers get aboard. The doors are closed and the human skyrocket starts on its journey toward the mouth of the "gun" once more. By proper design of the whole affair, it is possible for several rockets to be employed, the gun firing them at carefully timed intervals, a fraction of a minute apart. Of course, if one of the shells happens to get stuck on the water chute, and shell No. 2 comes sailing thru space directly behind it, then of course there will be a collision,—but that is nothing, for did you not start out to have a real sensation?—and you will have one sure enough, just the same as those you read of during the war, when one of the Hun's mighty shells and a French shell met in mid-air. Yes, this looks a little bit like a real accident, something on the order of the physicist's classic—"When an irresistable force meets an immovable body . . . . . etc."!!!??

Putting aside the smaller details, such as what kind of grease to lubricate the gun and what color to paint the projectiles, altho the inventors would like to see red, white and blue stripes painted along the tips of the shells, pointing rearward, we now come to some more serious problems. One of these is: What kind of a gun or projecting device can be used to hurl the shell skyward with possibly eight to twelve passengers with not too great a velocity, such as 12 K.M. per second, which would hurl the projectile away from Mother Earth so fast that little Johnnie and his sister would never come back to earth again to see Ma and Pa? Further, it should have enough speed to make the shell follow a carefully calculated trajectory, taking into consideration the ballistics of the air, and of course, the wind pressure, etc., all of which our able artillery officers are wont to tell us they have boiled down to such an exact science, that they can hit the head of a pin with a twelve-inch shell ten miles away.

As we were saying, this is one of the big problems, and four methods are proposed, at least one of which should certainly prove practicable, providing a rich Croesus from New York or some other well-known monetary mart, gets up enough nerve to back this invention, and if he cannot be found, it may be suggested that at least one of the inventors has signified his willingness to make the first trip, when the aerial passenger rocket shall have been built. Four ways in which the rocket can be projected heavenward with sufficient speed, are as follows:

First: An electromagnetic gun or steel tube around which are wound a number of magnet coils, each of which is successfully and progressively connected with a source of electric current, so that the steel body of the projectile will be sucked forward at ever-increasing speed in a well known manner, which has been described a number of times in the ELECTRICAL EXPERIMENTER.

Comprest air forms the basis of a second method for forcing the projectile thru the tube at high velocity, and a comprest air plant and tank are shown in the present illustration, which in any event would prove a worth-while auxiliary source of power for operating the device.

Gun powder used as a source of power to project the rocket upward thru the tube, would provide a fine spectacular effect at night, and in the day-time, the noise of the successive explosions, as the shells popt skyward one after another, would prove an excellent drawing card, but perhaps no passengers.

A fourth scheme may utilize the well-known belt with spurs on it, similar to that used in scenic railways at the present time, or some other form of modified rapidly moving belt can be devised which would rapidly carry the projectile skyward. This scheme may seem impractical and something that cannot be realized in a commercial way, but if it is possible for a person in an automobile to loop-the-loop in mid-air as has been done, then with the proper design of the apparatus here proposed and with the necessary precautions taken to arrange proper protective nets and other paraphernalia so that the "Aerial Passenger Rocket" cannot land so as to injure the passengers, it would seem quite possible with modern engineering technique, that the device would be practicable. It would not be surprising to us, if such a scheme as this should greet our eyes even within the course of another year or two at one of our great national playgrounds.

Articles to Appear in the January Issue

How Henri Becquerel Invented Radio-Activity—Special Feature Article. Written by Prof. Becquerel.

The Helicopter, An Accomplished Fact. By Robert G. Skerrett. The newest thing in vertically rising flying machines.

Electric Locomotives Cross Western Mountains. With special illustrations. By H. Winfield Secor.

Popular Explanation of the Einstein Theory. By Isabel M. Lewis, M.A., of the U. S. Naval Observatory.

Is There a Sub-Electron? By Rogers D. Rusk, M.A. An interesting and timely discussion.

The Giant 100-Inch Mount Wilson Reflecting Telescope. A brilliant discourse on large astronomical telescopes and their lenses. By Prof. Floyd L. Darrow.

The Capitol Theater of New York City and Its Electrical Stage Features. By Joseph H. Kraus.

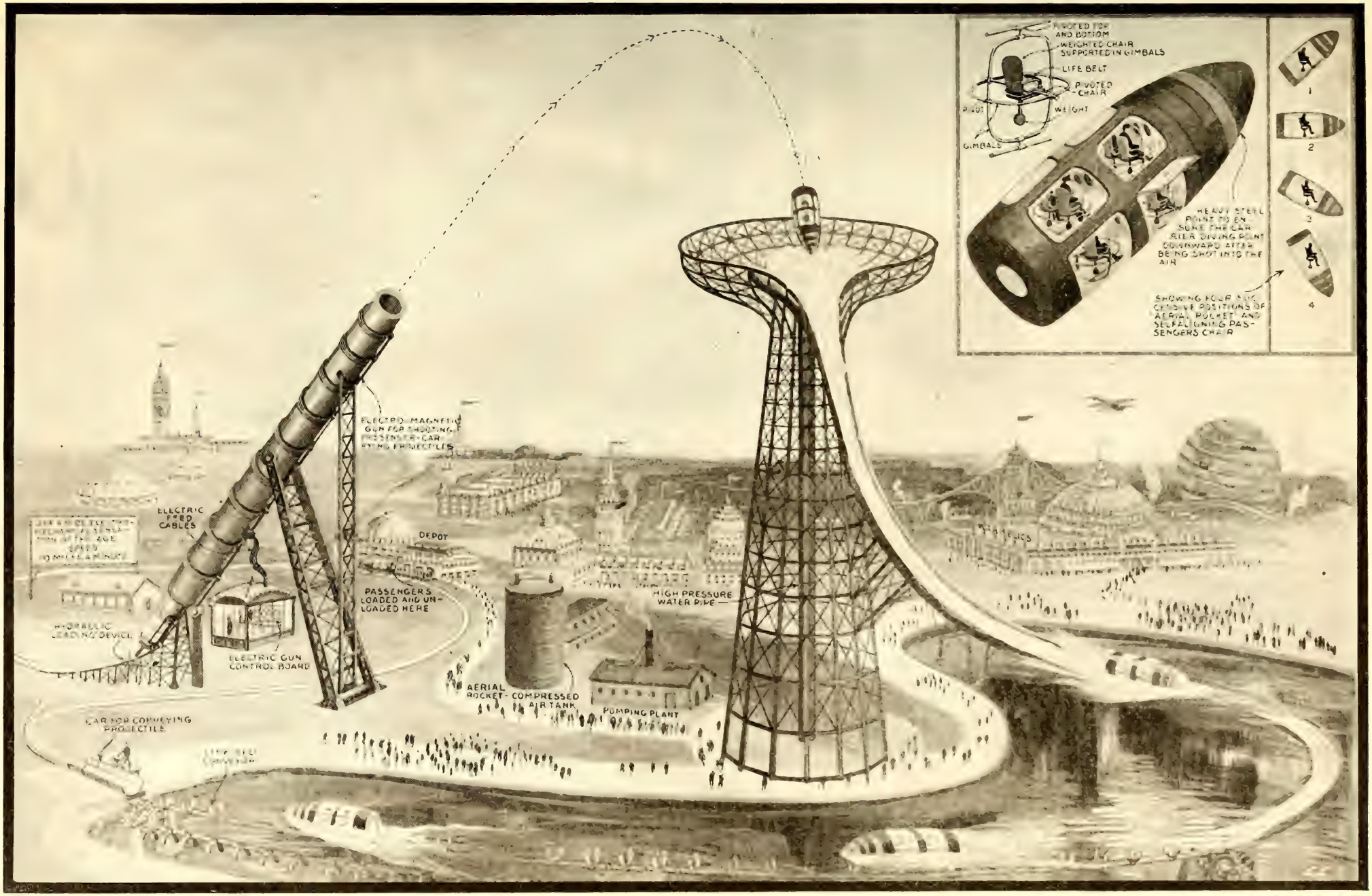
What Atomic Forces Could Do. A popular description of the tremendous energy locked up in the atom.

Exact Radio Direction Finding. With photos and diagrams. By A. E. Harper.

How the Electrical Engineer Works. Popular illustrated story of the daily work of the engineer.

Magnetic Storms. By Prof. Lindley Pyle.

Reversible Airplane Propellers and How They Work.



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The Illustration Herewith Shows a Novel Pleasure Resort Attraction Devised by Two New York Inventors. Altho, at a First Glance, It May Seem Impracticable to Construct Such a Daring Amusement Contrivance as This, a Little Reflection Will Show That It Is Not so Impossible at All. In the Circus We Are Used to Seeing a Person "Loop-the-Loop" or Turn a Somersault in Mid-Air While in an Automobile, the Vehicle and Its Passengers Landing Right Side Up on a Properly Inclined Platform, Down Which It Glides to Earth. Our Artillery Experts Can Compute with Extreme Accuracy the Trajectory of Various Projectiles, Both Large and Small, and Thus It Should Be Quite Possible, with the Aid of Modern Mechanical Engineering Technique, to Build One of These Aerial Passenger Rocket Amusements Successfully. The Gun Out of Which the Shell or Rocket, with Its Human Cargo Is Shot, May Be Operated by Compressed Air, by Powder, or It May Be an Electro-Magnetic Gun. After the Shell Has Sped Thru the Air, Over the Course Indicated by the Dotted Lines, It Lands on a Large Cushion of Water Emerging from the Stand Pipe Shown. It Proceeds to Glide Down to the Lagoon on a Cushion of Water Also, and Upon Striking the Lagoon, It Is Guided Back to the Starting Point by a Link-Belt as Here Illustrated. Electric Cars of Special Type, Seen at the Left of the Picture, Carry the "Rockets" Back to the Station, Thence Around to the Gun Breech, Where a Hydraulic Plunger Loads the Carrier Into the Gun.

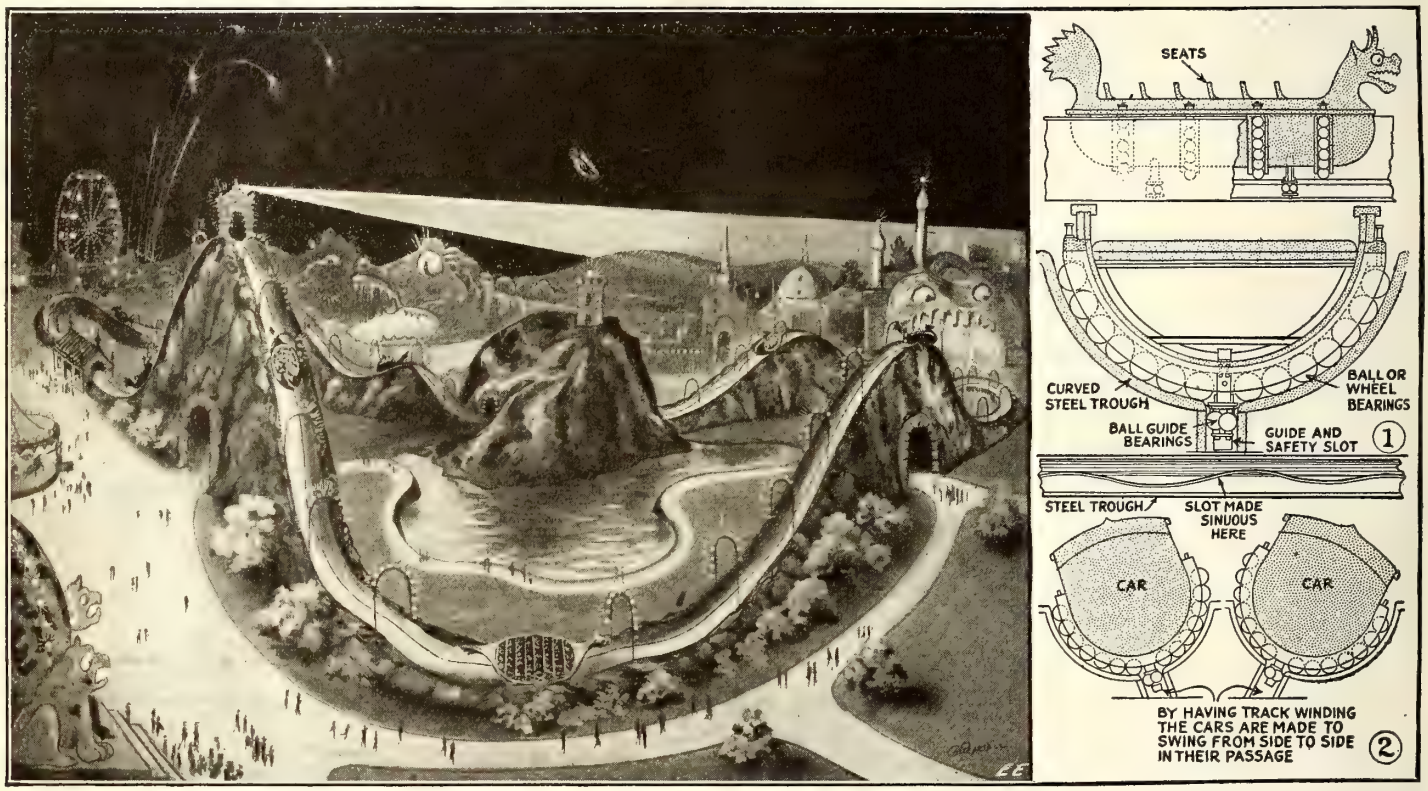
An Oscillating Scenic Railway

BY means of a sinuous undulating track on this new scenic raliway, the cars are caused to oscillate. Scenic railways are not new, by any means, but a radical departure in the design for an improved *Pleasure Railway,* as its inventor, Peter F. Meyer of Brooklyn, N. Y., calls it, is incorporated in the one here illustrated. Several novel and important features, both with regard to the amount of pleasure to be derived by the passengers on Mr. Meyer's pleasure railway, as well as with respect to their safety, have been worked out by the ingenious inventor.

One of the principal objects of Mr. Meyer's new design of scenic railway is the safety feature, and it is applied in a very simple manner. At the bottom of each passenger-carrying car there are two rigid vertical shafts, securely fastened to the base of the car, and suitable wheels are placed on these shafts in such a manner that they minimize any friction as the car rolls along, while at the same time preventing the car from jumping out of the rail slot, as becomes evident, as in order to do this the lower wheels on the vertical shafts would have to be wrenched off.

The inventor has provided an ingenious anti-friction scheme for supporting the cars in the hollow steel or wooden trough, along which the cars ride, and to this end he provides a series of round iron balls. These balls are held in grooves in such a manner that they cannot drop out, but they are held sufficiently loose so as to be easily rotated. The cars thus roll along on this series of balls in the same manner as a roller skate moves along with a minimum of friction on its ball bearings. Of course, where desired, and if the builders do not care to go to the expense of utilizing the ball bearings on the cars, wheels can be substituted, but these would have to be pivoted in two directions, preferably so as to obviate any undue noise or friction as the car sped along and suddenly changed to a tilting position, due to the grooves encountered in the guide rail or slot.

To begin with, the passenger-laden cars may be hauled to the top of the first highest incline by means of a link belt hoist or conveyor in the well-known manner. As the inventor mentions, the track over which the cars speed is best made continuous or endless; the cars to eventually finish a run in front of the station at which they started from. The track is made preferably of thin steel in a trough-like or semicircular form, and, as will be evident to the reader, the inventor has certainly shown original design, and also a very practical and feasible idea in bringing forward this new proposal for building scenic railways. If the people want something exciting and novel in this line, why not give them something that is really novel. For probably a generation now people have become accustomed to the old-fashioned, undulating, humpback scenic railway, but Mr. Meyer has, we think, given us something just as pleasing as its prototypes, and one which will bring in a new era for scenic railways. As you dash down one of the great inclines at mile-a-minute speed, you think you are safe and sound when you reach the bottom and have nothing to do until to-morrow, as the proverb goes, when suddenly—zowie!! the car careens sidewise, or slowly but surely takes an angular tilting position, the same as a small boat on the ocean. Of course you should not have a headache when you start on your journey over Mr. Meyer's oscillating scenic railways, but if you like good sport and feel right for the trip, you will wonder how it ever happened that the older type pleasure railways have existed so many years without a single change in their design or construction, excepting for the innovations now and then, with which we are more or less familiar perhaps, such as long dark tunnels (the longer the better some of us wish, what!!?? . . .), with a few "A Street in New York" hurdy-gurdy scenes, as well as Uncle Tom's "Little Eva" ascending to heaven, etc., ad lib. Possibly by next year they will degenerate to showing us scenes of the Bolsheviki regimé in darkest Russia, where you go down to the public "Spouse Market" and pick out your wife for the next six months.



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The Cars on This New Scenic Railway Sway Back and Forth Sidewise, Like a Boat on the Ocean, as They Shoot Along the Troughlike Tracks. The Cars Roll on Ball Bearings, as the Detail Drawings Show. This Pleasure Railway Provides a "Real Thriller" for the Amusement-Seeking Public.

Turf Fuel for Power

Electrification of Moscow factories on a basis of turf fuel is in progress under the direction of the engineering staff of the Soviet Government, according to Arthur Ransome to whom the scheme was explained by the President of the Supreme Council of Public Economy. ("Russia in 1919," Huebsch.)

"He said that there was no water power near Moscow but big turf deposits which would be used as fuel. In order not to interfere with the actual lighting of the town from the power-station already in existence, they are taking the electric plant from the Provodnik works, which will supply enough electricity for the lighting of the town. As soon as that is set up and working, they will use it for the immediate needs of Moscow, and set about transferring the existing power-station to the new situation near the turf beds. In this way they hope to carry out the change from coal to turf without interfering with the ordinary life of the town. Eventually when things settle down they will get a larger plant. . . .

"I asked how they were going to get the machines. He said that of course they would prefer to buy them abroad, but that, though this was impossible, the work would not be delayed on that account, since they could make a start with the machines they had."

Airplane Supercharger for High Flying

By CHARLES M. RIPLEY

IN 1783 Benjamin Franklin witnest a balloon ascension and after seeing it he wrote as follows: "A few months since, the idea of witches riding thru the air upon a broom-stick, and that of philosophers upon a bag of smoke, would have appeared equally impossible and ridiculous—these machines must always be subject to be driven by the wind. Perhaps mechanic art may find easy means to give them progressive motion in a calm, and to slant them a little in the wind."

Today our aviators laugh at a 60-mile gale—it is negligible compared with their own speed of 150 miles per hour. And 200 miles per hour and even more, is seen upon the horizon for regular commercial airplane service; for the new *Supercharger* or oxygen booster assures us that the long distance air transportation of the future will be conducted at from three to five miles up in the sky, where the air resistance is less than half that at sea level.

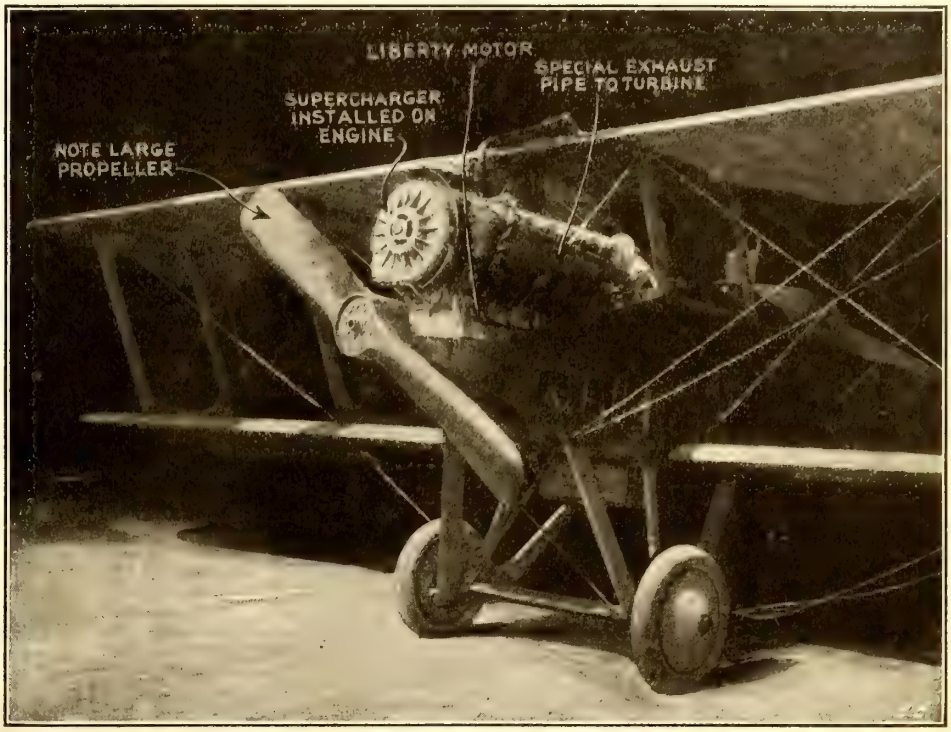
At Wilbur Wright Field, August 2nd, a U. S. Army aviator broke the world's speed record at high altitudes. Major R. W. Schroeder of the U. S. Air Service, while at an altitude of 18,400 feet, attained an official speed of 137 miles per hour.

The official report states that "he used a two-seated La Père biplane, built by the Packard Motor Car Co., and designed by Capt. La Père of the French Army, while in the employ of the U. S. Government. It had a 12-cylinder Liberty motor, equipt with a *supercharger* developed by Dr. S. A. Moss, a turbine research engineer of Lynn, Mass., working in cooperation with the engineers of the U. S. Air Service. So far as is known this is the highest speed ever attained at this altitude with a two-seated plane; and the best speed known for a single-seater at this altitude was only 128 miles per hour."

It is not generally known among "landlubbers" that heretofore every airplane engine lost 50% of its power when up 20,000 feet; and that at 25,000 feet its loss of power is between two-thirds and three-quarters—that is, instead of having 400 horsepower, as at sea level, it only has 100 to 150 horsepower.

So far as is known now, the *scarcity of oxygen* at the high elevations is the only factor which has made 30,000 feet "the Ceiling of the World." So the engine suffers from lack of oxygen, just as do the birdmen.

The thin "skin" of air which surrounds the earth is no thicker than the skin of an apple—relatively speaking. Thus it is that the daring birdmen who approach the ceiling of the world must prepare to take oxygen from a tank as they near 15,000 to 18,000 feet elevation. Otherwise they would suffocate.



La Pere Airplane That Broke World's Speed Record at 18,000 Feet Altitude. Liberty Motor Equipt With "Super-Charger" or Oxygen Booster, Which Is Shown at Front of Engine and Just Above the Propeller Shaft. This Small Attachment Practically Doubled the Horse-Power of the Engine at an Altitude of 18,400 Feet, Where the Air Is Extremely Rarefied and Deficient in Oxygen. In Future Flights It Is Expected That Previous Speed and Altitude Records Will All be Eclipsed.

The *supercharger* used recently by Major Schroeder and his observer, Lieut. G. W. Elsey, is one of the most remarkable inventions which have been developed as a result of America's participation in the World War. The observations (officially checked) show that altho the plane was 18,400 feet above the ground, the air supplied to the carburetor had the same density as that at 2,900 feet elevation. Thus the supercharger gave the engine an amount of power equivalent to what it would have had, if it had been 16,500 feet nearer to the ground. So this attachment is as useful and necessary to the engine as is the tank which supplies oxygen to the sky-pilot.

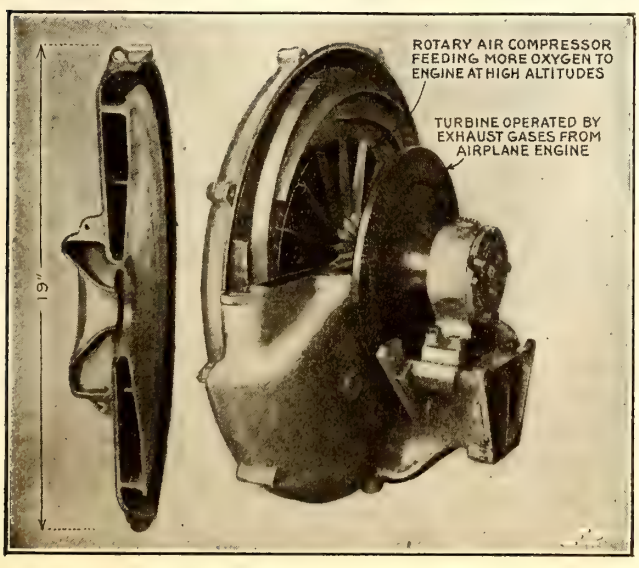
The supercharger or oxygen booster is a little device only 19" in diameter, and complete with piping, adds only 100 pounds additional net weight to the plane; yet it practically doubled the power of the Liberty motor! Such vast quantities of oxygen are needed by the motor that it is impossible to carry a supply in tanks as is done for aviators, so the supercharger TAKES IT FROM THE AIR! Literally the wonderful little device compresses the rarefied air until it equals that near sea-level, and then this "good, thick sea-level air" is fed to the carburetor. It takes a considerable amount of energy to suck in air which is already at 50 per cent vacuum or more and compress it—or "buck the vacuum." But there is where the engineer has played a brilliant trick—for he has found some energy there, miles up in the sky, which he can use.

Where do you suppose the power comes from which doubles the power of the Liberty motor as it approaches the "ceiling of the world"? Why, from the red-hot exhaust gases of the Liberty motor! It is so simple: heat is energy; heat is thrown away in the exhaust gases; therefore the Yankee engineers set about to collect this power.

Now the gases exhaust into manifold or flat-shaped pipes (one on each side) which convey it to a gas turbine. The turbine is thus driven at 20,000 to 25,000 revolutions per minute—40 revolutions per second! Thus the wasted energy is now reclaimed into a useful by-product power; and this power drives the air compressor. The combination of the turbine and the centrifugal compressor is called a *supercharger*, and the weight is only 100 pounds!

Engineers—whether airmen or not—have shown intense interest in and admiration for this outfit. A "gas turbine" itself is a

(*Continued on page* 820)

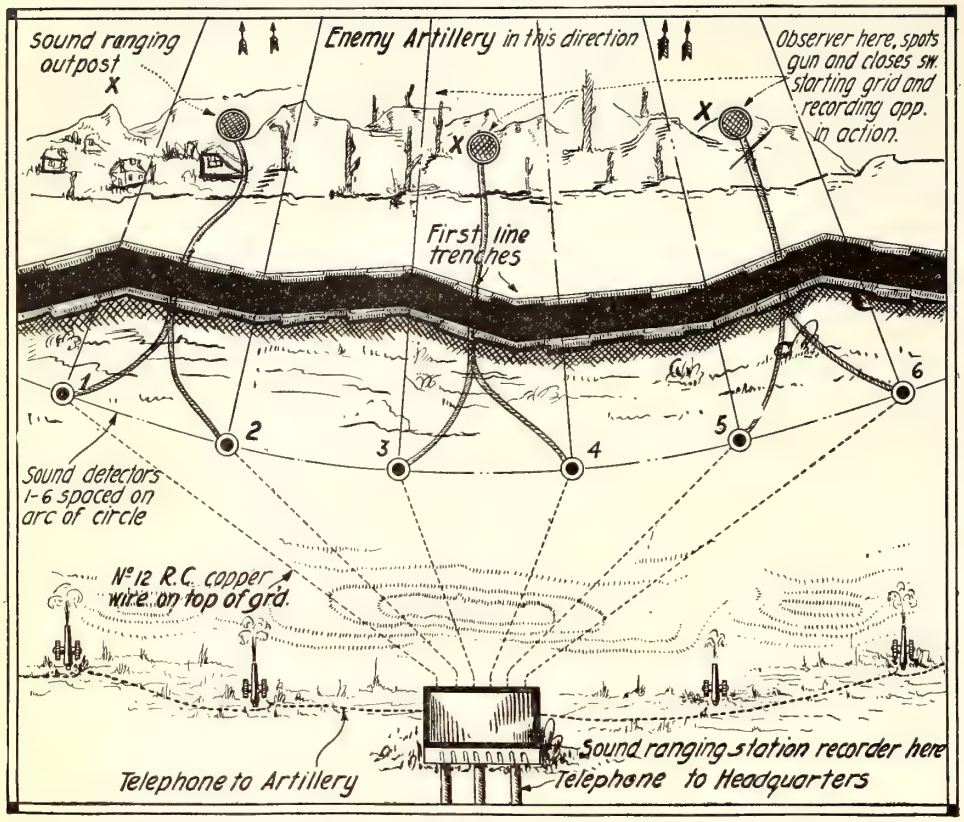


View to the Left Shows the Wonderful New Airplane "Super-charger" Which Pumps Increased Amounts of Oxygen Into the Gasoline Engine Carburetor System, When the Airplane Is Flying at High Altitudes. As Is Well-known, the Airplane Engine Loses About 50 Per Cent of Its Power at an Altitude of 20,000 Feet and to Overcome this Reduction in Speed and Climbing Power of the Plane, This Device Has Been Produced. A Turbine Drives the Rotary Air Compressor, the Turbine Being Operated by Exhaust Gases From the Airplane Engine.

Sound and Flash Ranging in the A.E.F.

By Prof. Augustus Trowbridge

DEPARTMENT OF PHYSICS, PRINCETON UNIVERSITY. LATE LIEUTENANT-COLONEL, CORPS OF ENGINEERS, U. S. ARMY, IN TECHNICAL CHARGE OF THE SOUND AND FLASH RANGING SERVICE OF THE AMERICAN EXPEDITIONARY FORCE.



The Above Chart or Map Shows a Typical Layout of "Sound Ranging" Stations at the American battlefront in France, as Actually Used for Locating German Artillery. The Photographic Record of Enemy Gun Bursts Was Recorded at the Sound Ranging Headquarters Station, From Which Wires Radiated to the Various Listening Stations, Placed Along the Arc of a Circle at 1, 2, 3, 4, and So Forth. Every Enemy Gun Was Accurately Located, Numbered and Charted in This Way.

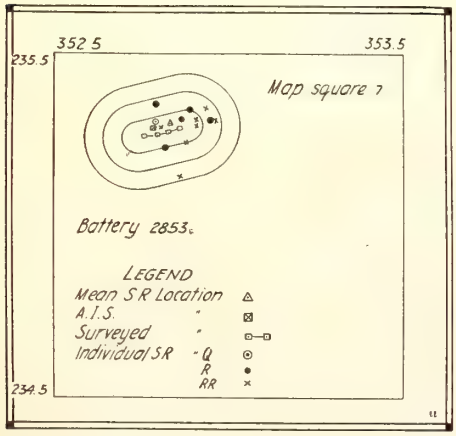
AFTER the first battle of the Marne in the early autumn of 1914 the war on the western front soon took on the character of a gigantic siege operation in which each belligerent played the parts both of besieged and besieger on different portions of the battle front. The long period of trench warfare set in during which each side increased the number, the caliber and the range of its artillery—the heavier calibers were most carefully concealed both through the choice of naturally favorable positions and through the use of the new practice of camouflage, so that the location of the enemy batteries by existing methods became increasingly difficult and often impossible.

The new problem, which the French were first to solve, was first, the location by some other means than sight of invisible enemy batteries and the directing of the fire of their own batteries on these and other enemy targets, and, second, the location of, and the *ranging* on, the enemy batteries which tho not completely hidden, were so distant that the ordinary triangulation methods from a short base-line hitherto practiced by the artillery were not sufficiently accurate to accomplish. To attain these two objects the French inaugurated two new services of artillery information which have been called respectively Sound Ranging and Flash Ranging. These services were copied by the British with but slight modification as regards organization and later by the United States, which organized both services under one head.

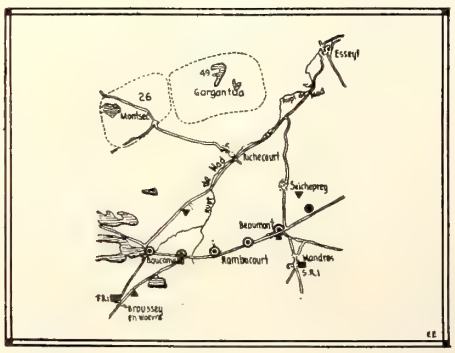
The flash ranging services in all of the allied armies were very similar both as regards instruments and methods of observation and report; such differences as there were were due chiefly to the methods of training and to the character of the personnel. The Germans also had an extremely efficient flash ranging service, many of the good features of which were copied by the Allies as they became known through prisoners and captured documents.

A flash ranging section consisted of about 100 men under the command of a lieutenant, who was assisted by three other officers. The installation consisted of a central calculating station—marked F. R. 1.—and from four to six advance observation posts—marked as erect triangles on the accompanying map, which gives approximately the positions occupied by one flash and one sound ranging section on a ten kilometer front in the spring of 1918.

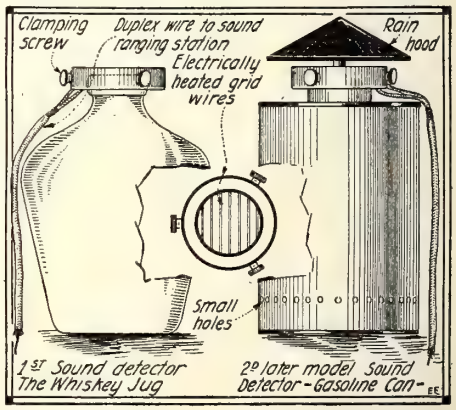
At each observation post two men were on duty at all times, day and night, and each post was in telephonic communication with the calculating station and with each of the other posts of the section. Each post was provided with suitable day and night telescopes mounted on graduated circles for measuring the bearing of a sight away from the north-south line. The method of operation was as follows: If an observer at one of the posts noted the flash of an enemy gun, or even only the smoke puff he called back to "central" the approximate bearing and distance; the calculating officer at central was provided with a large plotting board, on which the surveyed positions of all of the observation posts were accurately marked and which was provided with weighted strings and angular scales for each of the posts. When a report came from an observation post the calculator at the plotting board set the corresponding string in the direction reported and brought all the other strings to cross the first at about the estimated distance and called to all the other



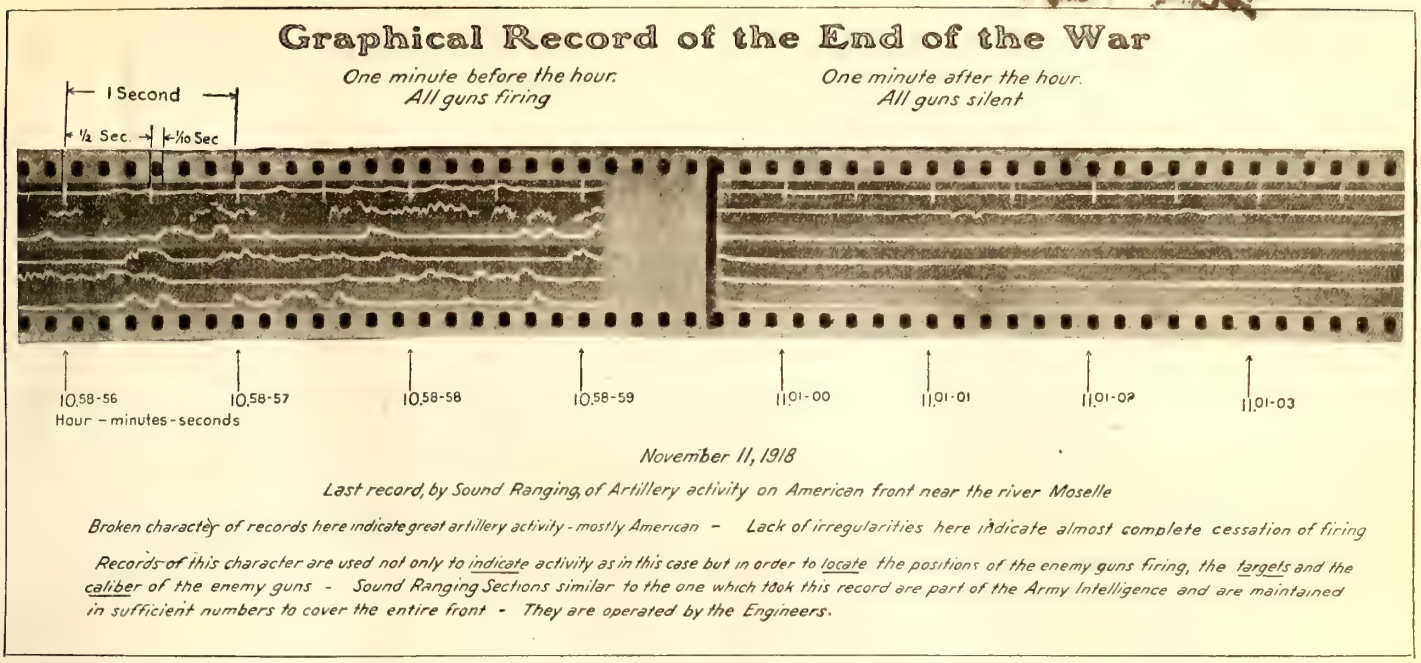
This Map of Which Thousands Were Made Daily by the "A. E. F." Engineers on the Battlefront in France, Shows the Accuracy With Which Enemy Guns Were Located by Sound Ranging, S.R. by Artillery Information Service, A. I. S., Etc. Dots in Squares Show Actual Location of Guns.



An Actual Map of Sound Ranging Stations in the Vicinity of Seicheprey, France. Sound Ranging Central Station at S.R. 1. Observing Instruments Indicated by Black Dots in Circles. Flash Ranging Stations F.R. 1. Enemy Artillery Located in Areas Enclosed by Dotted Lines.

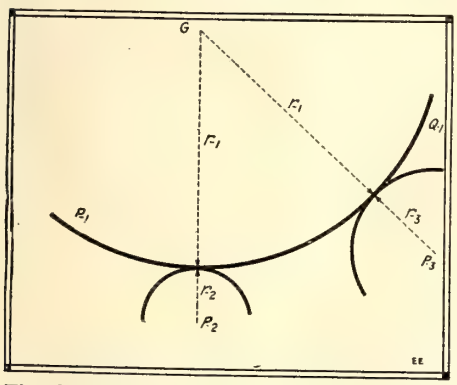


No Microphones of the Usual Carbon Grain Type or Anything Like Them Were Used in Picking Up the Sound of the Enemy Guns in the "A. E. F." Sound Ranging Work. What Was Used, However, Was a Fine Grid of Electrically Heated Wires Placed Over the Mouth of a Whiskey Jug, at First and Later Over the Mouth of a Discarded Gasoline Can, Which Latter Acted as Sound Resonating Chambers. When a Sound Wave From an Enemy Gun Several Miles Distant, Perhaps, Which of Course Was an Air-Wave, Impinged Against the Heated Wire Grid, It Caused a Variation in Temperature of the Grid, and in Turn a Variation of Its Electrical Resistance.



One of the Most Remarkable Graphical Records Extant Delineating the End of the Great "World War." This Is a Reproduction of a Sound Ranging Record Taken at the American Front at 11 O'Clock on the Morning of November 11, 1918. Note That the Gun-fire Was Very Active up Until the Last Minute Before 11 O'Clock; While at One Minute Past 11, the Firing Practically Ceased. Two Gun-bursts Appear on the right of the Chart at 11.01-01 and 11.01-025, Which Show Where a Boche Had Let Go a Few Seconds After the 11 O'clock Period When the Armistice Called for Firing to Cease.

posts to set their instruments in the proper direction as given on the board. After one or two more rounds by the enemy gun, several or all of the posts might be in a position to give an accurate report of the direction as seen from these posts, and the calculating officer be enabled to obtain an accurate intersection of the strings on the board and thus be able to report to the artillery the location of the gun which had been firing. In case of great enemy artillery activity when there was danger that all the posts might not be sighting on the same enemy gun, an electrical synchronizing device was employed which enabled the calculating officer to assure himself



The Chart Above Shows How the Sound of a Gun Fired at "G", Requires Different Lengths of Time to Travel to Various Locations and How the exact Position of the Gun may Be Surveyed by Sound When Several Listening Stations Located at Say P1, P2, P3, etc., are Employed in Determining the Exact Arrival Time of the Sound From the Gun at Each of These Points.

that all the observations were made at the same instant. This rendered it unlikely that different observers should report on different guns firing at about the same time.

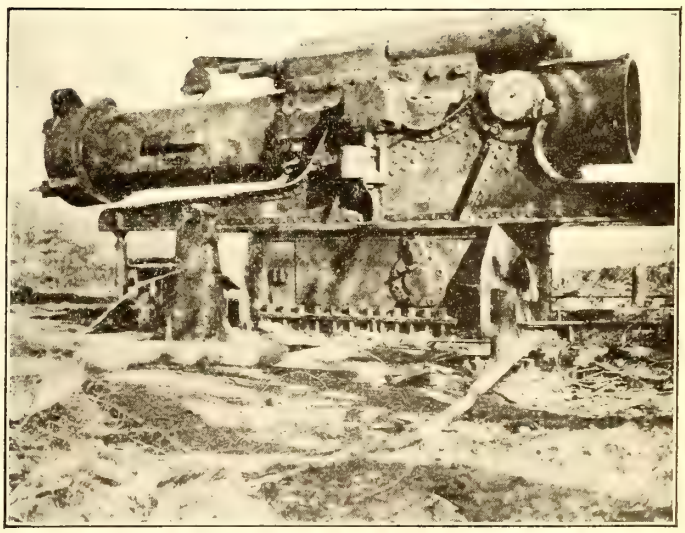
In directing the fire of the friendly artillery the procedure was similar with this difference that it was the *burst* of our own shells on the ground in the case of ranging on a visible target that was observed and plotted or the burst in the air in the case of an invisible target. In this latter case known corrections could be worked out to permit of a burst at or near the invisible target.

A sound ranging section was similar in organization to the flash section except that there were fewer men (60-70), due to the fact that instruments took the place of living observers to a great extent. The "central" instrument recorded photographically the time of arrival of the sound of the enemy guns at a series of instruments at surveyed positions near the front line and covering a length of about five miles; this instrument delivered automatically, developed and fixed photographic records in less than a minute after the sound of the enemy gun reached the front line and this record could be interpreted by the use of quick graphical methods so that the position of the gun could be telephoned to the friendly artillery in about a minute more. The probable accuracy of the location could be estimated and also the caliber and target of the gun which had just fired; this and the fact that neither rain, fog or darkness interfered with sound ranging were unique and valuable features of the service. Calculations were rendered difficult by great artillery activity tho they were not impossible except under actual barrage conditions.

On the accompanying map the sound ranging central is marked S. R. 1, and the observing instruments are shown as circles lying equi-spaced along a circular arc, whose center lies near the groups of enemy artillery shown enclosed in the two irregular areas, one of which was supposed to contain 26 and the other 49 active enemy batteries. The front line trenches ran about midway between these areas and the sound ranging instruments. In or near the trenches were two forward observation posts marked on the map as inverted triangles; at these posts observers were stationed, whose duty it was to start and stop by means of electrical relays the photographic mechanism at the central station whenever they heard the report of enemy guns whose positions it was desired to locate.

(*Continued on page 832*)

Stranger Than Any Fiction, Would Be the Tale That the "Sound Ranging" Experts of the "A.E.F." Could Tell You If They Wanted to, Regarding the Wonderful Hits They Made By Artillery. The Accompanying View Shows a Typical Hit on a Large German Howitzer Several Miles Behind the Lines, From an American Gun. This Shot Having Been Fired From Information Gained by the Sound Ranging Corps. The Enemy Gun Was Put Out of Commission, the Recoil Cylinders Having Been Blown Off and Totally Disabling It. In One Case, a Railroad Train Was Fired at Several Miles Behind the Lines the Train Being Completely Wrecked on the Bridge It Was Crossing at the Time, Due to Shell-fire. Not Only This, But the Location of Friendly Shell-bursts Could be Checked Up and Measured by the Sound Ranging Experts and the Gunners Told in a Fraction of a Minute, to Alter Their Range to the Right or to the Left, Until the Shell Landed Squarely on the Target.



Rohlfs Flies 34,610 Ft.—New World's Record

FLYING his Curtiss "Wasp" type triplane, with a 12-cylinder, 400-horsepower Curtiss motor, Roland Rohlfs, test pilot for the Curtiss Company, broke the world's altitude record, when, at Roosevelt Field September 18th, he reached the height of 34,610 feet, or more than six and one-half miles above sea level. On Saturday the 13th he had come within nearly 400 feet of this mark, but the flight was not official.

The previous unofficial record was 33,137 feet, made last May at Villa Coublay, France, by Adjutant Casale of the French Army.

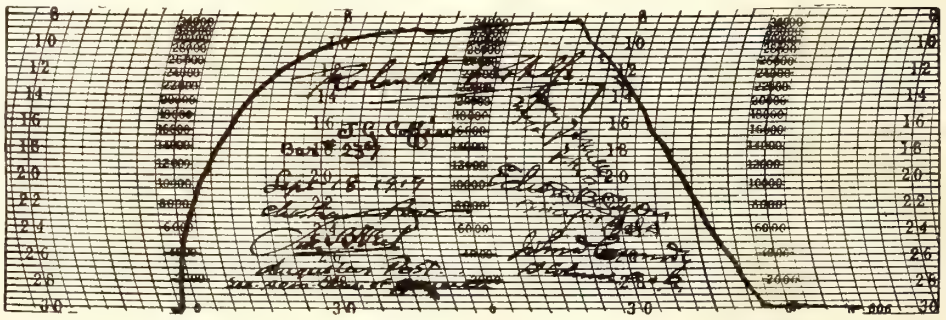
Every precaution was taken therefore to make sure that all official requirements for a record were observed. A committee representing the Aero Club of America, composed of Augustus Post, Secretary of the club; Sydney B. Veit, and Professor C. L. Poore, Professor of Celestial Mechanics at Columbia University, were present. The army was unofficially represented by Colonel John D. Carmody, in command at Roosevelt Field; Major E. B. Lyons, in charge of flying at Mitchel Field, and Major Henry F. Miller.

Rohlfs left the ground at 12:06 o'clock and landed within twenty feet of his takeoff at 1:59.



© International Film Service

Roland Rohlfs, Who Broke the World's Altitude Record. He Is the Test Pilot for the Curtiss Engineering Corporation, and Is Shown Seated in His Curtiss "Wasp" Machine Before the Start of the Flight Over Roosevelt Field, Mineola. He Ascended to a Height of 34,610 Feet, Establishing a New World's Record. The Inset Photograph Shows Rohlfs Rising From the Ground for His Record-Breaking Flight. The Chart Below Is a Copy of the Official Barograph Record of Rohlfs's Altitude-Breaking Flight.



As he landed he stept out and handed the sealed barograph to Mr. Post. When the latter called out that the instrument showed a new world's record the onlookers cheered. The barograph was then resealed by the Aero Club committee. It was shipt to Washington where it will be calibrated by the Bureau of Standards and subjected to the most detailed and exhaustive analysis and testing. Until the result of this examination is given out, the reading will not be recorded by the Aero Club as absolutely official.

Rohlfs wore a suit of fur-lined clothing, and heavy felt mittens made by himself from material half an inch thick. Of the flight, he said:

"At 20,000 feet, trouble began. I had to call on my oxygen bottle. This feeds air to my lungs thru a device something like a football nose guard. At first I tried drawing it in thru the nose and mouth, but this dried my throat and I had to shut my mouth and breathe thru the nose alone. If anything had happened to this oxygen apparatus I would have been a 'goner.'

"At 31,000 feet the plane began to wobble in a way that, frankly, frightened me. It careened this way and that, and while doing so dropt 600 feet. I threw on more power and up it went again." (The barograph markings showed the fall plainly.)

"When I reached the 'peak' the thermometer showed forty-three degrees *below* zero. It took seventy-eight minutes to get this high and I spent another twenty minutes trying to make the plane rise still higher. I used every trick I knew, but could not coax another foot of altitude out of it. I believe I attained the absolute top possible in this machine.

"I noticed several peculiar things up there. Near the top I felt nervous twitchings in parts of my body. These were at several scars left by an automobile accident several years ago. After my two other high flights my teeth ached severely and also my stomach. I guess I can count on the aches lasting about ten days more. They lasted that long when I went above 30,000 feet before."

Rohlfs reached 10,000 feet in eight minutes after leaving the ground. He flew as far as Riverhead, L. I., where a head wind made him turn about. When at the highest altitude he was above Lake Ronkonkoma, which is twenty-five miles from Roosevelt Field.

Rohlfs made his flight after most careful study of his problem, paying particular attention to how much weight he could spare from his machine with safety. Rohlfs contemplated removing the tires but changed his mind and left them on. By a judicious casting off of nuts, bolts, wires, and fire-fighting apparatus and lessening his gasoline supply to eleven gallons he reduced the weight of the machine by 100 pounds.

New World's Record for Pilot and Passenger.

A new official world's altitude record for pilot and one passenger was made at Dayton, Ohio, on September 6, when Major Rudolph W. Schroeder climbed to 28,500 feet in a Lepere biplane equipt with a 400 horse power Liberty motor, according to announcement made recently by the Contest Committee of the American Flying Club, which had charge of the recent New York-Toronto contest. The announcement followed the homologation of data and barograph charts sent by Colonel Thurman H. Bane, Chief of the Army Airplane Engineering Division at McCook Field, Dayton.

This new mark of 28,500 feet greatly surpasses the former two-man altitude record held by Captain Lang of the Royal Air Force, who ascended to 27,300 feet on January 2, 1919, in a 375 horse power English biplane. No official figures have been received in this country yet in regard to the reported altitude climb of Adjutant Casale, who, with one passenger, according to unofficial reports, broke previous records last June. Until official proof of this flight is received by the Contest Committee of the American Flying Club, Major Schroeder's record will stand as the world's record for pilot and passenger.

Major Schroeder's new record is of international interest because it was made possible by the new airplane engine *supercharger* originated during the war but

(Continued on page 826)

New York Electrical Show

THE annual Electrical Exposition held in New York was more resplendent than ever before, this year. It was discontinued during the war and, judging by the size of the crowds that visited the exposition this year, the public was pleased indeed to see once more on exhibit the latest advances in electrical wizardry. The exposition at New York was staged in the Grand Central Palace, a very handsome building and one that provided a commodious space for the beautiful display of the various apparata, instruments and devices, which included everything imaginable from a specially sensitive micro-ampere meter, the needle of which indicated in millionths of an ampere, the current produced by applying your dampened finger to an iron nail and a one-cent piece—up to a ponderous electrical storage battery truck, or a complete electrical dairy, where the electrically operated vacuum milker was demonstrated several times each day.



At the New York Electrical Show, Which the Editors Visited, There Were Several Ingenious and More or Less Practical Electric Apparata Exhibited and Demonstrated. A Few of the More Interesting and Useful Things That We Noted There, Are Illustrated and Described Herewith, for the Benefit of Readers Who May Not Have Had the Opportunity of Witnessing This Wonderful and Educational Electrical Display.

The accompanying illustration shows just a few samples of the hundreds of electrical devices exhibited and which appealed to every member of the family, from little Tommy Edison, Jr., up to old Grandad puffing contentedly on his old and tried "Meerschaum." What, between electrical washing machines that wabbled around, or back and forth, including some that oscillated up and down, with electric lights shining thru their soapy depths, electrical sirens and powerful X-ray machines, together with wireless sparks and a few dozen other choice crashes and flashes thrown in for good measure, the electrically interested populace was thoroly entertained. Excellent band music was furnished afternoons and evenings during the week of the exposition.

WHAT WE SAW AT THE SHOW

A very clever vase light was demonstrated and what "got our goat" was why—out of 100,000,000 people in America—some one had not thought of it before. It instantly converts any vase, no matter how big or small, into a beautiful electric lamp with a silk shade costing as much as you have money to buy yards of silk for. See Figure 1. As we walked down the aisle, our attention was arrested by one of the most efficient looking electric dish washers that we have seen for some time. The hot soapy water was forced up thru and around the dishes in great fashion, and if any microbes or bacteria could lift one of their hind legs after passing thru this scalding ordeal, well, they have got to show us, that's all! We told mother and the girls about it as soon as we arrived home, and as soon as the mail order houses start selling these electric dish washers on the installment plan, I and Mike McStinchy, the chief clerk at the office, have promised ourselves one apiece. Take a shot at Figure 2.

As we hove to, around the corner on one of the floors, we were almost "flabbergasted" trying to count the total number of electric vacuum cleaners exhibited. There must 'a been a million of 'em! One particularly large and interesting machine was being pushed slowly over a large Persian rug by a dusky demonstrator. "Some vacuum cleaner," quoth we. Egad, we had the wrong family this time! This machine (see Fig. 3) was an *electric rug and carpet washer*. When we got close up to it we saw that it had a rapidly oscillating scrub-

(*Continued on page* 815)

"Speaking Crystals"

By A. McL. NICOLSON*

ELECTRICITY is liberated in many apparently different ways. There are at least a dozen so-called "sources" of electricity which are mentioned in text books. It probably could be shown that in every case in which electricity is produced, the fundamental cause of the manifestation is the same. We have merely different ways of operating on matter with the dissipation of some form of energy; and the electric charge or current is generated. This signifies the transformation of one form of energy into another, and, generally, the mechanism is reversible. For example, in the case of static electricity the influence machine may be used reversibly as a "converter" of electricity or of mechanical energy,—that is to say as a generator or as a motor. When we hear of a "new" source of electricity we are curious to find out all about the mechanism of the source—as to its reversibility, efficiency of energy conversion, applicability to the mechanical arts, etc.

"Piezo-Electricity", discovered by J. and P. Curie, is the name given, in 1881, to a crystal source of electricity. In this case electric charges of different signs are liberated on different surfaces of a crystal when mechanical stresses or vibrations are impressed on certain of its parts. The word *piezo*, pronounced p ī é z o, is derived from the Greek *piezein*, signifying "to press"; hence "pressure" electricity.

Crystals Which Evolve Electricity.

Not every crystal is *piezo-electrically* active. Nature grows crystals, whether mineral or organic, in thirty-two differing classes of structure—of these, just twenty classes offer the necessary condition for piezo-electric activity. And this condition is *asymmetry* of structure or of molecular arrangement. While a very large number of crystals have the electric property, only comparatively few exhibit the phenomenon to a sufficiently interesting degree to warrant mention of it at this time.

Amongst mineral crystals quartz and tourmaline are the best known having the asymmetric structure — the molecules consisting of regular "bricks", are staggered into a *skew symmetry* or *spiral structure*. In the case of the organic crystals, the molecules themselves are asymmetric, that is to say, they do not comprise "regular bricks". They have, in fact, little skew symmetries of their own. Both the mineral and the organic crystal exhibit their respective asymmetries as right- or left-handed skew structures. This is revealed in their power to rotate the plane of polarization of polarized light in corresponding right or left directions.

We are, just now, more interested in the *organic* crystal since this type, comprising, as it does, the asymmetric carbon molecule, has proved to be more susceptible of large piezo-electric effect. Examples of active organic crystals are sugar, camphor, tartaric acid, etc.

*Research Laboratories of the American Telephone and Telegraph Company and the Western Electric Company, Inc.

MANY new and surprising things have come to light during the war. While the guns thundered in Europe, American scientists quietly went about their work, hatching out many new marvels.

One of the most unique inventions—at least from the Experimenter's standpoint—is the wonderful Piezo-electric effect of Rochelle crystals. In these, a veritable new gold mine has been opened to all experimenters. What these crystals will all do fairly staggers one's imagination. Think of a simple salt crystal that will actually talk, that can be a telephone receiver, and a transmitter combined, that will give as much as 100 volts when squeezed with two fingers, that will "sing" when current is supplied to it! And the best part is every one of us can make his own crystals and perform these experiments without having to buy this 20th century electrical wonder—for as yet it can't be bought, anyway!

We consider ourselves fortunate to present our readers with a very comprehensive article on the new invention by its inventor, Mr. A. McL. Nicolson. Many new uses will be found for the invention and we invite our readers to send us their experience for the benefit of all.—The Editors.

Rochelle Salt Crystal Very Active Electrically.

A crystal which is very active piezo-electrically is *"dextro rotary" sodium potassium tartarate or Rochelle salt.*

Recently, the Research Laboratory of the American Telephone and Telegraph and the Western Electric Companies investigated the possibility of developing piezo-electric crystals. It was soon found that crystals of *Rochelle salt* would give good results *if prepared in a special manner.*

Briefly, increased efficiency is brought about by the following conditions:

1. Selection of particular habit of growth.
2. Desiccation. (Preserving by exhausting the moisture.)
3. Development of the crystal into a composite polar structure.
4. Application of static compression.
5. Use of electric poles normal to each other.
6. Application of torque.

How the Crystals are "Grown".

Rochelle salt crystals are grown from nuclei or "seeds" of definite form. These are obtained by selection from crystal croppings spontaneously grown in a *supersaturated solution* of the salt (the formula is $Na\ K\ C_4\ H_4\ O_6.\ 4H_2\ O$). The solution should be made up of 8 parts Rochelle salts to 5.33 parts of water. The density of the solution at 50°C. is 1.33 and the nuclei from which large crystals are grown, are "planted" in the mother liquor when the temperature has dropped to 38°C. *The crystal grows rapidly as the temperature of the liquor falls to that of its surroundings.* The seeds are selected so that they are practically square shaped—the seed, for this purpose, must lie with its principal or optic axis in a horizontal plane.

When a crystal is grown very rapidly—as by the temperature gradient method described—it develops a *composite* structure termed by mineralogists the "hour-glass". Fig. 1 illustrates the entire process graphically.

How the Crystals are Mounted

Important use is made of this structure and its development is fully encouraged. It is found that if the crystal, when grown to the desired size, from 30 to 200 grams, and when thoroly desiccated, or dried, develops new and stronger electric poles on its surface. The vertical walls, surrounding the principal axis, *form one pole* while the *two horizontal*, or basal planes

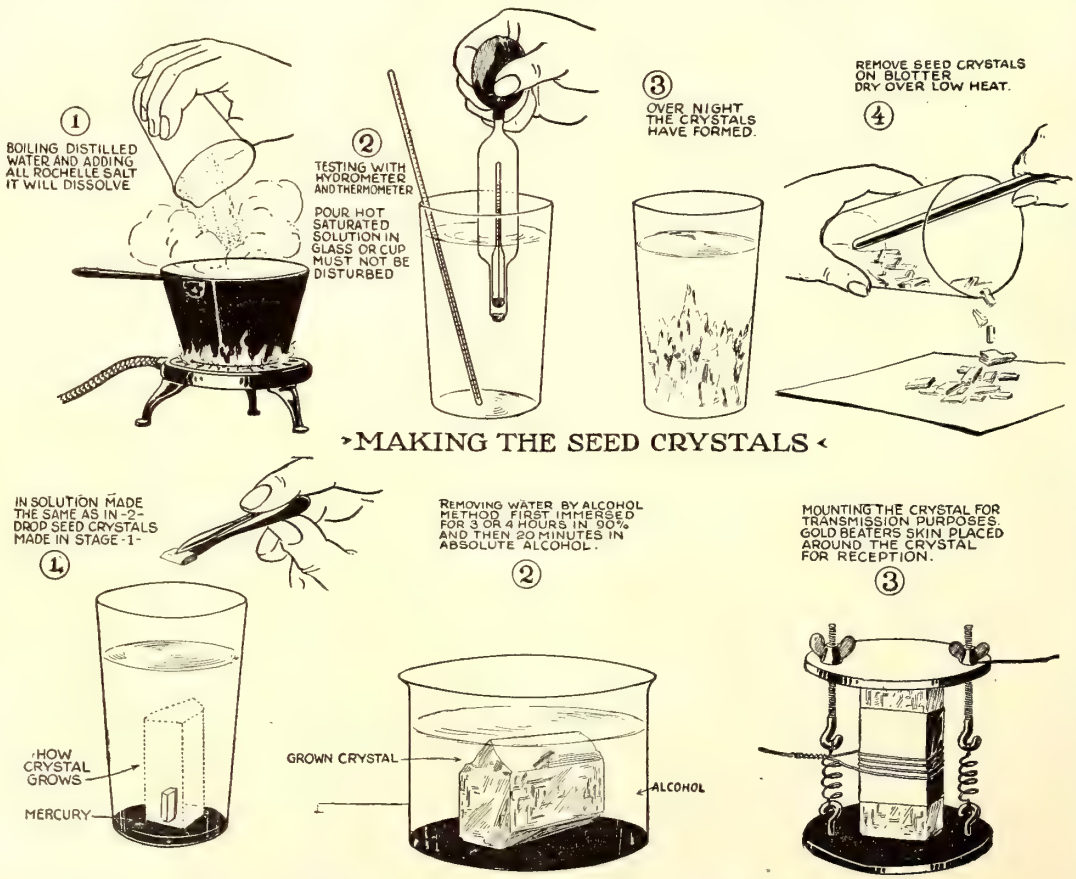
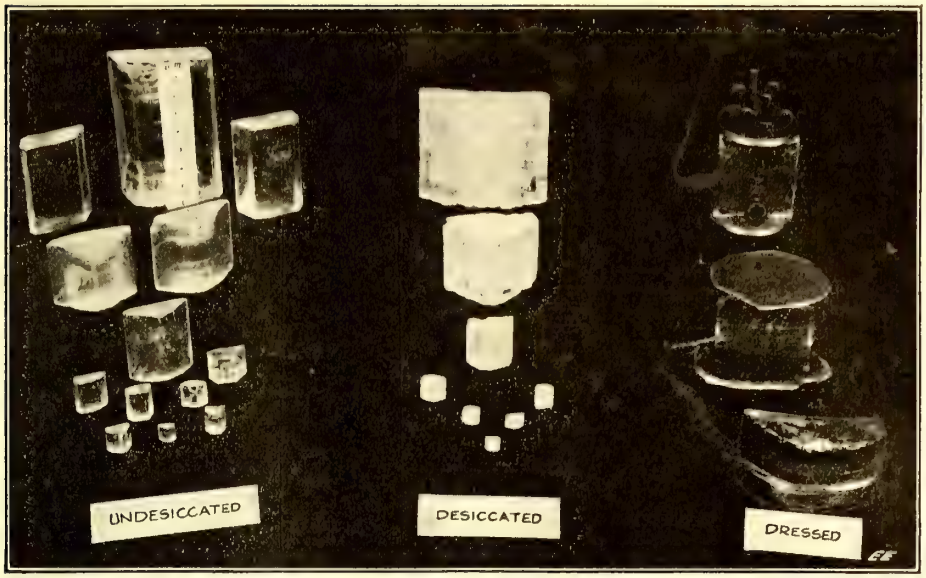
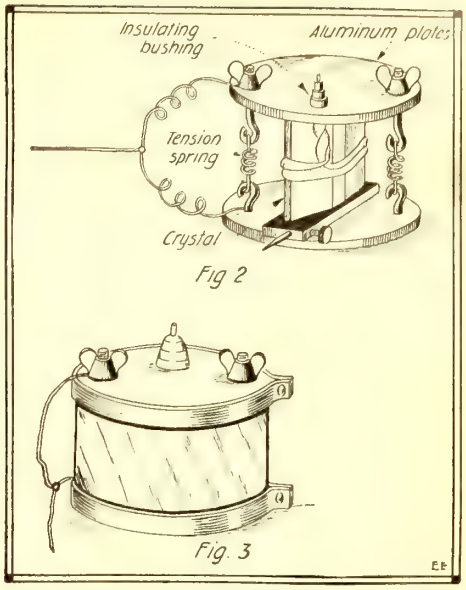


Fig. 1.



Appearance of Rochelle Salt Crystals Made By the Author,—Undesiccated; Desiccated and Finally Dressed, Ready for Mounting in Clamp.



Above:—Crystal as a Phonograph Transmitter. Below:—As a Transmitter or Receiver.

together *form the other pole.* Beeswaxed tinfoils serve as electrodes when applied to the crystal. Since compression greatly improves the piezo-electric effect in these crystals an appliance shown in Fig. 3 called the "spring compressor" may be used. The appliance comprises a pair of aluminium plates connected together with powerful springs. Thumb-screws are provided so as to apply 20 to 40 pounds pressure to the crystal. The compressor forms one pole, preferably the "grounded" pole of the crystal. The other is called the "girdle" pole, because fine wires may be stranded and wrapped around the crystal at its equator, making proper connection with the tinfoil coating there.

The mechanically sensitive regions of the crystal are at the four corners of the "square"—on the ends of the two basal planes. Care should therefore be taken to have the crystal *bear on these corners* in the spring compressors. This is readily accomplished by filing the crystal on its basal planes so as to render it slightly concave on both crystallographic poles.

An ordinary half round file is used, and the top and bottom faces filed in such a manner that the corners are elevated slightly; making them higher than the rest of the face.

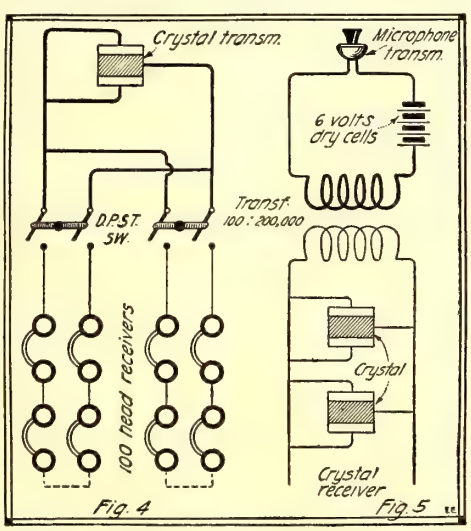
When *compression* is applied to the crystal an electric charge is imparted to its poles—so that the *girdle* electrode becomes plus and the basal planes, together (or the spring compressors) become minus. This electrification will leak away and when the compression is relaxed, the *crystal poles will reverse* the signs of the liberated charges. Great sensitiveness is also obtained if the crystal is subjected to torsion. *A charge of several micro-coulombs and potentials exceeding* 100 *volts may be obtained by twisting the crystal with the fingers.*

The Crystals "Talk".

If, now, we reverse the process and apply electric potentials to the crystal poles, *sounds will be emitted by the crystal due to its relative displacement.* It will be found, if a small mirror be applied with wax to different parts of a crystal and its motions examined by projecting a beam of light reflected by the mirror to a screen, that the principal component of motion is one of *twisting.* The crystal thus "wriggles" under electric stress and *will emit tones in consonance with the potentials applied.*

Several interesting experiments have been performed utilizing one or other or both of the electrical and mechanical effects produced by the piezo-electric crystal. We may first use the crystal as a transmitter or detector of mechanical vibrations or sound. A very convenient application is to the phonograph. A needle may be inserted in a plate attached to one end of the crystal, fig. 2, so that, if held properly over a moving record the needle will transfer torsional movements to the crystal, and corresponding electrical currents will be generated. The alternating potential generated by the crystal under these circumstances may be as large as 10 volts and the resulting current will be several microamperes. In the simplest form of this experiment, electromagnetic receivers of high impedance may be used to detect speech and music from the phonograph. Since the impedance of the crystal at acoustic frequency is about 300,000 ohms, the impedance of the receivers used should be very high—*at least a few thousand ohms.* The crystal itself can operate *several hundred receivers* in series and parallel. See Fig. 4.

Instead of using the phonograph to agitate the crystal transmitter, we can, by adding a diaphragm to the crystal, talk or sing against the diaphragm and thus excite the crystal to about the same degree that obtains with the phonograph record. Thus by singing against the diaphragm near a resonant frequency of the crystal housing, say at a frequency corresponding to "middle C" in music, or 256 cycles per second, *we can generate an alternating current* in the crystal of 20 microamperes and an open-circuit potential of 15 volts. The former may be



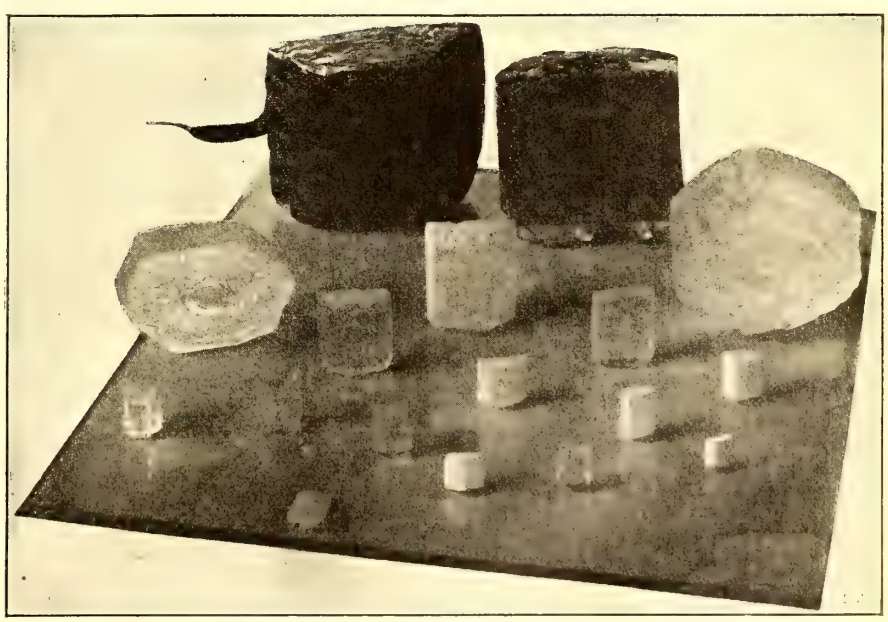
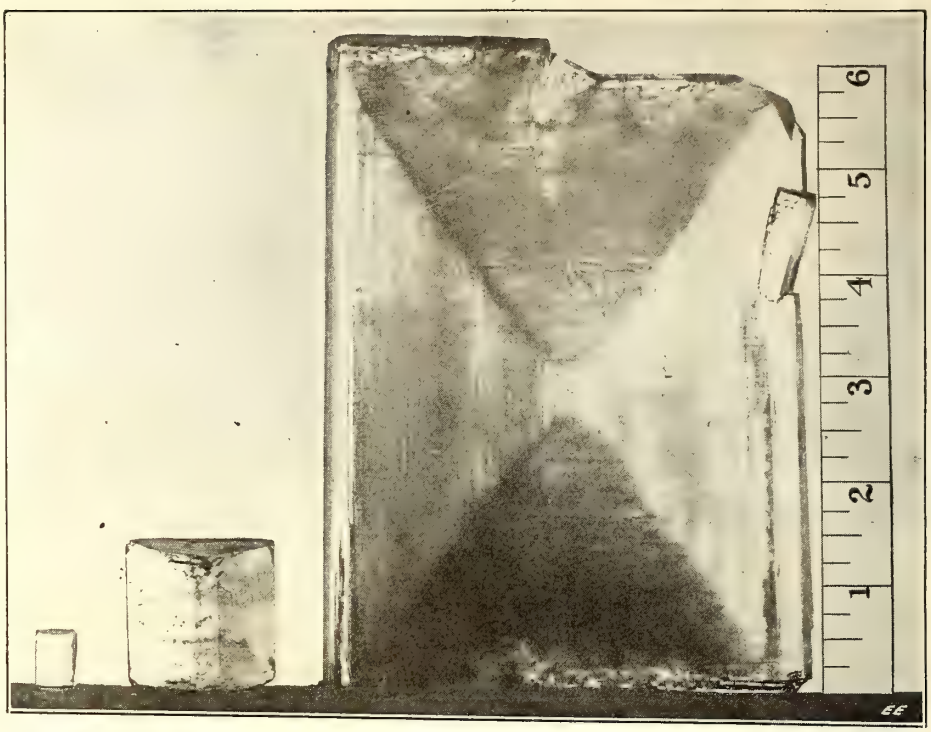


Fig. 4.—Circuit for Connecting Up 100 Telephone Receivers to Rochelle Salt Crystal Transmitter. Fig. 5.—Circuit for Crystal Telephonic Loud-Speaker. Photo at Right Shows Several Varieties of Rochelle Crystals.



Fig. 3-A. How the Dressed and Mounted Rochelle Crystal Appears. The Diaphragm Is of Paper or Goldbeater's Skin Stretched Around the Outside as Shown.



Some Excellent Rochelle Salt Crystals "Grown" by the Author from "Seed Crystals." Some of These Crystals Have Been "Grown" as Large as Two feet and More. The Editors Have "Grown" Some Crystals Several Inches in Length Very Successfully, Following the Author's Instructions.

measured with a transformer, thermocouple and D. C. microampere meter, the latter with an electrostatic voltmeter.

The diaphragm used is rather novel. A strip of gold-beater's skin or even of paper (stiff bond) is wrapped around the spring compressors, holding the crystal, as in the first experiment, and metal bands tighten the strip on each of the two spring compressors. We now have a cylindrical diaphragm surrounding but not touching the crystal—yet conveying stresses to the crystal thru the spring compressors. The diaphragm, in order to be effective, must be corrugated as shown in Figs. 3 and 3A. This is done very readily by twisting the bands holding the diaphragm in opposing senses prior to its stretching and tightening. Usually a separate and removable appliance is used to perform these operations on the diaphragm.

Vibrations, due to sound waves, proceed from the cylindrical diaphragm thru the spring compressors, to the enclosed crystal. The crystal, when it is disturbed by the vibrations, converts these mechanical effects into corresponding electrical charges or currents, which may readily be detected in the receivers placed in the circuit.

Crystal Transforms Electricity into Speech.

But, as shown above, another interesting function of the crystal is that of a *receiver of electrical oscillations*. If we impress an alternating potential on the crystal poles and use the transmitter construction just described, then the crystal, itself vibrating under the electric stresses applied, will impart axial and torsional vibrations to the cylindrical diaphragm. Thus, corresponding acoustic effects will be produced which *may be heard considerable distances away from the crystal receiver.*

This experiment, using the crystal as a receiver, may be performed in different ways. Most simply, a carbon microphone may be applied as transmitter. This is shown in Fig. 5 with a local battery and high ratio transformer, which matches fairly well the low impedance of the local microphone circuit with that of the high impedance crystal. In this arrangement *the crystal operates as a "loud speaking" telephone* and may be heard several hundred feet away.

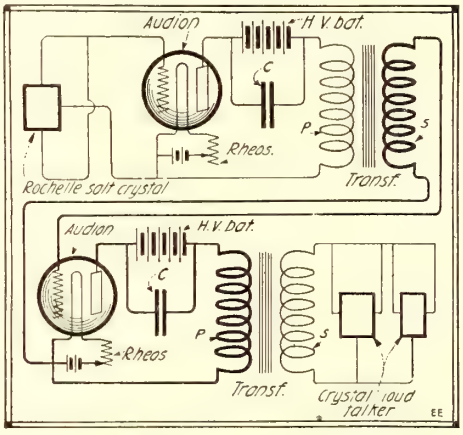


Fig. 6. Circuits for Connecting Speaking Crystal, Vacuum Tube Amplifier and a Second Crystal as a "Loud-Talker."

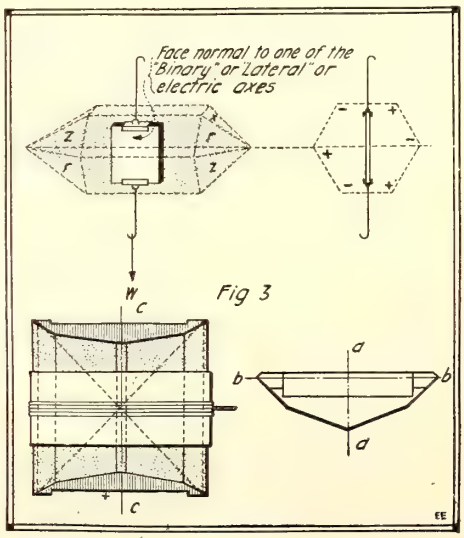


Fig. 7. Above:—Stress Applied to Quartz Crystal at "W" Produces Electric Current of Polarity Indicated. Rochelle Salt Crystals Act Similarly. Below:—Dressing of Crystals for the Girdle Orientation.

Another experiment is the use of crystals at both ends of a line. In order to increase the detecting and emitting effects of the piezo-electric crystal, the vacuum tube amplifier may be used. Fig. 6 shows a crystal transmitter, a crystal receiver, and an intervening two-stage vacuum tube repeater or relay. Speech and phonograph effects applied to the transmitter may be heard proceeding from the crystal receiver, with sufficient volume to fill a large auditorium. Under these conditions, if the crystal receiver is placed nearer than a few yards from the crystal transmitter, the receiver will *sing* to the transmitter. This well-known phenomenon in ordinary telephony is known as "howling" and is due, of course, to the presence of local free energy, of battery or amplifier, which will maintain circulatory oscillations of the acoustic and electrical effects.

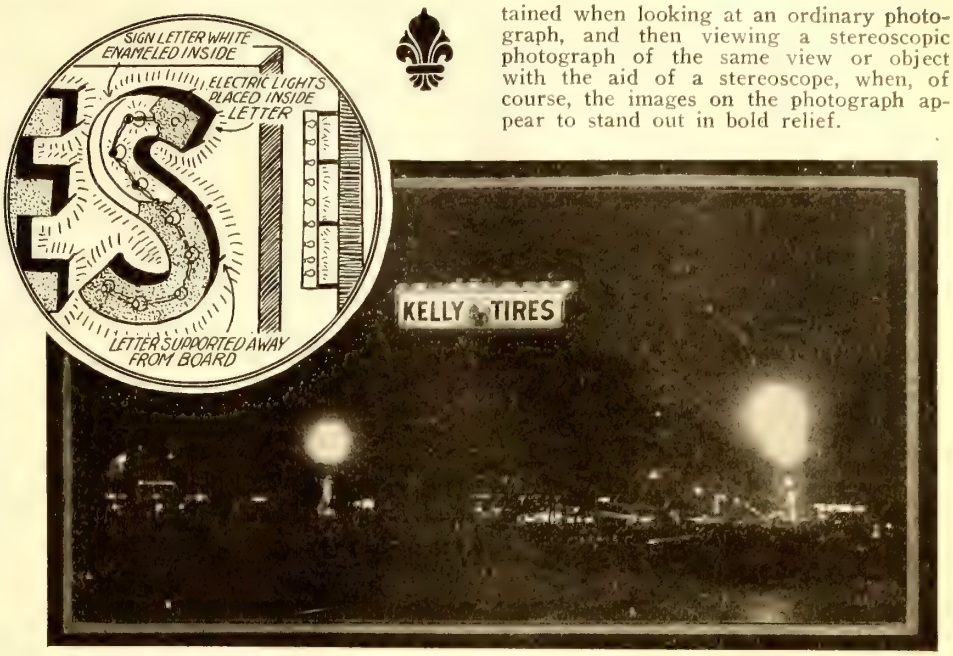
At present the efficiency of these crystals, as defined by the ratio of the *output* to the *input*, is not high. This is principally because of the difficulty of associating a perfect *housing* with the crystal. The housing, is, of course, necessary in order to translate vibrations to or from the crystal. The efficiency becomes greater only when the frequency of the applied vibrations is close to that of the natural frequency of the combined crystal and its housing. Hence the comparatively large values of the alternating currents and potentials generated by the crystal when it is operated near any of its resonant frequencies—for, it may have several modes of vibration.

Some day it may be possible to pick up a pebble from the beach, place it to the ear and listen to voices spoken to another pebble found on some other shore.

[*As transmitters and loud-talkers, these crystals produce remarkable results and the amateur will be well repaid by his results, provided he follows the instructions given in this paper. As detectors for wireless telegraphy, however, they are practically valueless, if used in the regular way. Perhaps some amateur may some day hit upon a scheme which will produce the much-looked-for perfect crystal.*—EDITOR.]

Electric Sign With Indirect Lighting

The accompanying illustration of an electric sign, and which is mounted on the north side of 73rd Street and Broadway, New York City, involves a new departure of electrical advertising displays of this type. Instead of outlining the forms of the letters on the sign with electric light bulbs or illuminating the entire sign by indirect or flood lighting, reflected on to it from long reflectors placed at the sides and at the top, as is quite common practice, the letters themselves in this new sign form



One of the Newest Wrinkles in Electric Sign Design Is That Here Shown. The Letters Stand Out in Black Relief Owing to the Arrangement of the Lamps, Which Are Placed in Back of the Hollow Letters, as Illustrated in the Sectional View.

the reflecting troughs, in which the lamp bulbs are mounted. The inside surfaces of the hollow letters are painted white so as to serve as reflectors. The lights are supported at a short distance from the sign itself by means of iron rods as shown in the detail illustration herewith. In this way the letters seem to stand out in relief on the face of the signboard, and give a very pleasing and mysterious appearance indeed. The effect is much the same as that obtained when looking at an ordinary photograph, and then viewing a stereoscopic photograph of the same view or object with the aid of a stereoscope, when, of course, the images on the photograph appear to stand out in bold relief.

Aviators Instructed on Electric Chart

Many ingenious devices as well as mov- g pictures and electrical chart boards, and pecially illuminated maps, were devised id employed in training American aviators



Clever Electric Chart Board for Instructing Aviators in Firing at Enemy Planes. After the Dummy Machine Gun Has Been Sighted, the Lights Are Flashed On and the Gun Is Checked With Them.

ıring the World War. Some of these ndered such excellent service and gave so ıch promise that they have been retained d improved upon for utilization in the regular aviation training schools of the Army and Navy Departments. One of the most difficult things which the military or naval aviator has to learn is to shoot accurately while flying in the air. To the layman this may sound quite simple, but it is far from being such, and the experts who train aviators for this duty know it.

One of the methods used for instructing the soldier aviators in which electricity played its part is here presented. The bright spots indicate the positions of small incandescent lamps behind the screen on which the airplanes appear in various flying attitudes. These were all flashed on for the picture, but ordinarily are not visible. Aiming and firing practice is accomplished by sighting a dummy machine gun at the position ahead of the plane, so that the time of travel of the bullet will be the same as that of the plane, and therefore it will reach a vital spot. After the sighting is completed, the lights are flashed on and the gun setting is checked by them. The three spots indicate the correct setting of the gun for various plane speeds of 75, 100 and 125 miles per hour.

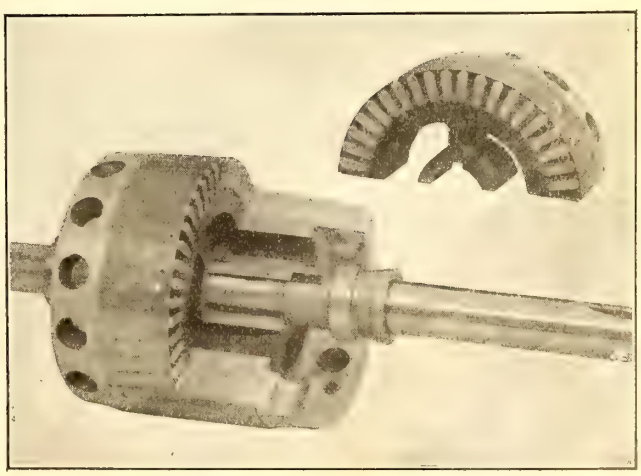
"Casting" Motor Windings

A new type of rotor with cast winding, ıich has been recently designed by one the leading electrical concerns, presents w features and improvements worthy of tice.

The bars and short-circuiting rings com- sing the windings employ the same mate- l and are cast in a single operation. With windings thus made a solid unit, rigidity, rability and better balance is produced. ıe cast winding from an electrical point view also insures uniform cross section d union between the bars and the end ıgs. This has become a factor in elimi- ting operating difficulties due to open- cuiting of joints between bars and end ngs.

Holes bored radially thru the cast end ings give effective ventilation for rotation ı either direction.

The new cast winding rotor is said to ɔe especially effective on induction motors of the *Squirrel Cage type*. The illustration shows a sectional view of the cast rotor.



The American Electrical Manufacturer Is Always Intent Upon Producing Machinery in Large Quantities and One of the Latest Departures in This Direction Is in the Form of a "Cast" Motor Winding. This Particular Cast Motor Winding Is a Squirrel-Cage Rotor for an Alternating Current Induction Motor. Not Only Is This Idea Mechanically Advantageous, but It Is Also Said to be Very Superior in the Electric Efficiency Achieved.

Each year sees more and more the mechanical manufacture of such parts of machinery as this.

Beauty by the Kilowatt



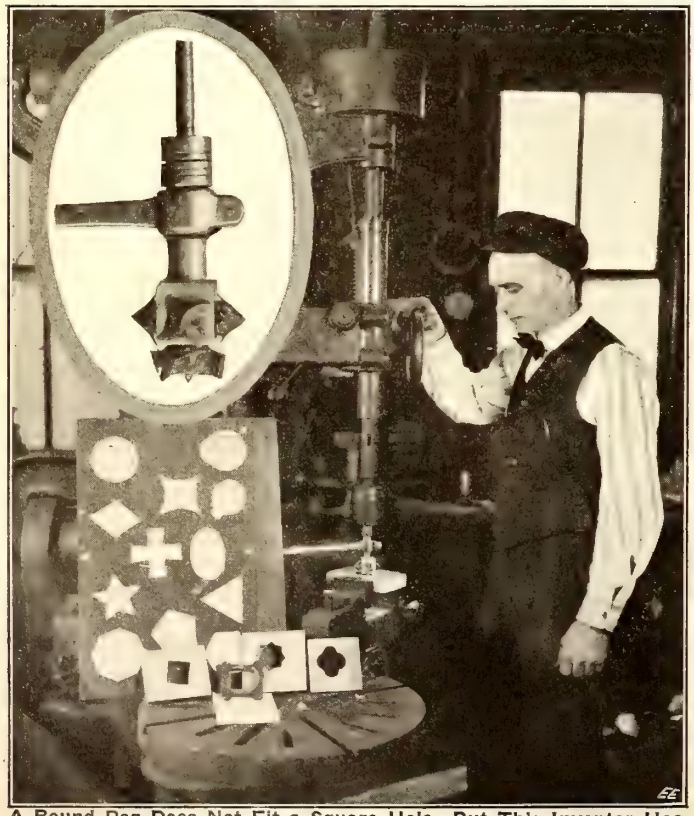
London, England, Has Started on a New Road to Fame—Making Women Beautiful by Electric Tattooing! A Permanent "Peaches and Cream" Complexion Is Yours, Gwendolyn, for Six Bits.

We have always been under the impression that the English women were blest with one of the finest complexions in the world, but here comes a cable from London telling of the popularity accorded to a new fad in the English city—that of electrically tattooing a permanent complexion or blush on the face. The report goes on to say that the pallid and sallow faces of London women are being permanently brightened and given a rosy tint by expert tattooists, whose electric needle applications can be graduated to suit any physiognomy, and further, that the tattooists report they have never done such a thriving and profitable business among women as now.

Howsomever, and be that as it may, our artist has depicted in the accompanying illustration one of London's fair damsels receiving the electric tattooing treatment for a permanent rosy complexion. Such an outfit comprises an electric tattooing needle operated from a battery and supplied with current thru a flexible wire, while a small rubber tube leads thru the needle proper to whichever complexion is selected by the customer. In some of these tattooing needles the coloring pigment is contained in a small hollow chamber on the base of the needle itself. We presume this fad will cross the ocean and become a new art on Broadway—the lane of many brilliant accomplishments, the least of which is Beauty.

Drill Bores Square Hole

Did you ever have a dream of a drill that would bore a square hole? All of us have at one time or another, perhaps. An auger *to bore square holes* has at last been invented by Carl H. Schmidgall of Peoria, Ill. The simple tool works its way by rotary motion thru wood, iron or stone. It is really five augers in one—four little conical rotary cutters milling out the corners of the square after the main shaft has bored a round hole. Drilling a square hole thru a one-inch piece of marble by present methods takes four hours or more of careful work by a skilled man. The new invention does it in five minutes. There are only a dozen parts in the machine, and, according to experts, it can be manufactured at a comparatively low price. A simple variation in the shape of the cutters makes possible the boring of holes of many different shapes.



A Round Peg Does Not Fit a Square Hole—But This Inventor Has a Circular Drill That Bores a Square Hole.

Mr. Schmidgall has been working on his invention since he was twelve years old. He is now twenty-nine, and operates the biggest hand-made tool shop in Illinois, outside of Chicago. Master mechanics from all parts of the United States have recently visited his shop to look at the square hole auger.

HANDLESS, HE USES TELEPHONE.

In the latest bulletin as issued by the American Red Cross we come upon the remarkable story of a man whose arms were amputated midway between the elbows and wrists. The best way to tell his story perhaps would be to quote directly what this man has done and is doing:

"At the time of the accident the oscalcis was removed from my left heel with tendon of Achilles. A brace made of steel, leather, and felt is a substitute for the tendon of Achilles, and with it I can walk several miles every day with ease. I frequently walk five miles just for the joy of walking.

"I have the following implements, each of which has a fitting that is an exact duplicate of the butt ends of the hooks. These hooks and the implements fasten into the wrist plates of the artificial arms with a spring catch, so that I can release either or both hooks and insert the other implements at will:—Knife, fork, and spoon for eating; hair brushes; tooth brush; whisk broom and hat brush; blacking brush for shoes; Gillette razor and lather brush; tooth-pick; fountain pen; match-holder; telephone-holder.



Without Hands—He Uses Telephone. A Striking Example of the "Reconstruction" Work on Crippled Soldiers Being Performed by the Red Cross Hospital Experts. Soldiers Without Arms or Minus Perhaps One or Both Legs, Are Being Trained to Do Most Everything Any Normal Man Can Do. They Are Taught Clerical Work, Drafting, Painting, and Many Other Arts and Trades.

"On the dressing table in my bedroom, I keep a pair of extra long hooks with which I put on and take off collar and necktie. The remainder of dressing and undressing is not with the standard hooks which are not long enough to reach collar button at throat. I button the collar at back of neck before I put the shirt on. I dress in about twenty minutes and undress in about half that time. Shaving takes from twenty-five to thirty minutes, depending on condition of razor. I do this entirely alone, washing and drying face afterward, taking the razor apart and drying it and changing razor blades when they are dull. Brushing hair and clothes, attending to teeth, and shining shoes are simple matters.

"I meet with little difficulty in telephoning, or the ordinary routine of desk work. Have been receiving good living wages for more than twelve years.

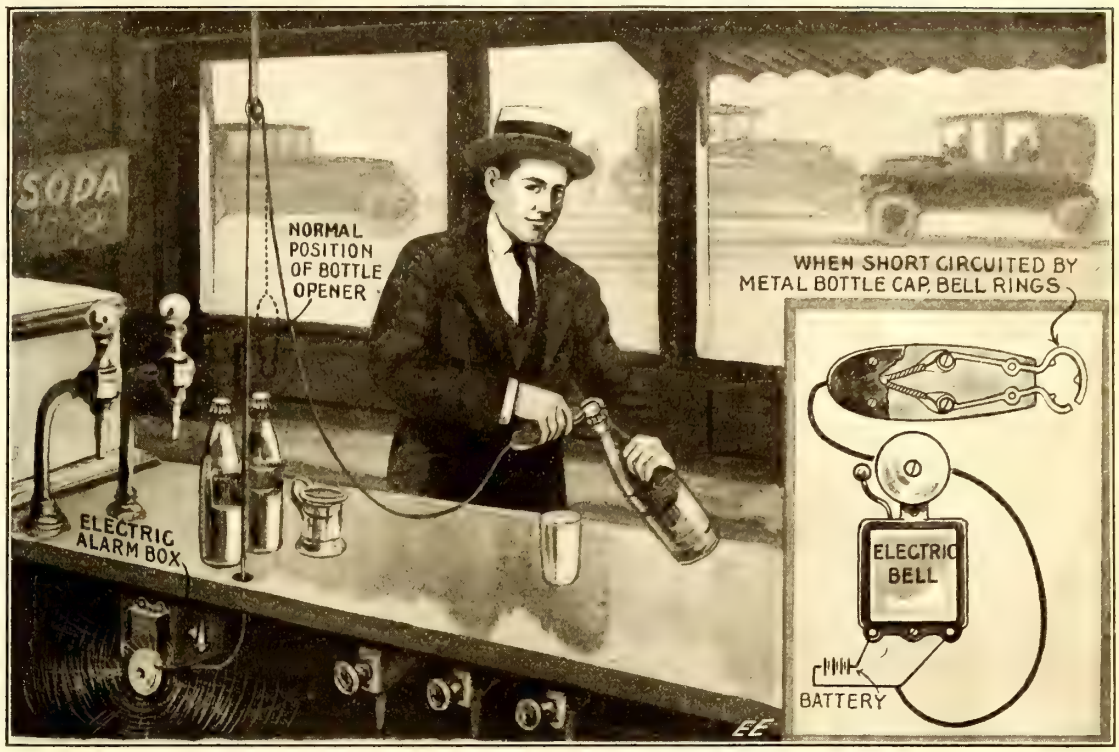
"About four years after my accident, I married one of the several nurses that helped care for me in the hospital. We have four children."

Thus the great work goes on—every day sees new and more remarkable developments in helping the lame to walk and the sick to get well.

Soda Water Bottle Alarm

The thousands of owners of small soda water stands all over the country annually lose hundreds of dollars due to people helping themselves to the various drinks when the proprietor is conveniently absent. To mitigate this loss to the owners of soda water stands the inventor, Mr. Charles F. Scarborough, has brought out a clever, electric alarm which is combined with a bottle-cap opener in the manner here shown.

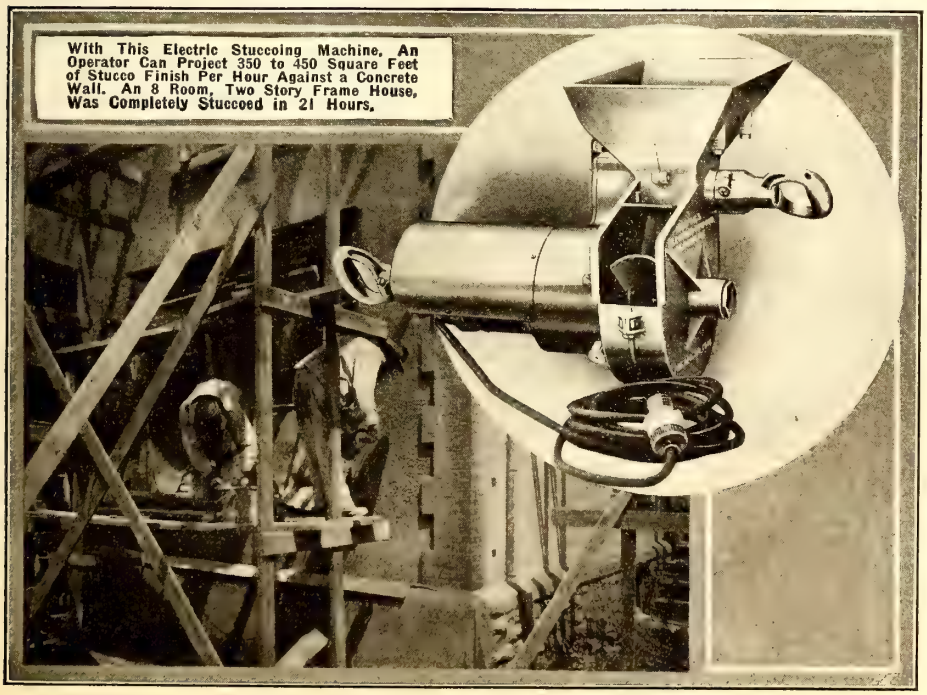
The alarm apparatus comprises a dry cell battery and bell mounted in small box, which can be placed out of sight so far as the customers are concerned. A flexible duplex wire or cable leads from the alarm box to the bottle-cap removing device. This cap remover comprises two distinct and thoroly insulated metallic rings which are connected to the bell circuit. If the circuit is closed as would be caused by a piece of metal coming in contact with the two metal fingers of the cap remover, then it will sound the alarm. Such soda bottles are usually opened up by a regular cap-remover and to make sure that the person desirous of stealing a drink, will use the electrified bottle opener, this is placed in as conspicuous a position as possible as the illustration shows. He grabs the cap remover, and the minute that it is placed in contact with the metal cap of the bottle, the circuit is closed—the bell rings, thus notifying the proprietor that he has "customers".



An Electric Soda Water Bottle Alarm, Which Has Recently Been Patented. It Comprises Two Electric Contacts Fitted in an Insulating Handle, Which, When Short-Circuited by the Metal Cap on the Soda Bottle, Will Cause the Bell to Ring.

Stuccoing Houses by Electricity

A recent house-finishing development is a motor-driven stucco machine by which the material is applied by projecting it from the machine by centrifugal force set up by revolving spider blades. The manufacturers of this device state that by applying the stucco in this manner, a skin, or enamel, is formed, making an outside coating which is impervious to moisture. As an instance of the speed at which the machine works it is said that an operator with a helper to supply the material can project 350 square feet an hour against hollow tile, brickwork or concrete blocks, and a trifle less against such material as metal or wood lath. The equipment is light in weight, aluminum castings being used for the frame and tool steel for the revolving spider blades and automatic feed. The weight of the motor, therefore, represents the greater part of the total weight of the machine. An auxiliary hopper is provided by which pebbles, crushed granite and similar materials can be effectively thrown into the stucco base.



With This Electric Stuccoing Machine, An Operator Can Project 350 to 450 Square Feet of Stucco Finish Per Hour Against a Concrete Wall. An 8 Room, Two Story Frame House, Was Completely Stuccoed in 21 Hours.

All of the work on an eight-room, two-story frame residence, including piazza posts, was accomplished with one machine, and the actual running time of the machine in completing the entire contract was just 21 hours. The lapsiding was not removed, but is covered with a saturated felt paper, against which was nailed the metal lath and the stucco then applied. The metal lath was completely imbedded within a projected depth of 5/8", and after being roughly floated, the white stucco finish effect was projected with the machine.

The following will be found a conservative average estimate of stucco projected by this clever machine.

Against a poured concrete base, a coat of stucco from 1/4" to 3/8", an operator should project 350 to 400 square feet per hour; against unpainted brick, hollow tile, concrete blocks, and like materials or construction from 300 to 350 square feet per hour; against Bishopric Board and like wood, lath backing, in filling up the keys and projecting as above, 300 to 350 square feet per hour; against Gypsum Plaster Board and other like materials from 400 to 450 square feet per hour.

Against Metal Lath furred out 1/4" with a backing of building or tar paper applied to a sheeted surface or studding, 350 to 450 square feet per hour.

Popular Astronomy

By ISABEL M. LEWIS, M.A.
Of the United States Naval Observatory

IS THE MOON A DEAD WORLD?



Photograph of the Moon Taken with the 60-Inch Reflecting Telescope of the Mt. Wilson Observatory Showing Regions of Albategnius and Hipparchus. This Photograph of the Moon Shows All the Varieties of Walled-Plains, Ring-Plains and Craters as Well as a Number of Conspicuous Clefts and Rills. Almost Exactly at the Center Is the Walled-Plain Albategnius, 65 Miles Wide, and Adjoining It on the North Is the Walled-Plain Hipparchus Nearly 100 Miles Wide. This Is One of Many Walled-Plains That Clearly Show Signs of Wreck and Ruin. Note the Superimposed Craters of a Later Origin. Just to the Northeast of Albategnius Is the Great Walled-Plain Ptolemaeus, 115 Miles Wide. In Its Interior to the Northwest Is a Very Conspicuous Little Crater 4 Miles in Diameter. Almost Due North of Ptolemaeus Is the Typical Ring-Plain Herschel, with a Rampart Rising Nearly 10,000 Feet Above a Dusky Floor From Which Rises a Central Mountain Peak. The Rampart Is Symmetrically Terraced Both Within and Without. To the Northwest of This Ring-Plain Is a Deep Lunar Valley About 80 Miles Long and in Places 10 Miles Wide. South From Ptolemaeus Extends a Long Chain of Great Walled-Plains Reaching to the Southern Border of the Photograph. Near the Western Border Which Marks the Terminator Appear Ring-Plains and Craters in the Greatest Profusion and the Harsh, Black Lunar Shadows Are Very Conspicuous. The Distinction Between Walled-Plains, Ring-Plains and Craters Becomes Clear From a Careful Study of This Photograph.

SUSPICIONS that changes are continually taking place in certain surface markings of the moon have been held for many years and as the face of our nearest neighbor and satellite is scanned more carefully from year to year with telescopes of high power these suspicions are being confirmed, rather than disproved, by many diligent and careful observers.

It has been estimated that at an elevation of about one mile above the surface of the moon the density of its atmosphere is only one ten-thousandth that of our own atmosphere at an equal elevation. It is, therefore, impossible for water to exist in the liquid form on the moon at moderate elevations, tho it may exist in the form of water vapor, hoarfrost or snow.

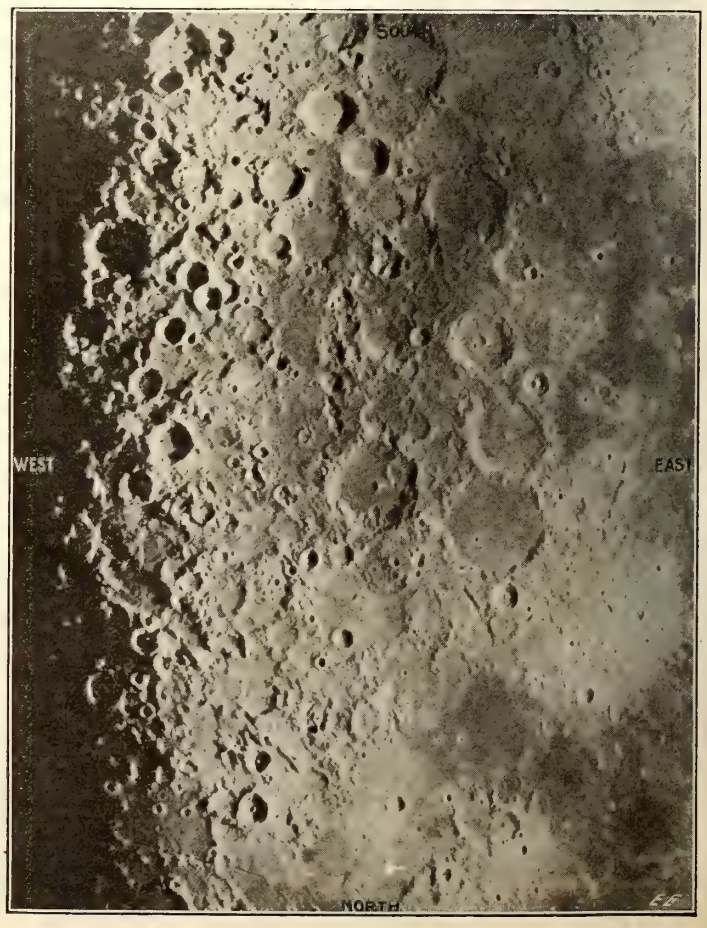
Comparatively recent researches of Very indicate that the highest temperature to which the surface of the moon is heated in the middle of the long lunar day, equal to fourteen of our own days in length, is probably about 200° F. During the long lunar night the heat rapidly escapes owing to the extreme rarity of the lunar atmosphere and within a few hours the temperature probably drops far below zero and at the lunar midnight may approach closely to the absolute zero of interplanetary space or —473° F.

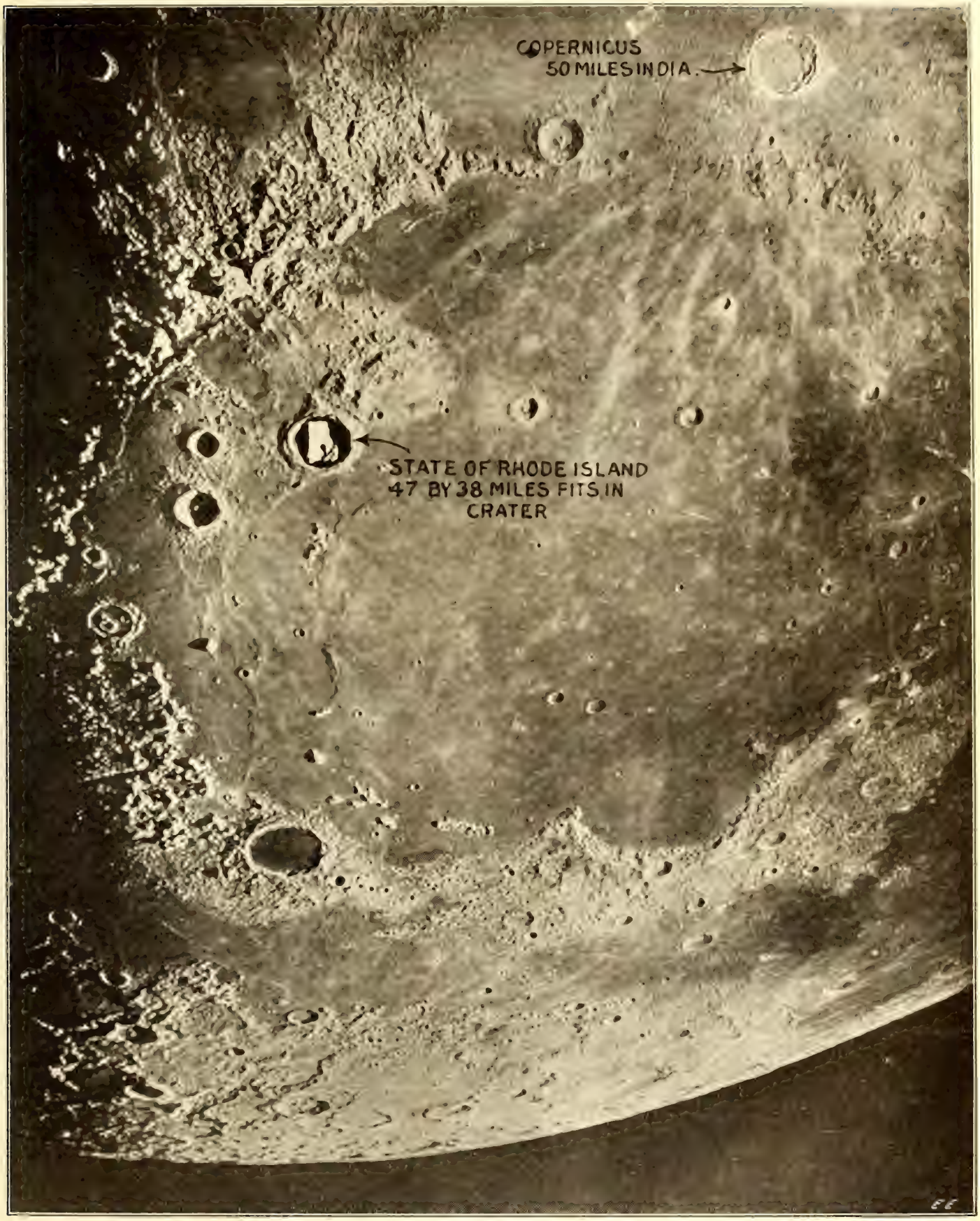
If there were no other causes to produce changes in the lunar surface markings, it might be expected that these great extremes of heat and cold alternating periodically would register their effect upon the face of our satellite.

The evidence of change in the appearance of lunar features, aside from the expected and periodic changes due to variations in the lunar phase and altitude of the sun, which are of course not changes in the markings themselves, is to be found chiefly in connection with the more minute markings such as the crater-cones and

(*Continued on page* 820)

An Enlarged View of the Moon Taken by Ritchey With the 40-Inch Yerkes Refractor Showing Ray System of the Ring Plan Tycho (to the South), and of Copernicus. One of the Most Conspicuous and Magnificent of all Lunar Features (to the Northeast, Near the Lower Rim of the Photo). The Dazzling Whiteness of the Southwest Quadrant of the Moon Contrasts Sharply With the Dark and Comparatively Smooth Maria or Seas to the North and East. The Nearly Enclosed Sea, Mare Humorum, is Shown Near the Center of the Eastern Rim of the Photo. Its Area is Approximately 50,000 Square Miles. The Walled Plain Gassendi, on its Borders, 55 Miles in Diameter, is One of the Most Beautiful Telescopic Objects on the Lunar Surface. A Lunar Mountain Range, the Riphaean Mountains, is Shown a Little to the Northwest of the Mare Humorum. The Highest Peak is About 3,000 Feet Above the Surrounding Region, Which is a Very Moderate Lunar Elevation. This is One of the Least Important Lunar Mountain Ranges. Close to This Mountain Range is the Little Crater Euclides, 7 Miles in Diameter, One of the Most Brilliant Objects on the Lunar Surface; the Region Surrounding the Crater is Equally Brilliant. The Ray Systems of Tycho and Copernicus are the Most Consnicuous of These Peculiar Markings Which are Found Associated With a Number of Other Lunar Craters. According to Prof. W. H. Pickering, Who Has Very Carefully Observed Them Under Excellent Observing Conditions, the Rays of Tycho do not Come From the Center of the Crater, But Originate in a Number of Minute Craters That Lie on the Outer Rim; While the Rays of Copernicus Originate in Craterlets Lying on the Inner Slopes of the Ramparts, Ascend to the Summit and then Spread Out Over the Surrounding Mare in Feathery Streaks.

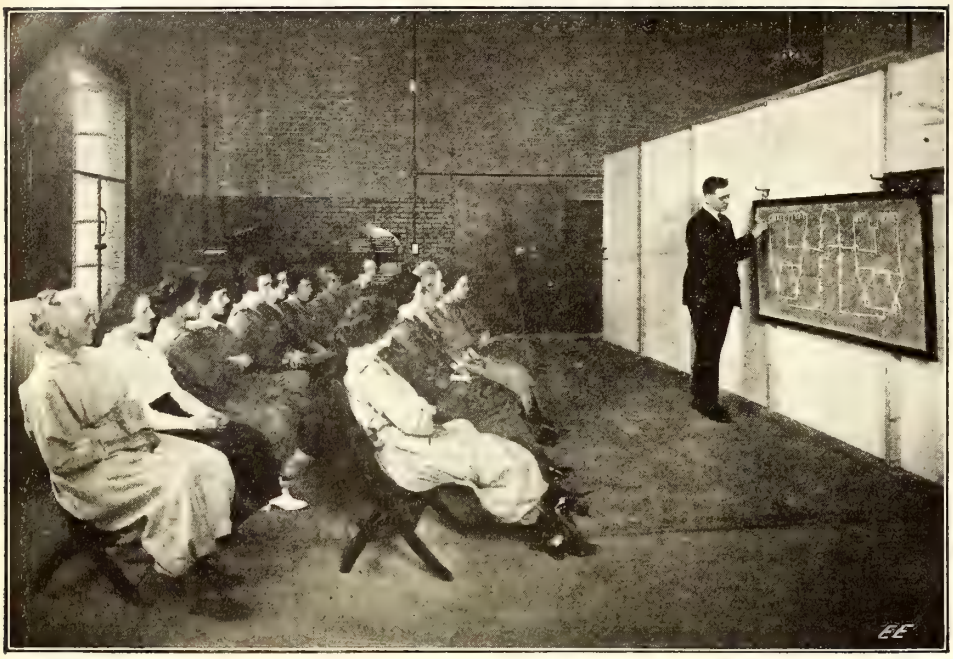




Wide World Photos

The World's Great Satellite at Closer Range Than Ever Before Seen by the Eyes of Man Was Made by the New Hooker Telescope of Mount Wilson Observatory of the Carnegie Institution of Washington, Just Installed, and Was the First Taken After the Telescope Went Into Commission. The Picture in Detail and Definition Is Superior to Any Hitherto Made. The Mirror of the Telescope, the Largest Yet Constructed, Is 100 Inches in Diameter. The Scale of the Illustration Is About One Hundred Miles to the Inch, or a Little Less Than Eight Feet to the Moon's Diameter. The Mountains Above and to the Left Are the Lunar Apennines; Those on the Left Below the Centre Are the Alps. Both Ranges Include Many Peaks From 15,000 to 20,000 Feet in Height. The Ring-like Formations Are the So-Called Craters, Most of Them Far Larger Than Anything Similar on the Earth. In the Upper Right Corner Is Copernicus, About Fifty Miles in Diameter. The Largest of the Conspicuous Group of Three Just Below the Apennines Is Archimedes, and at the Lower End of the Alps Is Plato. Attention Is Called to the Long Sunset Shadows Cast by the Isolated Peaks on the Left, and the Shadows Cast Within the Craters by the Crater Shells Can be Plainly Seen. The Central Portion of the Picture Is a Vast Plain, the Mare Imbrium.

Training Women Sub-Station Operators



Sister and Auntie Go to the Electric School—It Happened in Boston—and Learn All About Dynamos and Motors, and How to "Parallel" Alternators; What a Synchronous Motor Is; What to Do When a Circuit-Breaker "Opens"; Yes, They Learned Easily, Says Their Instructor.

The accompanying illustration shows women substation operators being trained at one of the power stations of the Edison Electric Illuminating Company of Boston. We do not usually associate electrical diagrams, circuit breakers, dynamos and storage batteries with women operators, possibly because we are not used to them, and being used to anything is mostly nothing more nor less than a habit. As we become used to these newer adventures of the fair sex in the electrical and mechanical branches of applied science, we shall, after a while, think nothing of it. Women substation operators have served faithfully and well in many power stations in England during the war, and undoubtedly will continue to serve in these capacities. It is a common practice both in this country and abroad for all women operators running power houses and substations to wear modified overall suits, so as to eliminate the danger of loose clothing being caught in any moving machinery. We know that women's minds are very subtle and quick to respond, and moreover they are eager and quick to learn, in any trade or art which they may set their minds on. We therefore presume that the serious-faced students of electric power house matters shown in the accompanying photo have graduated into full-fledged switchboard and dynamo operating experts.

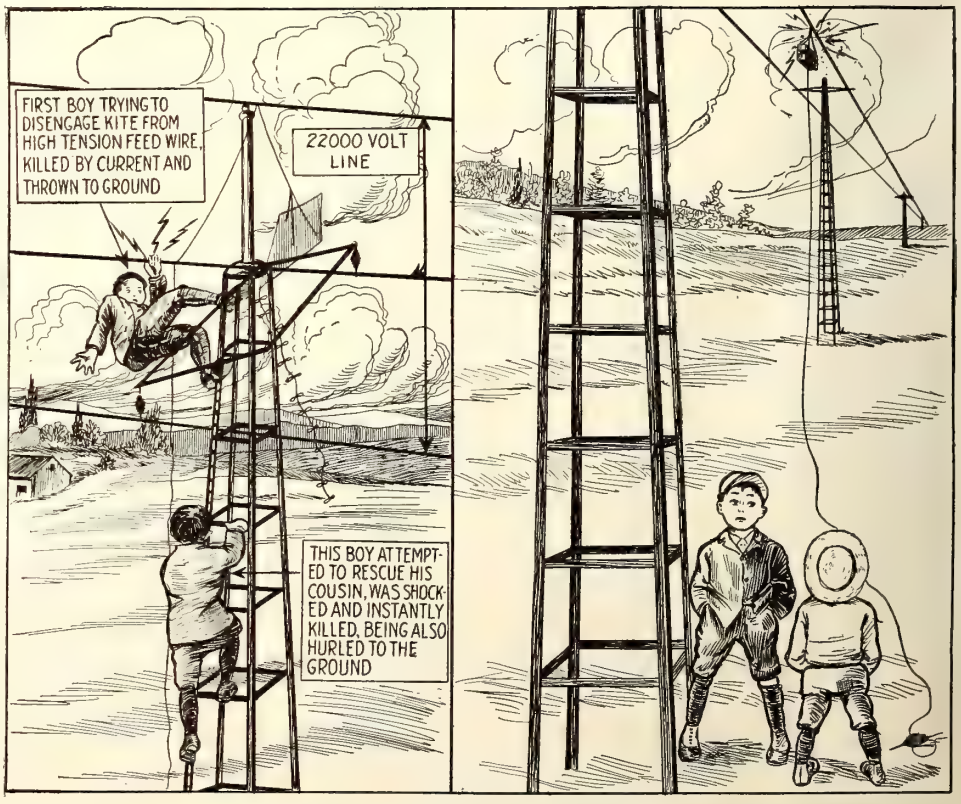
Ye scribe, having spent several long and patient years in power houses, pauses to philosophize on the mental equilibrium of the lady switchboard operators and dynamo tenders at the psychological moment when about steen thousand amperes charge over the line on a "dead short," and "blows" the breakers and perhaps the dynamos, too, with a roar like a young Niagara and flashes of fire like Pain's fireworks on the Fourth of July at Brighton Beach. And that is not all, for when a large steam main goes blooey and starts spitting out several hundred cubic feet of super-heated steam per second into the power room, they will think the end of the world has surely come; as the station fills up with steam accompanied by a deafening, seething roar as the steam escapes. But probably they will get used to these things the same as the male operators, and after one good initiation or so, never mind such little things as a 500 per cent overload short-circuit on the main generator bus-bars. We said "probably." But who can tell?

Two Kite Fliers Killed by Live Wire

Two boys came to their death recently at Winsted, Conn., as a result of contact with a high tension electric wire carrying 22,000 volts. Edward Isaacson, Jr., 13 years old, and his cousin, Walter Lindblad, also 13, were flying a kite on the elder Isaacson's farm when the kite caught in the electric wires atop a 50-foot steel tower.

The boys tried to disengage the kite and failing climbed the tower. Young Isaacson touched one of the wires carrying the heavy voltage and was thrown across the feed wire, dying instantly. Lindblad tried to assist his cousin but the current coursed thro his body and hurled him to the ground, where he was picked up dead.

The accompanying illustration shows how the current past thru the victim's body to earth. On such high tension lines all you have to do to get electrocuted is to touch one "live" wire; there is always a cross current or leak current somewhere which will complete the circuit as soon as this act has taken place. It is not safe to touch one rubber covered wire of a 2,500-volt feed circuit, let alone a 22,000-volt line. The electric chair requires only 1,800 to 2,200 volts to electrocute a man, and if you bear in mind that people have been electrocuted by touching a circuit carrying as low as 110 volts, then you will be extremely careful about touching any wires. If you are not the electrician who is *familiar* (understand that word) with the wire or pole in question, **leave it alone!** It may spell death. Electricians included.



How Many Volts Kill? Sometimes 110 Volts Will Kill; 500 Volts (Trolley Lines) Liable to "Jar" You to a Fall; 1,000 Volts—DANGEROUS! 1,500-2,000 Volts—FATAL. (1,800-2,200 Volts Used in the "Electric Chair".

Don't Fly Kites Over High Tension or Other Electric Wires. If the String Drops on the Wires, Even if Dry, You May Be Severely Shocked or Killed. Don't Touch the String—Leave It Alone.

The Amateur Magician

By JOSEPH H. KRAUS, Jr.

THE MAGIC BELL.

PROFESSOR HARGRAVE was known to all magicians as the originator of many ingenious tricks and sleight-of-hand passes and consequently aroused a feeling of considerable jealousy among others in the same field of work which he himself was engaged in. When, however, he made arrangements to publish broadcast those of his more spectacular tricks, the Magicians' Council, an order of the "Black Art," as that science is known, attempted to stop him, but their efforts were fruitless.

By special courtesy this publication has secured his consent for placing some of his works before the public in such a way that the lay readers who are the least handy with tools can construct apparatus to duplicate his marvelous feats. With this end in view not only the "gift of gab," or magicians' "patter," as it is sometimes called, is given, but also the constructional data are given. Let us attend one of Prof. Hargrave's performances.

"Good-morning, ladies and gentlemen," ventured Professor Hargrave, as he stept onto the stage in a recent performance at one of our largest theatres, "Evening, did you say?" he continued, "Oh, yes, to be sure it is, how absentminded I am. Well, what shall be your pleasure? This?" as he pointed to a beautiful bell hanging on a highly polished stand. "Very well."

Suiting his action to the words he reached for a pack of cards on one of the small tables and proceeded off the stage. Having had the audience select three cards,



The "Mystery Bell"—The Magician Shows That the Bell as Well as the Hook Upon Which It Normally Hangs, Including the Stand Separating the Bell, Are All Separate and Independent Pieces, Having No Strings or Electric Wires Attached to Them; Yet When the Bell Is Replaced on the Stand and Combined With the Stand Support, It Taps Out the Answers to Various Questions Asked by the Audience. It's Easy When You Know How!!!



View of the Glass Bell, Which Can be Made From an Ordinary Chandelier Shade.

he stept back to the stage again. Carrying the bell forward in full view of the audience and placing the stand right down front, he exclaimed:

"Now, friends, I don't want to deceive you." He removed the hook from the rest of the stand; passing the hook to the public on one side of the stage and the bell down the other.

"Now examine those two articles carefully and note that there are no strings to deceive you; that hook is genuine silver. I bought it myself at Woolworth's jewelry counter, an emblem of the first thing I got when I appeared upon the stage some years ago from the enthusiastic manager." (To wit—the hook!)

By this time the bell had come back and Professor Hargrave continued: "The bell answers by ringing twice for *yes* and once for *no*." Then placing the hook into its position in the remainder of the stand, and resting the bell on its hook, he added: "Don't you, bell?" to the beautiful object of glass and metal.

The bell pealed forth two melodious sounds.

"Well, bell, suppose you tell me the number of spots which were on the first card I gave out? Seven? Very well. Did the lady choose hearts?"

The hammer rose and descended twice in succession.

"Seven of hearts. Was that correct, speak out please?"

The victim answered in the affirmative.

"Thank you."

"Now, bell, will you please tell me the name of the next card? (You know I have to talk kindly to the Little Miss). How many spots were on that card?"

One ring was the answer.

"Only one? Well, was it a spade?" The response was *yes* again.

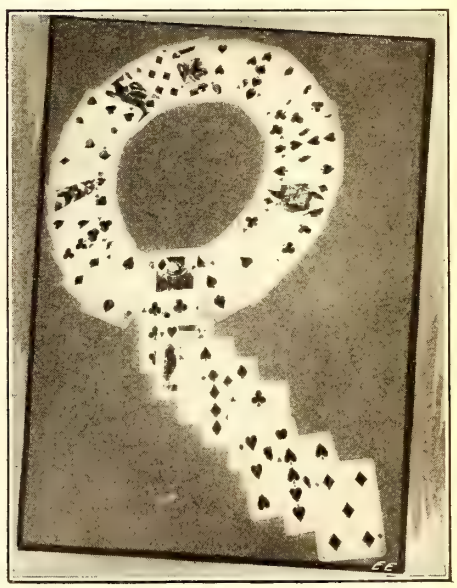
"Ace of spades, was that right, sir? Don't shake your head, because I'm too far away to hear it rattle."

"Now for the next card. Tell me the number of spots on that." Hargrave awaited an answer but no response from the bell. "What— don't you know?" The bell answered in the affirmative by ringing twice. "Well, tell me then." Again no response, whereupon the performer became excited, exclaiming: "I hope you will all excuse the bell, but I don't think she knows, so we will have to go on with the rest of the performance.

Ding-Ding, Ding-Ding, Ding-Ding.

Oh, you *do* know. Well? How many spots on it, please?"

(*Continued on page* 792)



A Clever and Interesting "Card Trick" Which Anyone Can Perform at Parties and Evening Gatherings Without Lengthy Practise. The Performer Telling the Name of the Card Without Being Present. All That Is Necessary Is to Know the Number of Cards in the Tail of the "Q" Formation.

THE CONSTRUCTOR

A Model Electric Village

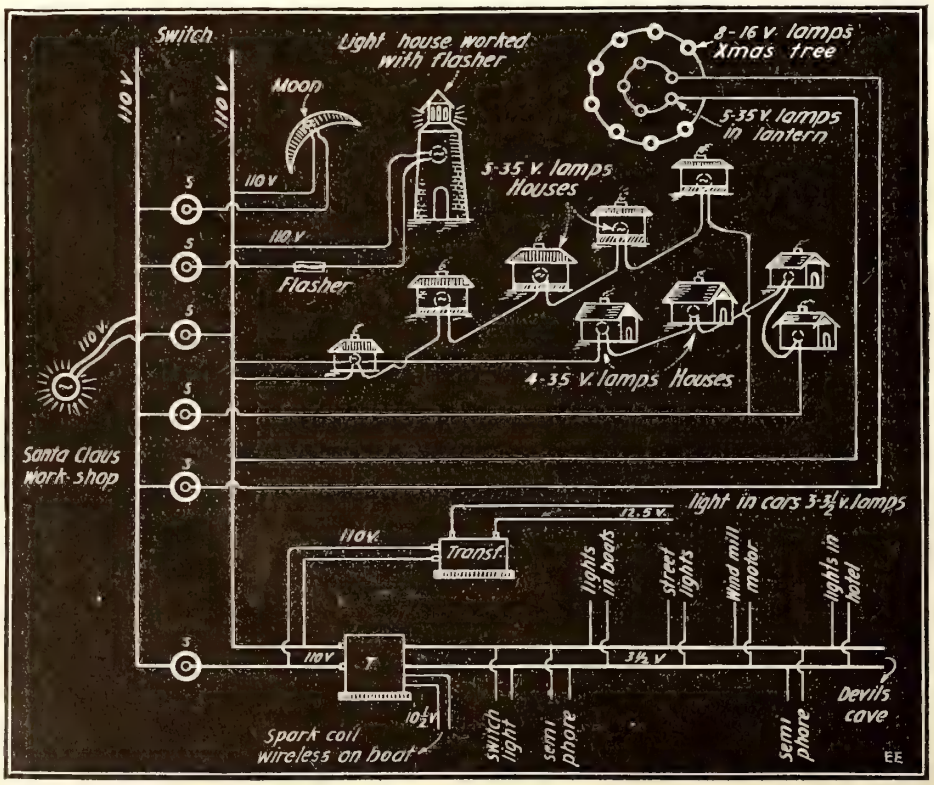
By FRED F. PHILLIPS



THE accompanying photos illustrate an electrical Christmas display that I got up for my boys, and as most of the ideas were taken from your magazine, I thought perhaps they might be of interest to your readers.

Three years ago I built a few simple electrical devices in connection with the boys' Christmas Tree, from ideas that I took from the EXPERIMENTER and the display made a "hit," not only with my own sons, but with a great many others and also the grown-ups in the vicinity. This has been followed by adding something new each year and the display here illustrated is the result of last year's work and I trust that thru new ideas gained in 1919, to build something more elaborate this Christmas.

Herewith is a diagram of wiring plan; this plan does not show telephone wires from rear of house to display in front room. I had a phonograph in the rear of the residence and transmitted music of bells and other Christmas pieces to the little church in the display. The mountains were built of wire netting over boxes and newspaper was used to cover them, the same being wet with flour paste and shaped over the wire, about 8 or 10 thicknesses were used. After it was dry, the same was painted with water color paints; white paint was used for snow and fireproof snow, such as is sold in the stores for the holidays, was used to make it sparkle. The boats are in a tank 4 feet square and 2½ inches deep; connections for lights in them and wireless on them, were run thru rubber tubing. The tank is made of tin. The light-house is made of tin and connected up with a flasher, made according to a diagram given in the EXPERIMENTER.



Wiring Diagram for Electric Christmas Tree and Village.

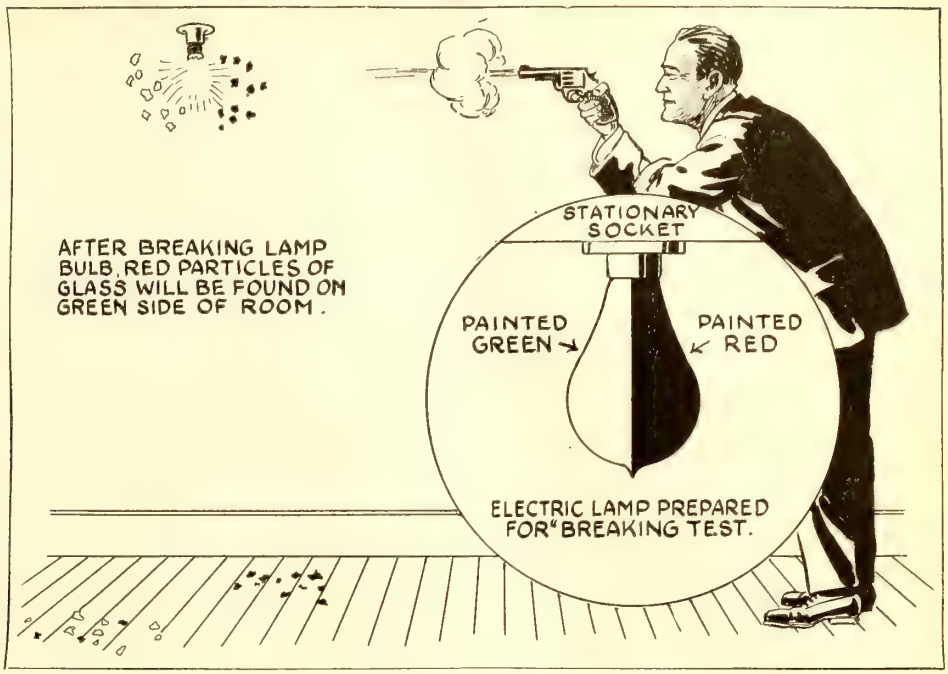
The back-ground is a piece of cheap canvas painted with water colors; inside the left-hand mountains, viewed thru a peek hole, was Santa Claus' work-shop, built on the idea of the old style candy Easter eggs. In the right-hand mountains was the "Devil's cave," where the bad boys go. This does not show up in the photo very well, as the red photographs black; it was built of red paper with lights under the same, to appear as hot coals.

The miniature houses were built of cardboard and painted to represent different buildings. The display base was 3 feet from the floor, the display itself was 9 feet long, 4 feet wide and 6 feet high from the base.

Do Lamps Burst Inward or Outward?

When an electric lamp is broken by force the glass walls are driven inward and do not fly outward as generally supposed. To prove this take a burnt-out lamp bulb and paint one half of it red and the other green. Then screw it in a socket suspended in the center of a room so that it cannot revolve. Note the direction each color is facing. Then break the bulb with a shot from a revolver or air rifle. Upon examination of the bits of glass that are scattered on the floor red particles will predominate on the opposite side of room which this color faced before the lamp was shattered, and green particles will predominate on the opposite side from which it faced also. This proves that the pressure of the air crushed the glass walls inward instead of exploding outward.

Contributed by J. A. WEAVER.



Which Way Do You Think Incandescent Lamps Break—Inward or Outward? Paint One-Half the Bulb Red, the Other Half Green and Break It with a Pistol or Air Rifle Shot. It Bursts Inward As This Experiment Shows, the Colored Fragments Falling on Opposite Sides of the Room.

Photographic Experiments

By MARION B. REYNOLDS

"DODGING" photographs to bring out the artistic values in an apparently unartistic negative is one of the tricks of the trade which offers a great many possibilities, even for the amateur photographer. If one has either acquired or was fortunate enough to be endowed with a little patience and perseverance, plus a little ingenuity and imagination, there is no end to the variety of "stunts" one can perform with ordinary negatives.



An Ordinary Photograph by the Author—Note the Table Lamp. It Has No Glow About It.

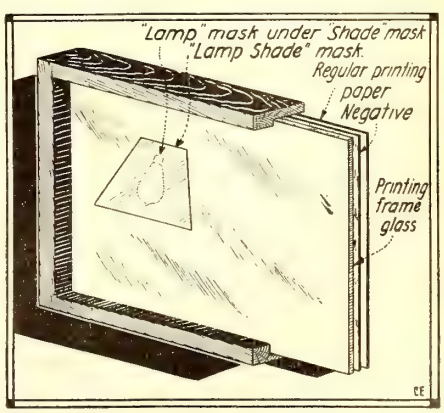


It Is Almost Impossible to Photograph a Scene Like This. By the Clever Use of a Simple Printing Mask, Such an Effect Is Readily Obtained from Any Negative.

One of these "stunts" is the introduction of artificial light in photographs snapped during the daytime, giving the effect of a picture taken in the evening. The accompanying photographs illustrate this point vividly. Obviously it is practically an impossibility to take a direct photograph giving the effect as shown in the photograph. With the average amateur's hand camera, the exposure would necessarily have to be rather long, as the only lighting used would come from a shaded lamp. A lengthy exposure would impose a trying job on the part of the sitter, as holding a position for any length of time is a difficult task and I will admit that he would have to possess a much quieter nature than I am blessed with. Then, too, halation would destroy to a great extent, the effect originally intended. This photograph was made on a bright day with a 3-A Folding Pocket Kodak, Rapid Rectilinear Lens, using Stop 16 and an exposure of four seconds. Incidentally I might say that it was taken by myself, using a black thread to release the shutter.

Printing the picture, producing the effect of a lighted lamp, was not a difficult procedure. The materials and equipment used were as few in variety as it is possible to work with and consisted entirely of amateur equipment. My printing frame glass happened to be thicker than is ordinarily used and very conveniently softened the lines of the masks used to obtain the result. The masks used need not be accurately cut as they are not used in contact with the negative but are placed on the *outside* of the printing frame glass. In making the masks, a piece of manila paper was cut to a shape resembling an electric light bulb, and another was cut to the exact size and shape of the lamp shade. In order that these masks might be placed in the correct position on the printing frame glass, the negative was placed in the printing frame and temporarily secured by means of gummed strips of paper. A piece of white unsensitized paper was then inserted in the frame so that the objects in the negative might be clearly defined. The first mask, cut to the shape of the bulb, was then placed in position with a little mucilage and the second placed immediately over it in the same manner, directly over the lamp shade in the negative, taking care to place mucilage only on the edges, making it possible to remove it without disturbing the first mask. After removing the white paper and replacing it with a sheet of sensitized paper, an exposure was made of about three seconds, using a very strong but soft light and dodging the lower portion of the negative with a triangular piece of cardboard. A second exposure was made of the same duration, but with the second mask removed, and a final exposure was made with both masks removed and without the use of the triangular cardboard. Upon developing the result, the effect was found to be just what was wanted.

Numerous other effects may be produced in this manner, such as a family circle around an open fireplace, or the rays of a light-house may be introduced in a daytime picture, turning it into a night scene. If one is willing to put a little thought and study into his experiments many other subjects and effects will suggest themselves, which if carried out will produce very pleasing results.



Showing How the Two Paper Shades or Masks Are Arranged in Front of the Printing Frame to Give the Effect of an Illuminated Table Lamp, As Shown at the Left.

The "Finer Workings" of Static Electricity

By FREDERICK VON LICHTENOW

THERE is hardly a branch of experimental electricity which requires a closer observation of its functional details than *Electrostatics.* The field itself, seemingly unlimited, not only offers a great variety of experiments, finished and complete in

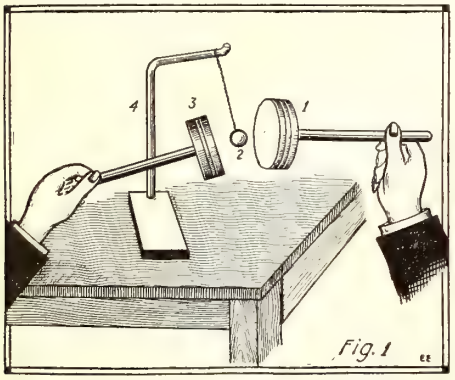


Fig. 1. Repulsive Action of Induced Charges. 1—Electrophorus Cover No. 1 (Charged). 2—Light Body (Pith). 3—Electrophorus Cover No. 2. 4—Insulating Stand

themselves and clearly demonstrating the basic principles of this element, but an additional multitude of variations from these—due to more or less marked changes in their conduction—which *in some instances* exemplify the "Finer Workings" of this earth-endowed mysterious power to a remarkable degree.

Many things about Static Electricity have doubtless remained unknown, just as well as even the action of the Wimshurst Static Machine, so long and widely used, is as yet not understood to the fullest extent.

Electrical experiments in general teach much; static experiments, however, are *in principle* and *in part* true replica of the great atmospherical movements and disturbances which occur above and around us, in consequence of which a favorable amount of conclusions regarding the latter may be drawn from these experiments. So much for static experiments in general.

Additional "clues" however, leading to the fuller understanding of this particular branch of the electrical science, may be gathered from experiments, which in a more or less pronounced way, expose the "Finer Workings" of static electricity.

Only the simplest apparatus is needed for their reproduction, in fact, weak charges-sources are a necessity to that end, since the

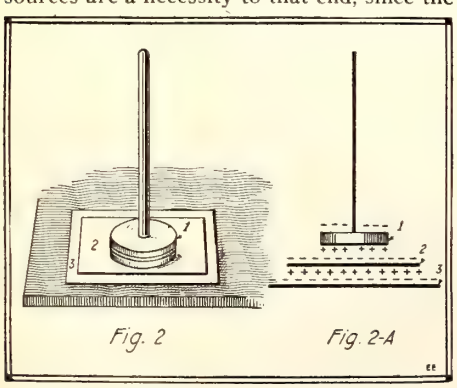


Fig. 2. Electrophorus Cover Charged Thru Glass. 1—Electrophorus Cover. 2—Sheet of Glass (1/16") 3—Hard Rubber Plate (Charged)

more powerful generators (static machines) liberate entirely too much unwanted energy (influence) into the surrounding air, as well as deliver too strong a charge into the instruments in operation, as to ever allow these very tender static actions to evidence themselves.

EXPERIMENT NO. 1.

Some light object (such as a pith ball), after suspending it by a silk thread from an insulating stand, is gradually approached by a charged electrophorus cover (a tin box fastened to a stick of sealing wax or hard rubber rod will do) until it moves toward the latter and is held under the influence of the charge in a position near the cover. "Near" means in this case the distance between the cover and the ball, when the latter, altho attracted, still hangs under *medium tension* and *will not move further on its own accord.* This has to be carefully worked out!

If now the cover of another electrophorus, *not* charged but in a so-called neutral condition, is brought near the light object from the opposite side and moved slowly toward it, the (supposedly neutral) cover will during this motion "force" the suspended pith ball ahead of itself and "push" it thru the intervening space up to the charged cover. (Fig. No. 1.)

The phenomenon finds its explanation in that the positively charged cover in attracting the light object induces a negative charge upon it as well as upon the so far neutral electrophorus-cover, repelling at the same time all positive electricity.

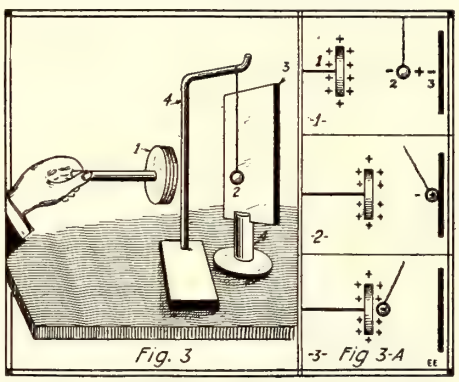


Fig. 3. Inductive Action Upon Neutral Body. 1—Electrophorus Cover (Charged). 2—Light Body (Pith). 3—Sheet of Glass. 4—Insulating Stands

(The small amount of positive electricity repelled on the light body (pith ball) is neutralized thru the air (at a distance) by the induced (—) charge on the face of the second El-cover). Both cover No. 3, and pith ball, carrying a like charge, repel one another and since this cover, which has besides the larger amount of induced charge (reflex-energy, so to speak) of the two residing upon it, is moved steadily in the direction of cover No. 1, the light object can not help but make contact with the latter.

It goes without saying, that, if the experiment is interrupted before the ball reaches the charged cover and the latter is removed altogether, the field of influence vanishes automatically, and both ball and the other cover are once more restored to a neutral condition.

The insulating stand to be used *in this experiment* should contain no metal parts and the pith ball should hang well off the table surface, as in all static experiments of a similar character.

Another way of gaining similar results—the effect, however, will be not quite so pronounced—is by employing a charged hard rubber plate instead of the charged electrophorus cover, using otherwise the same instruments and tactics. In this case, as is quite natural, the polarity of the respective parts will be found *reversed.*

If in either of the above cases the neutral El-cover is replaced by a *grounded conductor,* such as the operator's hand, for instance,

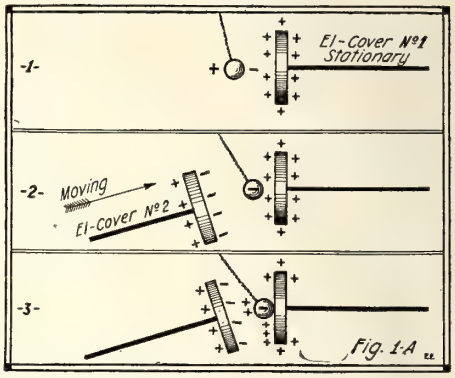


Fig. 1-A—Diagram Showing the Three Principal Stages of the Static Experiment Illustrated at Fig. 1.

which changes the fundamental principle of the experiment, then the pith ball will be first attracted to the hand (providing the latter is brought close enough to it) where the ball "unloads" its complement of positive electrons and an instant after, fully negatively charged, fly over to the + charged El-cover and make contact with it, which it, again, would not accomplish "under its own power."

Concerning the first two instances, I may further add, that, whenever the induced charge is too weak to neutralize the positive element repelled on the pith ball at a distance, the ball will (quite naturally) be momentarily attracted to the second El-cover, which in turn is a sign only, that cover No. 1 is not properly charged.

EXPERIMENT NO. 2.

(Electrophorus Cover Charged Thru Glass)

That an electrophorus cover will receive a charge, altho separated from its "cake" (charged hard rubber plate) by an insulating body, is proven by the following simple experiment:

The cover of an electrophorus (metal box used in experiment No. 1) is charged in the usual way, discharged and charged again until the sparks are raised to their

(*Continued on page* 837)

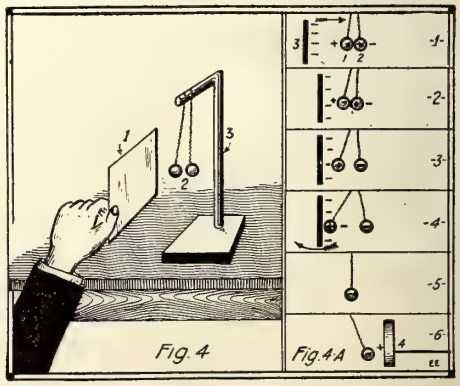


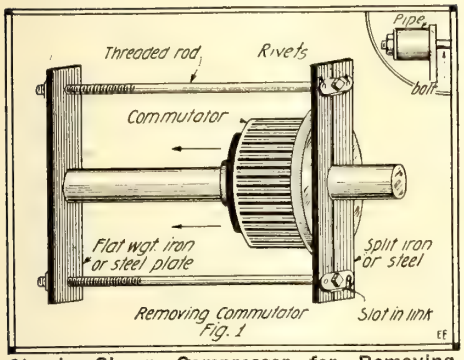
Fig. 4. Imprisoning Charge Upon Neutral Body by Induction. 1—Hard Rubber Plate (Charged). 2—Pith Balls. 3—Insulating Stand. Ball Hanging Nearest to the Plate Should Be Suspended by a Thread with a Wide Loop. Explanation for This Is Given in the Text

Fig. 4A. 1 and 2—Light Bodies (Pith). 3—Hard Rubber Plate (Charged). 4—Electrophorus Cover.

The Electrical Machinist

By H. WINFIELD SECOR

No. 2—Commutator Work (Continued)



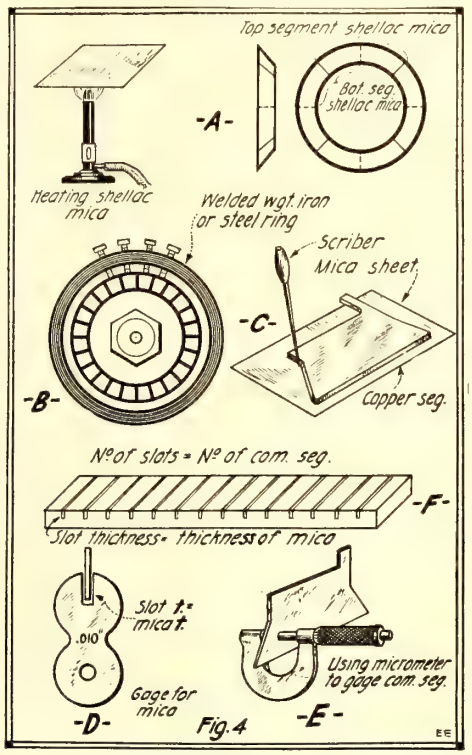
Simple Clamp Compressor for Removing a Commutator From an Armature Shaft.

IN the opening installment of this new series of articles describing the work of the Electrical Machinist, the subject of *commutators* was discust. Commutator work is of such great importance to all electrical workers, that it has been thought advisable to have this second paper continue with some interesting and practical wrinkles concerning this class of work. For the benefit of those who happened to miss the first paper, it may be said that this treated on the best methods of turning commutators in the lathe, how to repair burnt mica between commutator bars, and so forth.

Figure 1, shown herewith, illustrates a simple form of clamp for pulling commutators off the armature shaft. Of course the size of the clamp and the parts composing it, will depend upon the size of the commutator to be removed. A very satisfactory and efficient form of commutator clamp is that illustrated, wherein the plate which is placed behind the commutator is made in two parts, these parts being held together by small iron links which can be held in place by machine screws or rivets. The lower link has a slot in one side, so that when the clamp member is to be removed from the shaft, this link can be moved out of register with the pin on the one side of the clamp, thus enabling the user to swing the two clamp plates apart and thus remove it from the shaft. At the center of this spliced plate, the hole is made large enough to fit around the average size armature shaft. Two long bolts, threaded at least for half of their length if possible, are used to create the compression force to pull the commutator from the shaft. The iron plate over the end of the shaft must of course be stout enough to withstand any bending stresses.

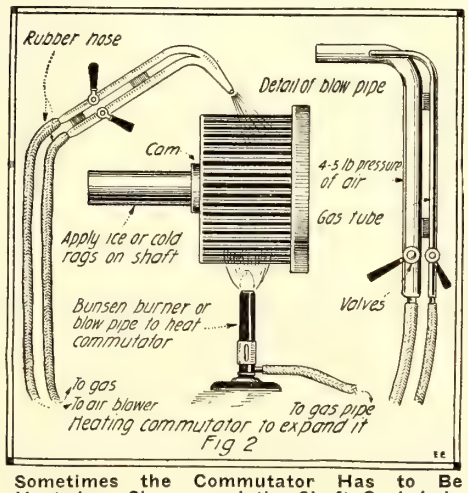
In emergency, all that is required to perform this work is two substantial blocks of wood instead of the iron bars. By means of suitable iron washers and nuts, similar results to those obtained with the iron clamp can be obtained. Where ordinary bolts are available in an emergency, it may have threads extending only for a few inches at the ends; they can be used very effectually by using washers or pipe nipples behind the nuts. When the commutator is removed as far as this action will permit, then the nuts can be backed up towards the ends of the bolts and by means of washers or short lengths of iron piping (nipples) placed under the nuts and washers, a new compression force can be utilized. Many a stubborn commutator has been removed in this fashion in actual practice.

Sometimes, a commutator will set fast on the shaft, aided by corrosion, so that it will not yield even when a powerful clamp such as that described and illustrated at figure one, is applied. Then it becomes necessary to make use of a well-known principle of physics, viz., to *expand* the outer ring or commutator and to *contract* the inner metal member within the ring, or in this case the shaft. If we expand both ordinarily, we will not gain very much toward loosening the commutator gript on the shaft, but owing to the different coefficients of expansion of the steel shaft and the commonly used brass commutator shell, we would gain something in most cases, even tho the shaft is not cooled by special means. There are two usual methods of heating the commutator,—the first being to use a Bunsen gas burner, and the

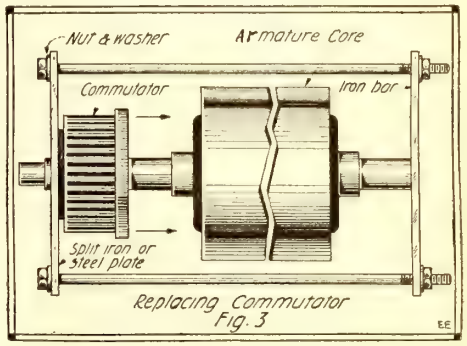


Practical Shop Wrinkles for the Young Electrical Machinist.

other a comprest air gas blow-pipe, which every electrical repair shop is fitted with. The mica and copper composing the Com-



Sometimes the Commutator Has to Be Heated as Shown, and the Shaft Cooled, in Order to Force the Commutator Into Place.



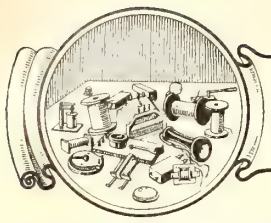
Utilizing a Compression Clamp Rig for Forcing Commutator Into Position on Armature Shaft.

mutator will stand a lot of heat and the Electrical Machinist warms up the commutator by applying heat directly to it, in order to expand it, where he deems it necessary. Of course, it should not be heated red hot or anything like that, but simply heated up only until it is hot enough to make water sizzle when a drop or two is applied to the commutator. The expansion of the commutator and a relatively large contraction of the shaft can be greatly enhanced or augmented by applying rags soaked in ice water to the shaft during the heating of the commutator and at the time the clamp is applied in an effort to remove it from the shaft. On large commutators the heat is maintained from a blow-pipe, etc., while the clamp presses are being applied in order to remove the commutator. At figure 2, there is shown an outline sketch of the comprest air and gas blow-pipe. These blow-pipes are often home-made, or can be obtained at any machinist's supply house. The blow-pipe comprises two distinct and separate tubes usually made of brass as shown, there being a valve placed at the lower end of each tube, by which the amount of gas and air can be regulated. Flexible rubber hose connects the two blow-pipe tubes respectively with the gas main and air pipe line or blower. The gas used is ordinary illuminating gas, and a small, simple form of air blower such as the cam type is satisfactory for the purpose. The blower is invariably driven by a small electric motor or else it may be belted to the line shaft. A ⅙ to ⅛ horse power motor is sufficient for driving a small single-stage blower feeding a 1½ inch pipe line to which four of these blow-pipes are attached. The air pressure required is only a few pounds, four to five pounds being about right.

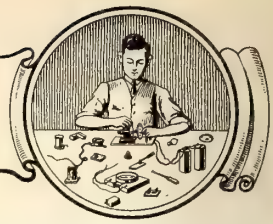
REPLACING COMMUTATORS.

Some form of clamp is necessary and usually employed in replacing commutators on the armature shaft. One method of applying pressure with a clamp is shown at Figure 3. Here the two-part spliced clamp or else a solid plate with a hole thru the center, big enough to fit over the shaft, is placed against the commutator while a second plate member is applied over the front end of the shaft. Now, when the wrench is applied to the nuts on the two bolts, pressure is applied in such a way as to force the commutator on to the shaft. Right here it should be pointed out that great care should be exercised before re-

(*Continued on page 788*)



HOW-TO-MAKE-IT

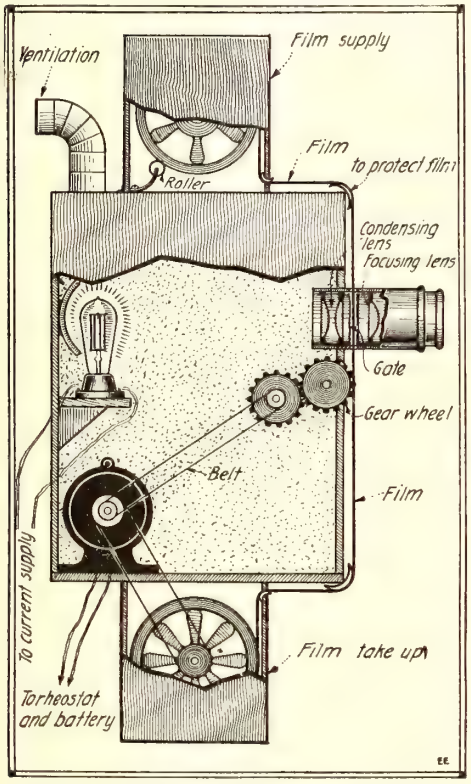


This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

HOW TO MAKE AN ELECTRIC "MOVIE" MACHINE.

The condensing lens as shown in sketch comprises two plano convex lenses which can be bought at any optician's or second-hand shop cheaply. The focusing lenses are



Every Experimenter Will Enjoy Making a "Movie" Machine. This One Uses Standard Films.

two anastigmat types of a speed about f:4.5. They are each enclosed in a tube made of tin, one tube sliding in and out of the other to obtain proper focusing on the screen. These lenses can be bought all ready in the tubes or at an optician's store.

Standard film is proposed for use with this machine and since it is 1¾" wide, the film gate will have to be a little wider. The take up boxes for the film will have to be large enough to hold a coil of film 18" x 3". A strong box should be used since the film is quite heavy. The camera part will have to be necessarily larger to accommodate a small motor, lighting system and cogs and gears. A roller should be put in the lower left hand corner of the upper box to prevent the film from unwinding too rapidly. Tin should be put on the edges of the machine where the film is pulled over, or else a worn film is sure to be the result. By looking in theatrical papers you can obtain the name of a concern who sells films. The gate should be fitted with an intermittent stop motion permitting each picture to stop for a fraction of a second.

Contributed by FRANCIS E. ZIESSE.

SECOND PRIZE, $2.00

TABLE LAMP FROM TELEPHONE STAND.

A certain SPERRY had a "Sis" that always wanted something new for her Xmas. SPERRY, being an intelligent and polite gentleman, would never refuse. So this Xmas he's going to give her a cute table lamp. Here's how he went to it:

SPERRY gets into his shop, or rather, laboratory, and conducts a search. He finds a good-looking desk telephone (that is devoid of every bit but the stand)—a nickel-plated (⅜") pull-chain socket, a nickel-plated socket cap, a length of (⅜") pipe, a crowfoot for it, and some strong metal wire.

He then follows this routine: The pipe (D) (threaded) is slipt thru the stand (A) and screwed into a crowfoot (E), the crowfoot being fastened with screws to the base of the stand. The socket cap (B) is screwed to the top end of the threaded pipe, until the stand is made tight. There should be a little projection of the pipe—about ¼" above the cap (B), so that the socket (C) can be screwed to this. The shade holder is made of metal wire, or, of anything SPERRY happens to find at hand to suit him. The only trouble for SPERRY is to get the shade—it must be bought. The rinktum is then shined up and polished to a luster, and (the price tag attached) presented to "Sis."

Contributed by B. DOPPKE.

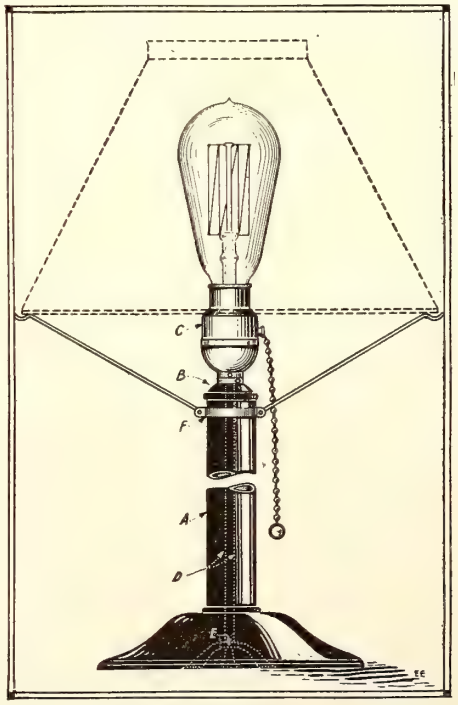
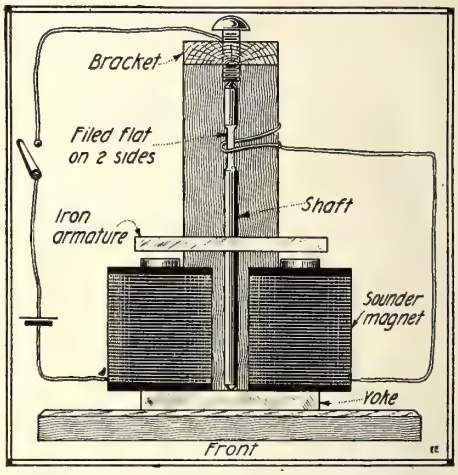


Table or Boudoir Lamp Which Anyone Can Make from an Old Telephone Desk Stand or Similar Pedestal, Together With a Few Pieces of Wire and Some Colored Silk. Old Rose Silk Outside and Blue Inside Gives a Wonderful Color Effect.

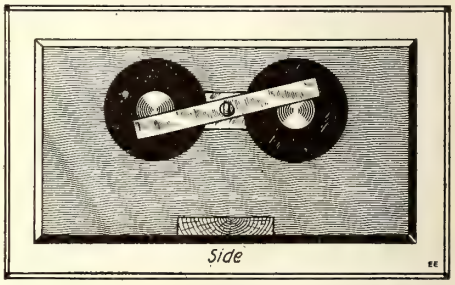
THIRD PRIZE, $1.00

A TELEGRAPH-SOUNDER ENGINE.

The following article explains how to make a simple electric engine from a telegraph sounder, a steel rod and a few pieces of wood:



Side View of Small Battery Motor Constructed From Discarded Telegraph Sounder



Top View of Telegraph Sounder Engine Without Upright or Top Bearing.

The wooden part consists of a base of 3 x 4 inches and upright 5 x 1 inches mounted at one end of the base, with a bracket 3 x 1 inches to hold the upper bearing screw. Mount the magnets and yoke on the base and make a slight indentation with a drill or center punch in the exact center of the yoke to form a bearing for the shaft.

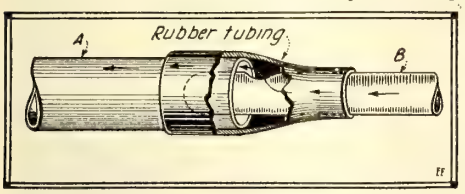
The shaft consists of a mechanical toy rod about 4 inches long. File each end to a point and also file two flat surfaces on opposite sides of the rod, about 1 inch from the upper end. The iron armature should just clear the top of the magnets, and is fastened to the rod with solder or friction only. The brush is formed from a piece of copper wire fastened to the upright and bent around to touch the flat surfaces on the rod. It should make contact twice in every revolution. It should be adjusted so that contact is made when the armature is farthest away from the magnets and broken when the armature is over the magnets. This engine will run at a very high speed with one dry cell.

Contributed by HOWARD ROLLO.



SIMPLE STOP-COCK.

The following sketch shows clearly the construction of a simple stop-cock: A and B are glass tubes, the latter having such a diameter that it will pass into tube A. It also has one end rounded, i.e., closed, and a hole in its side about 5/8-inch from the closed end. This hole is made by directing



A New Idea of a Stop-Cock. Using Just Two Glass Tubes and a Piece of Rubber.

a pointed flame (from blowpipe) at the desired spot, till red hot, and then blowing into the open end. Fuse the edges of the hole. In operation, the small tube B is moved backward or forward, i.e., into or out of the rubber tubing. It is best to have the liquid enter B, and leave A.

Contributed by RAYMOND B. WAILES.

FREEZING "WATER" BY MAGIC.

In a small Erlenmeyer flask or beaker place 50 grams of ordinary photographers' hypo and 10 c.c. of water. Heat to boiling and allow to cool. Be very careful to see that the flask is clean and that no dirt enters during the operation.

When the solution has become cold pick up the flask, add a tiny crystal of hypo and give a quick shake. Practically instantaneously the liquid congeals into a solid mass with the liberation of a considerable quantity of heat.

To the uninitiated this is a very striking demonstration. What happens is this: Photographers' hypo is a salt containing a large quantity of chemically combined water, called water of crystallization. The heat releases this water and the salt dissolves in it together with the 10 c.c. of water added. The solution, however, is what we call supersaturated and is in an unstable state of equilibrium, such that a tiny crystal of the same salt and a quick shake will drive the salt with its water of crystallization out of solution.

The heat liberated too, illustrates the scientific fact that water or any other liquid in freezing actually gives off heat.

Contributed by FLOYD L. DARROW.

IMITATION SILVER AND PLATINUM AND OTHER WRINKLES.

Herewith are a few suggestions that may be worth something to the Wrinkles, Recipes and Formulas Department:

Imitation silver: Copper, 4 pounds; zinc 4 ounces.

Imitation platinum: Copper, 4 parts; zinc, 18 parts.

Impression metal: Bismuth, 3 pounds; lead, 1 pound; tin, 8 ounces.

To separate silver from copper: Sulfuric acid (H_2SO_4), 1 part; nitric acid (HNO3), 1 part; water, 1 part. Boil in mixture and a little salt (sodium chlorid) it will subside.

Contributed by JOHN V. CRAIG.

IGNITING ALCOHOL OR ETHER WITH A GLASS ROD

In the bottom of a tumbler place a half teaspoonful of potassium permanganate and moisten with an equal quantity of water. On a glass plate pour a little alcohol or ether.

Now cover the potassium permanganate with *strong* sulphuric acid. A vigorous action is immediately set up. Upon thrusting the end of glass rod into the sputtering mixture and touching it to the alcohol or ether spontaneous combustion immediately occurs.

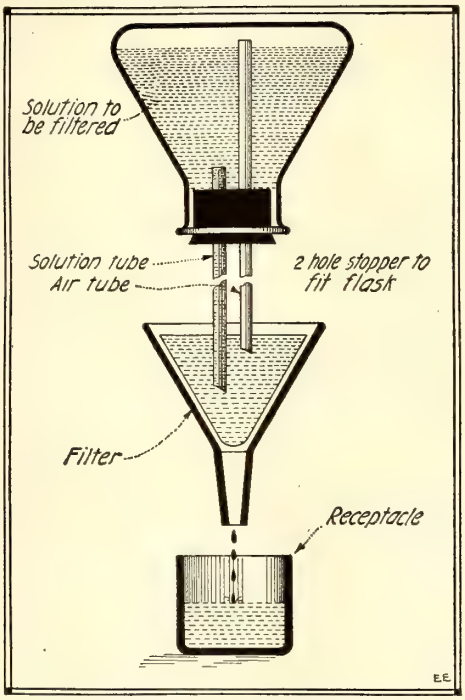
The potassium permanganate and sulphuric acid liberate ozone, a very concentrated form of oxygen, and resulting rapid oxidation quickly ignites the inflammable liquid.

If desired gasoline may be substituted for the alcohol and ether.

Contributed by FLOYD L. DARROW.

AN AUTOMATIC FILTER.

When filtering solutions which filter slowly it is very tiresome to keep refilling the funnel. The filter shown in the present drawing saves this trouble. As soon as the solution gets below a certain level in the filter, air is allowed to pass thru the air tube until the filter is filled, when the solution stops the flow of air. The air tube should be about one-half inch below the top of the filter; the length of the



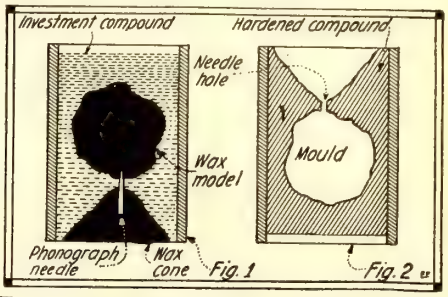
An Automatic Filter Which Once Started Will Run Without Attention Until the Last Drop Is Filtered.

solution tube does not matter. When properly adjusted this filter will refill regularly until the flask is empty.

Contributed by MORRIS TUTTLE.

MAKING SMALL BRASS CASTINGS.

Make a model of the desired size and shape from paraffin wax. Procure a piece of iron pipe about 2½ inches long and of a sufficient inside diameter to admit the model, with at least 1/8 inch clearance at all points. Now make a cone of paraffin about 3/8 of an inch high and the base of a diameter a trifle larger than the inside diameter of the pipe. Into the vertex of this wax cone force a phonograph needle,



To Make Small Castings Without Much Trouble Will Be Welcomed by Every Experimenter.

blunt end first, so that there is ¼ inch of the point projecting from the wax. Then heat the cone around the edges and force it into one end of the pipe, with the vertex in (Fig. 1). The wax will harden and hold the cone in place.

From the open end of the pipe insert the wax model and stick it on the sharp point of the needle (Fig. 1). Procure some of the investment compound used by dentists in making gold inlays. Mix this with water until the mixture has the consistency of heavy cream. Take a small camel's-hair brush and paint the model with this. Then add a little more powder, so that the mixture thickens a trifle, but yet is not so thick that it will not run freely. Fill the pipe with the paste in this state (Fig. 1), and lay the whole on a wire screen far enough above the flame of a Bunsen burner so that the wax will not melt. Leave it for at least one hour, then lower it to a point about one inch above the flame. When the wax cone has melted and run out, pull out the phonograph needle with a pair of pliers, and let the melted wax of the model run out the hole left by the needle. Remove from the flame and invert. Pour the melted brass into the depression left by the cone, and it will run into the mould thru the needle hole. Allow it to cool, wash out the investment compound, and you will have a perfect reproduction in brass of the wax model.

Contributed by RODNEY H. GOTT.

MAKING A FUSE.

Prepare a saturated solution of potassium nitrate by dissolving a considerable quantity of the salt in a cup of hot water. While still hot place in the solution a long cotton string and strips of porous paper, as blotting paper. When they have become saturated remove and allow to dry thoroughly. Ignite either the string or the paper and the combustion will be identical with that of a fuse.

Try one on the following mixture: mix equal quantities of magnesium dust and potassium nitrate powder and place in a heap on asbestos paper or a piece of tin plate. In the top of the heap insert one of the fuses and ignite. An intensely bright light results.

Powdered potassium chlorate is even better than the nitrate for this demonstration.

Contributed by FLOYD L. DARROW.

RADIO DEPARTMENT

Carnarvon Radio Station

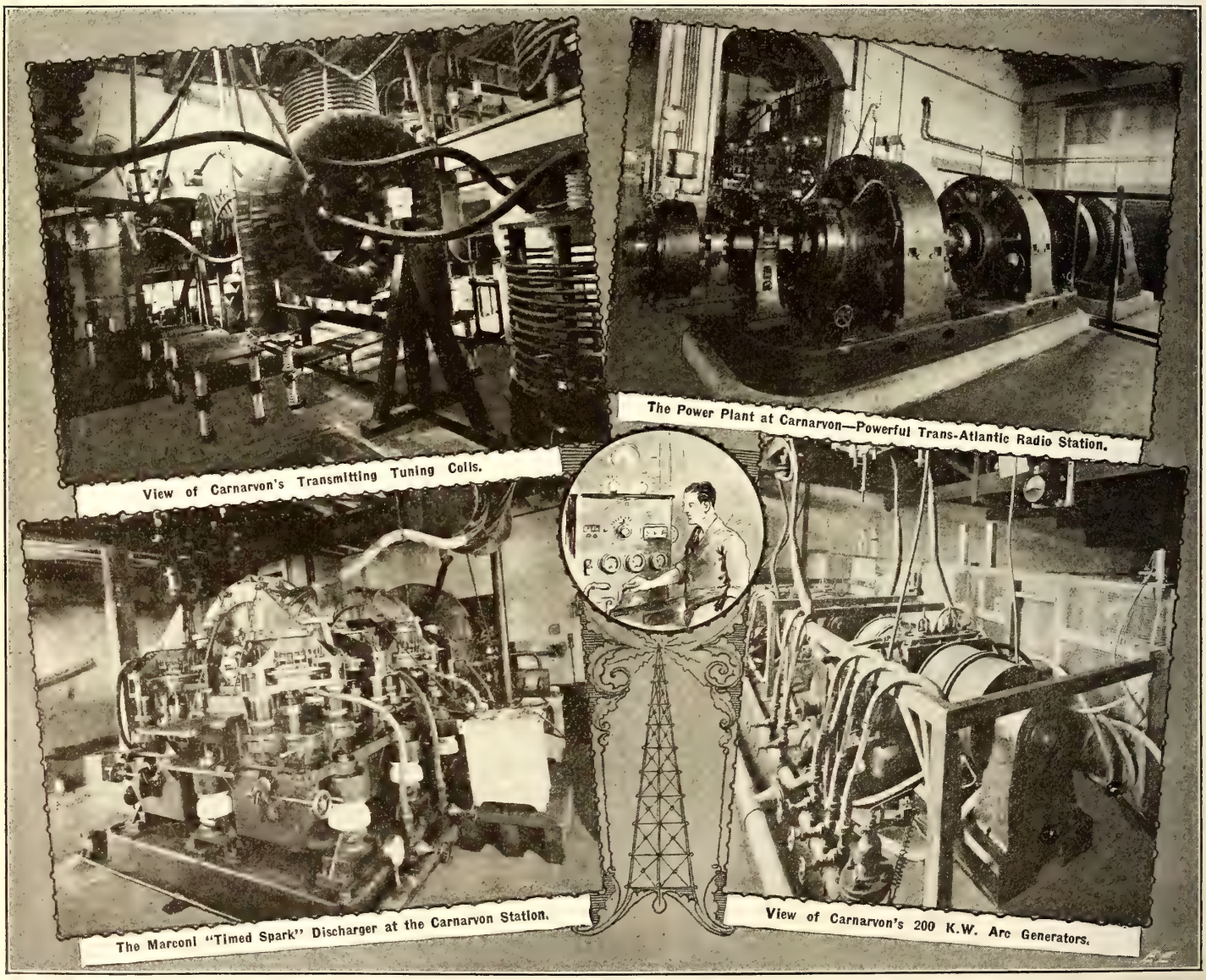
THE Carnarvon Wireless Station is situated at Ceunant, Llanrug, five miles from the historic town of Carnarvon. Built on the site of Cefn Du, 800 feet above the sea level, it commands a magnificent view of the Menai Straits, and on very clear days, of the Wicklow Hills. To the eastward, along the line of the aerial the ground rises about 1 in 10 to the top of the hill which is 1,450 feet high. The last set of masts supporting the aerial is 1,100 feet above the sea level and at this point a fine view of the Snowdon Range is seen, the Snowdon Peak being about six miles distant.

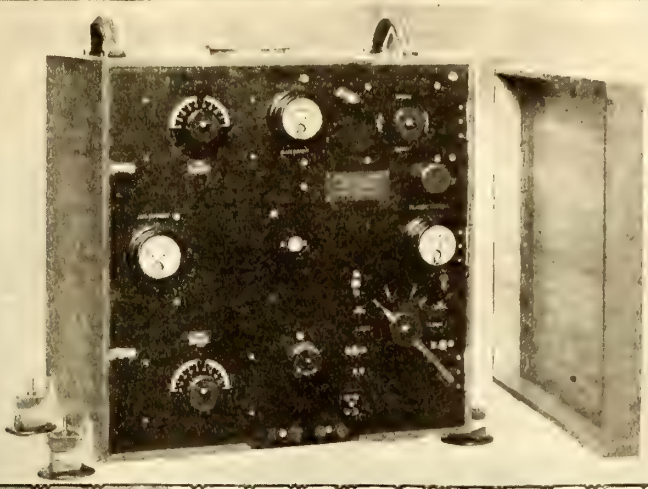
The aerial is of the Marconi directional type, so arranged that the maximum radiation is in the direction of New Brunswick, New Jersey, with which station commercial service will shortly be carried on. The wires, of which there are 20, are of 7/18 silicon-bronze, the breaking strain of which is 1,300 pounds. Each wire is 3,600 feet long and is separately hung by insulators from steel triatics supported by steel masts 400 feet high. There are 10 of these masts supporting the four triatics which have an average length of 500 feet, the distances between the triatics being 900 feet. Owing to the greater strain at the ends of the aerial three masts are provided to support the end triatics (which are split into two), two masts being provided for each of the inner triatics. The natural wave length of the aerial is 5,600 meters, and adjustable inductances to carry 300 amperes are provided for increasing this wave length to 14,000 meters. The effective capacity of the aerial at the latter wave length is .04 mfd and its resistance 2.1 ohms.

The electrical energy used for the wireless plant, heating and lighting, is obtained from the North Wales Power and Traction Co.'s Hydroelectric Station at Cwm-Dyli which is about two miles on the east side of Snowdon. It is of interest to note that here is one of the few places in the British Isles where we are able to use "white coal" or the natural energy of falling water, for this power station utilizes the waters of Llyn Llydaw which are led thru pipes to the water turbines 1,000 feet below the level of the lake. The turbines are direct coupled, the 3-phase alternators generating at 10,000 volts. Two aluminum power lines each of 500 k. w. capacity carry the current from the power station to the Marconi station, one being a line for the exclusive use of the latter, the other being the branch of a line supplying one of the slate quarries and used as a spare.

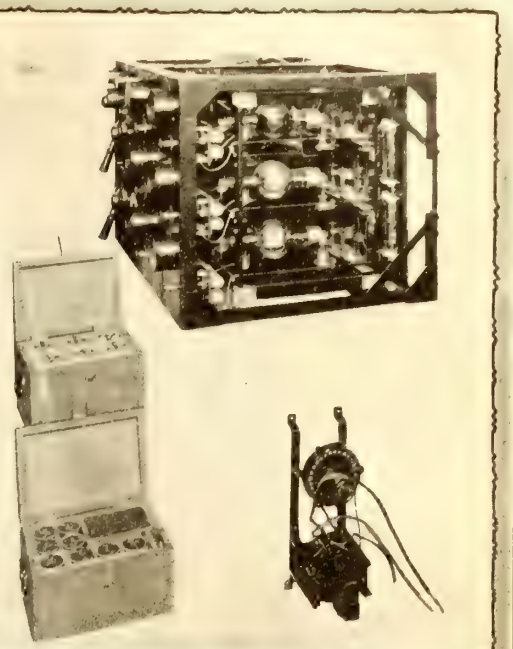
At the wireless station two 500 k.w.

(*Continued on page* 826)



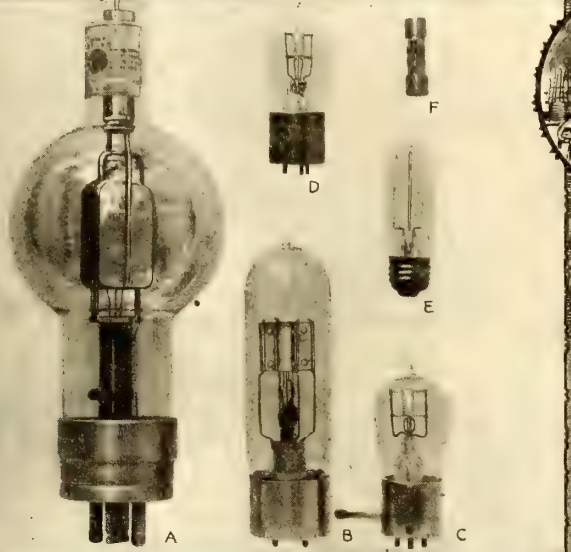


600-Mile Continuous Wave Transmitter Employing Six 50-Watt "Pliotrons."

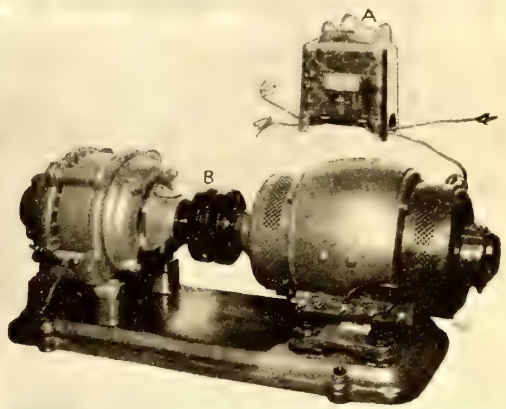


Side View of the Pliotron Cabinet, Front View of Which Is Shown at Left.





(A) 250-Watt Pliotron; (B) 50-Watt Pliotron; (C) 5-Watt Pliotron; (D) Regulator Tube; (E) Ballast Lamp; (F) Resistance Tube.



Motor Generator Set (B) and Transformer (A) for Supplying Energy to Base-Station Type "Pliotrons."

Modern American Radio Apparatus

AMERICA'S accomplishments in radio work both in the field of telegraphy and telephony were many and varied. One of the striking technical results of the war that will probably have far reaching peace-time results is the development of Transatlantic radio communication into an accurate and dependable system that can be counted on every day of the year and almost every hour of the day.

The demands that are now being made on this system of communication can be shown by the recently announced policy of the government to send all government department dispatches by radio to relieve the congested cables.

Now that the bar of secrecy has been lifted it is possible to announce that during the last year the greater part of the government's dispatches were transmitted by a new radio system developed by the General Electric Company. The company equipt the high powered radio station at New Brunswick, N. J., with its newly developed apparatus for Transatlantic telegraphy and telephony and placed it at the disposal of the government for official dispatches early in 1918, to meet the urgent demand for communication. The continuous and reliable service by this station has since been favorably commented on from distant parts of the world and has caused the government to place orders with this concern for two transmitting sets.

It is a matter of historic interest to record that it was the New Brunswick radio station that directed the first message to Germany after America's participation in the war. It will be remembered that it was in this message that President Wilson demanded the abdication of the Kaiser. That series of history-making messages which followed one another in such rapid succession and finally led to the speedy conclusion of the armistice were also sent from the New Brunswick station.

This new system of radio communication is known as the Alexanderson system and includes very marked improvements in all four stages which are common in all radio systems. These stages are, first, the generation of high frequency electric oscillations; second, the modulation of these oscillations into the dots and dashes of the telegraph code, or into the modulation of the human voice; third, the radiation of these electric oscillations in the form of waves, which travel with the velocity of light over the surface of the earth, and the fourth stage is the reception or detection of these waves by suitable instruments.

(*Continued on page* 828)

In December Radio News

Underground Radio for the Amateur. By E. T. Jones.
The Construction of Vacuum Tubes. By R. S. Hawkins.
German Radio War Instruments.
The Priess Loop Set. By Walter J. Henry.
Amateur Ethics. By Pierre H. Boucheron.
Primary Batteries for Audion Filaments. By R. H. Langley.
Describing Some Foreign Apparatus. By Fred M. Gill.
A Wavemeter of New Design. By W. S. Heppner.
A Triple Coil Receiving Transformer. By H. E. Parsons.
Junior Radio Section.

Calculation of Tree Wavelengths

By A. N. Tenna, V. T., Q. R. S., H. F., K. W., A. C.

Proprietor of Tony's Fruit Stand

NOW you see it's all plain, Jim, just take your wavemeter and set it right under this oak tree and have your buzzer to excite the tree and —zingo—"The Wavelength." Of course, great errors occur in the wavemeter method, so I have devised a method of calculating mathematically the wavelength of trees, bushes, acres of trees, etc.

I have found also, that trees with fruit have a greater capacity than those without, and rosebushes without roses have greater resistance and less capacity—of course, this is all clear when you take into consideration the fact that trees with half the leaves dead (in the month of October) have less capacity. From this we see that the leaves length of any tree depends upon the season. For instance, a tree in June was found to have a wavelength of 650 meters, while in October only 450 meters and the same tree in December but 150 meters. Therefore you will have to have an automatic wavelength changing device inside your station to add inductance in the loading coil according to the changes in the thermometer.

Wavelength of Pear Tree.

A tree with 6,000,687,564,765,543,409 leaves and 72 large branches, 64 medium sized branches and 20 very thin branches had a wavelength of 750 meters. Now this same tree with four large branches chopped off gave a reading of 690—a recount of the leaves gave us—6,000,687,564,235,001,202 leaves. The counting of the leaves of course was the smallest part of the work. (Naturally) The formula for calculating the wavelength of a pear tree and found to jibe with the wavemeter readings, is:

$$\text{W. L. equals} \frac{H \times NL \times NF}{\text{Number of branches.}}$$

Where: H—Average height.
NL—Actual number of leaves.
and NP—Number of pears on the tree.

This has been found to vary with the season; for instance, this same tree without leaves or fruit with the same number of branches and height will naturally give you a lower wavelength as is evident from the above formula. In other words, the wavelengths fall off as the leaves and fruit fall. Simple eh?

Some people think this Tree Wireless is a joke; well, if they want to find it out just begin counting the leaves on any tree —and they will be convinced—that it's no joke.

Capacity of Same Pear Tree.

The formula for the capacity of the tree is as follows:

$$\text{Capacity equals} \frac{\text{Wavelength found from above.}}{(tl \times NL) \times (\text{area of } P \times NP) - H}$$

Where; tl—Thickness of the leaves.
NL—Total number of leaves.
P—Pears.
NP—Number of pears and H the height of tree.

Below is given a graph of the wavelength of trees for the various seasons—this is for pear trees 35 feet high.

H. F. Resistance of The Tree

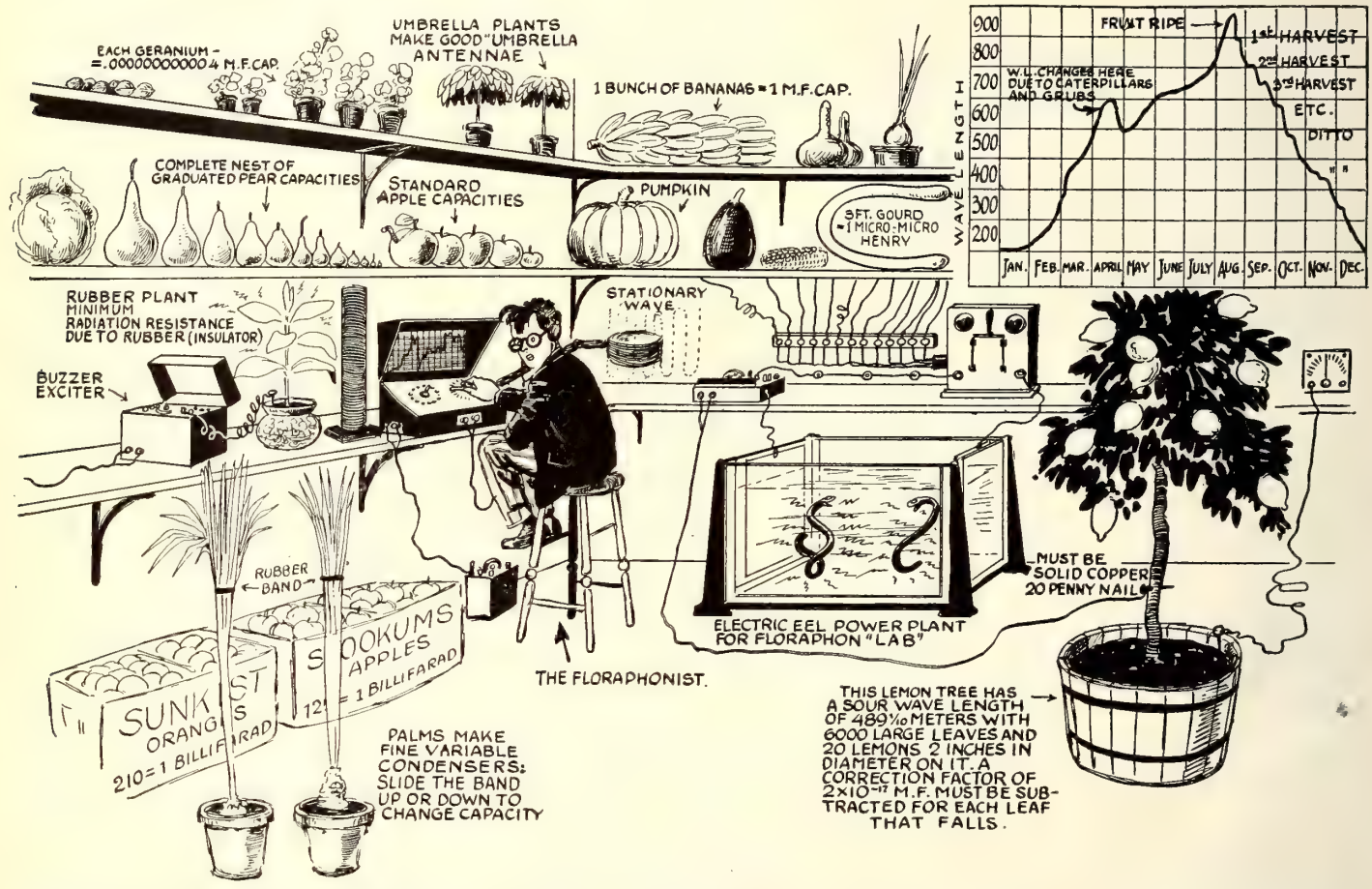
About the most suitable formula devised for the calculation of high frequency resistance of tree antennae is as follows:

$$\text{H.F.R. equals} \frac{drLB \times drMB \times drSB}{\div dr \text{ of trunk of tree}} \times NP.$$

$$\frac{}{\text{resistance of one leaf} \times NL}$$

Where; dr—Direct resistance.
drLB—Direct resistance of large branches.
drMB—Direct resistance of medium size branches.
drSB—Direct resistance of small branches.
NL—Number of leaves.
NP—Number of pears.

(Translated from the Hertzian Wave Nut-book by E. T. Jones.)



Well, Papa Squier Started Something When He Wished This "Tree Wireless" on Us. Here Is a Typical View of a Young and Enthusiastic "Floraphonist" Busily Engaged in His Frost-Proof "Lab.," Doping Out the Natural Wavelength of a Healthy Rubber Plant. It's a Man's-Size Job to Calculate the Wavelength of a Tree, Especially on a Windy Day, When the Leaves and Fruit May Be Blown off in Considerable Numbers. Each Leaf and Pear or Apple Can Be Compensated for in the Calculations, However, Once the Micro-Farad Capacity and Micro-Micro Henry Inductance, Values for Each Are Determined and Known. If Anyone Can Successfully Compute the Wavelength of a Healthy Young Pear or Plum Tree in Full Fruitage, He Should Certainly Be Awarded the "Nobel" Prize in Physics—We Said It,—"If" He Can Do It. We'll Wager He Will Need a Dozen "Einsteins" Before He's Thru. And Then the Wind Comes Along and Spoils All the Calculations. Gads, Tho!!!

Radio Guides Ships Thru Fog

"YOUR naval communication service, especially in its radio compass stations and their activities, is a great institution and a distinct boon to seamen. It ought to be maintained permanently," said Captain W. F. Wood, D.S.C., master of the steamship *Lancastrian* of the Leland line, recently, as he described what the U. S. Naval radio-compass service had done for him on his latest entry into New York Harbor. Consulting his log from time to time for the sake of accuracy, Captain Wood said:

"We were bound in from Antwerp to New York on the afternoon of October 3rd and had expected to make the Nantucket lightship by six o'clock. At 5:50, however, we ran into a dense fog. I slowed the engines to half speed and kept heaving the lead, which registered from thirty-six to twenty-five fathoms. We got the latter sounding at eight o'clock. This gave me a good line of soundings to compare with the chart, but we could not yet hear the foghorn aboard the lightship. At about half-past seven o'clock I had the radio officer sound our signal and call up the radio-compass station on Fire Island, the signal letters for which are N. A. H. The message we sent by wireless to Fire Island read:—'What is my true bearing?' It was signed, 'Wood, Master.'"



Photo New York Herald

Sandy Hook Got Captain Wood's Appeal at a Distance of Sixty Miles. Mantoloking Was Even Further Away. These Stations and Also That at Fire Island, by Their Land Lines Into New York, Reported the Bearings of the Lancastrian From Their Respective Positions. The Central Station, Within Ten Minutes Then Sent All Three Bearings by Radio to the Leland Line Ship and Her Master's Mind Was at Ease.

RADIO COMPASS LOCATION GIVEN IN TEN MINUTES.

"I was standing in the radio room at the time, looking over the shoulder of the operator, who kept sounding our letter code signal on his transmitter. Within ten minutes after we had asked for our true bearing from Fire Island the following reply came crackling back to us:—

"'Your true bearing at 7:39 P. M., from Fire Island, 109 degrees; Sandy Hook, 87; Mantoloking, 65.'

"This radiogram was dated from the *central compass control station* of the Naval Communication Service, at No. 44 Whitehall street, New York. When I wrote my message of inquiry and handed it to our Marconi operator I handed him along with it a slip of paper on which I had written my own estimate, by dead reckoning, of our position at that time. I had figured it to be a bearing of 108 degrees from Fire Island. When, as I looked over the shoulder of the receiving operator, I saw him write down, 'From Fire Island, 109,' I was pleased that I had estimated our position within one degree.

"Imagine my delight and surprise when, right on the heels of this bearing, came the additional readings for our direction from Sandy Hook and also from Mantoloking, N. J. It was then a matter of only a few moments to project these three lines upon the chart, and the point at which they *intersected* was, of course, our precise position at 7:39 P. M.

"So we carried on then with entire confidence, tho the fog continued dense. At ten o'clock I hauled my course to the northward and at 10:40 o'clock the fog lifted and revealed the Fire Island light abeam, exactly where it ought to be to prove the precisely accurate information flashed to us out there in the murk three hours earlier from the central compass control station in New York City.

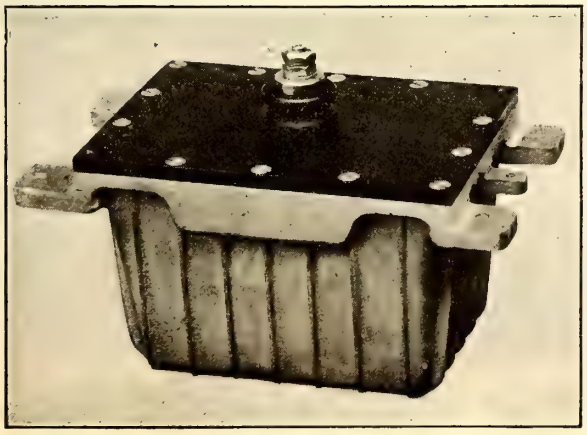
"There is not the slightest doubt of the inestimable value of these radio position finders. We have nothing of the sort installed as yet in England, but I hope we soon shall have them. The Admiralty, however, has instructed all masters concerning their use on this side and has emphasized their value."

Thus does the field of the "Radio Compass" expand daily almost.

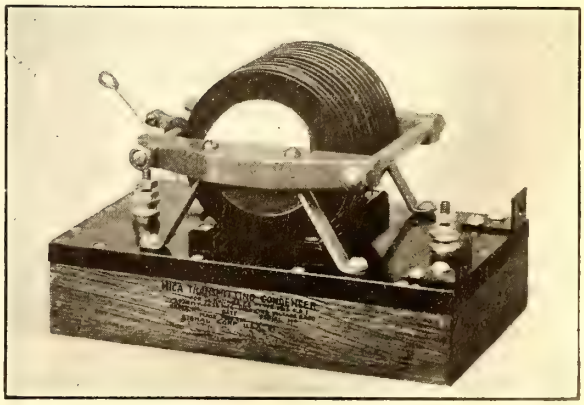
Mica Condensers for Radio Sets

A new mica condenser for radio equipments is now being made which the manufacturer states is in use by the United States and Allied Governments and many of the large companies manufacturing radio apparatus. The maker calls attention to the fact that since its invention in 1745 the Leyden jar has been used in practically its original style, without any radical improvements or changes. Practically every radio equipment is used to its capacity, and up to the time this new mica insulated condenser was invented Leyden jars were used especially for high potentials. When in operation the radio apparatus thus equipt was not safe and reliable, as the Leyden jar would crack and break down after a continued use for an hour or so making the apparatus inoperative.

Wherever metal containers are not suitable the condensers can be mounted in wooden or other insulating boxes, or the metal case can be insulated from the condenser itself and the condenser terminals mounted independently on two insulated posts.



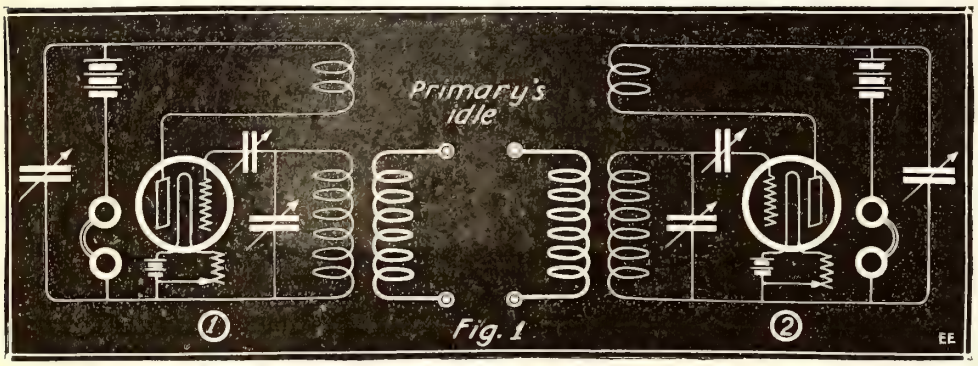
A New Mica Condenser for Radio Equipments Which the Maker States It Is Practically Impossible to Break Down Even When Used for High Potentials.



"Locating Submarines by Audion Syphoning"

By Edward T. Jones, A.M.I.R.E.

PRACTICALLY every one familiar with the present day types of audion circuits employing the feed back systems realizes the fact that if two such receivers in close proximity are tuned to the same wavelength "syphon-effects" of considerable magnitude are produced, and the oscillations emitted by one tube are picked up by the other receiver and vice versa.



Two Audion Receiving Sets Arranged Some Distance Apart Have, Under Actual Tests By the Author, Shown That When Both Are Tuned to the Same Wave Length, That Station No. 1 Can Hear the Note of the Oscillating Audion At Station No. 2, and Vice Versa. This Effect is Termed "Syphoning".

Recently, the H-2 (U. S. submarine) successfully demonstrated the ability of underwater craft to transmit and receive while submerged. The H-2 submerged and communicated with airplanes and vessels of the fleet. This naturally proves that during wartime a submarine can easily keep in touch with the ships and shore stations, and receive its radio compass locations at various intervals. However, it is to be expected that this system will come into general use on all the submarines of the foreign Navies, and that during wartime they will endeavor to exercise the use of such a system freely. We may then consider an enemy submarine as having submerged after having sighted its adversary; it then naturally maintains silence in respect to its transmitting apparatus, and continues to listen in for what the destroyers and other vessels may have to say. The fact is, that the vessel while endeavoring to maintain silence is defeating its own endeavors, for while listening in, the receiving bulb is actually *transmitting*, and if any of the destroyers tune their receiving apparatus to the same setting which the submarine is listening in on there will result the syphoning effect described previously. Should the destroyer be equipt with a direction finding apparatus it can without any difficulty run down this undersea craft without the latter knowing what is happening. This is only one of the many uses this previously dubbed nuisance can be put to.

POSSIBILITIES OF LOCAL COMMERCIAL STATION SYPHONING AMATEURS.

Since the general use of audions and their associated circuits was adopted, it has been heard from numerous sources that Amateurs who have copied a certain station one night could not receive this same station the following night. This further lends aid to my beliefs and as the reader shall understand from what follows, it was due to the fact that *the "Large Commercial Station" in that particular vicinity was syphoning the smaller stations* and the following night the effect was not present because the "Controlling" station was not listening on that same wavelength and no syphon effect took place; naturally the short range of the smaller Amateur installation did not permit it to copy signals from the extraordinary distances recorded the night previous. In figure 1 two receiving sets of the feedback type are shown and are separated in this instance fifty feet apart. Both sets are tuned to the same wavelength (say 1000 meters) and the two sets are then in resonance. Number One can hear the true clear note of the oscillating audion at station Two, and vice versa; this is caused by the receiver also acting as a transmitter and if a key is arranged in the circuit to vary either the inductance or capacity, intelligent signals can be transmitted between the two. This effect has been termed "syphoning" and is very pronounced at stations where the receiving apparatus are very near to each other.

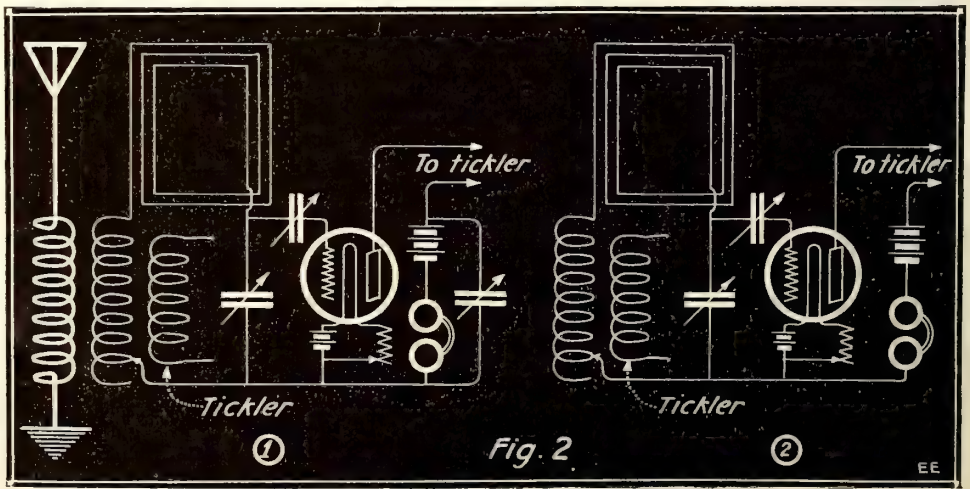
I have personally carried out experiments at distances up to two thousand yards and with suitable receiving apparatus informed the receiving operator the correct wavelength he was listening in on. Of course, as mentioned before, this depended upon the receiving operator having his bulb oscillating, and likewise my own, in order to pick up the undamped oscillations being emitted by his receiving apparatus.

Furthermore, I have, without an antenna connected to my receiver and same maintained in a state of oscillation, been syphoned by a large receiving station, when I was located some five hundred feet from the antenna and receiving apparatus. Now the MAIN FEATURE OF THIS PARTICULAR INCIDENT IS THAT THE SYPHONING EFFECT (WAVE) ACTED AS THE CARRIER OF THE SIGNALS BEING RECEIVED FROM THE OVERHEAD ANTENNA CONNECTED TO THE RECEIVING STATION SOME FIVE HUNDRED FEET FROM ME. This prompts me to believe that many of the Amateurs in and about a city where there is a large Commercial or Naval plant should not put too much faith in their own receiving apparatus in respect to the remarkable distances covered with the same; for it may be that they are being syphoned by the local station which has the apparatus to easily cover the distance.

Another fact which I may mention here is that, when a station is in the act of syphoning another, it tends to reduce the strength of signals received at that station, and tends to rob it of some of the signal's strength. It may be that the total is proportionately divided between the two, three or four, whichever may be the case.

ELIMINATION OF STATIC BY SYPHON METHOD.

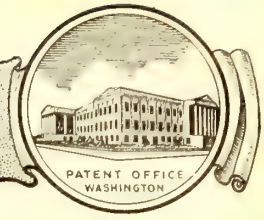
I have also found thru my extensive experiments and investigations into the possibilities of this phenomena that when syphon waves act as the carrier of signals from the main receiver to another receiver installed some several hundred feet away, the static which is so pronounced in the first instance is hardly perceptible at the second receiving apparatus, although the signals have not undergone a great degree of weakening. It is my contention, that if a receiver, say number one in figure 2 had a coil of fairly large dimensions inserted in the secondary circuit so that this syphon wave could be directed to one certain point (where the second receiving apparatus is installed) that a maximum of the signal would be received there, in a greater proportion than the static. While I have no good theory to offer at present for this statement, it has proven so in actual tests and therefore there does not seem to be very much need for lengthy explanations.



"Static" is Reduced When the Signals are "Syphoned" from the Main Receiving Station to a Second Receiving Set, Says the Author. He Suggests the Use of Two Loop Aerials as Shown, to Transfer the Energy to the Second Receptor.



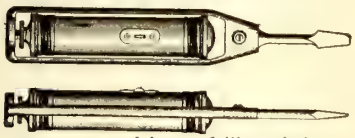
LATEST PATENTS



Illuminative Tool.

(No. 1,309,363, issued to Edward J. Meinke.)

We have seen illuminative pens and pencils, now comes the illuminative tool. This patent, recently granted, consists of a device which will hold various instruments such

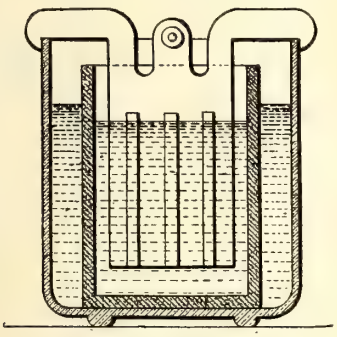


as a screw-driver, drills, gimlets, augers, chisels and the like, in the form of a handle or a frame, so that any well-known standard electric flashlight can be mounted therein. Hammering on the frame will not injure the flashlight, which can be removed if necessary, and a new battery inserted.

Primary Electric Cell.

(No. 1,310,695, issued to Harry E. Evans.)

Generally, in primary electric cells employing two fluids, the electrolyte and depolarizing fluid, a porous cap was heretofore necessary in order to separate the two liquids or else the gravity method had to be used. In this idea, however, a new use is given to the carbon inasmuch as it acts not only as the positive pole of the battery, but also as the porous cup separating the electrolyte placed within its recess, from the depolarizer outside. The zinc being suspended in the carbon cup. In this manner the cell is not only simplified, but cheapened, and the internal resist-

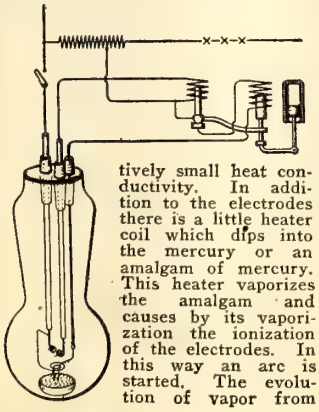


ance caused by porous cups in the past is greatly reduced.

Enclosed Electric Arc.

(No. 1,310,067, issued to Philip K. Devers, Jr.)

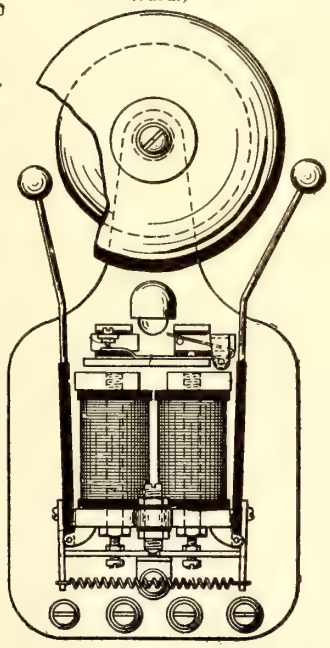
This relates to enclosed arc lamps in which an arc is operated between electrodes of refractory materials. The entire arc is enclosed in a chamber which has a constriction in its center and is filled with a gas at a pressure slightly above atmospheric. The gas contained within the globe has rela-



tively small heat conductivity. In addition to the electrodes there is a little heater coil which dips into the mercury or an amalgam of mercury. This heater vaporizes the amalgam and causes by its vaporization the ionization of the electrodes. In this way an arc is started. The evolution of vapor from the mercury or amalgam displaces the nitrogen or other gas into the upper chamber, and hence increases the efficiency of the lamp by supplying an atmosphere of vapor between the electrodes.

Novel Electric Bell.

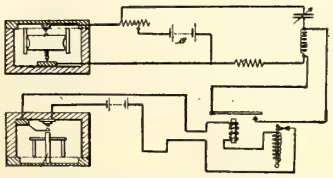
(No. 1,310,813, issued to Albert M. Ward.)



This idea comprises two bells, one over the other, with respective hammers to operate either of them. Each hammer may be attracted when an outside circuit is closed, energizing one of the coils. The make-and-break in this case is at the lower end of the bell in the form of a set screw. A winding is placed on both cores in such a manner that the third circuit in the form of a buzzer may likewise be operated. Inasmuch as this third circuit is of a much higher frequency than that at which the bells can operate, no noticeable effect is perceived, and the hammers do not actuate, altho the buzzer vibrates and the cores themselves are energized.

Acoustic Actuating Mechanism.

(No. 1,310,568, issued to A. C. Heap and O. B. Field.)

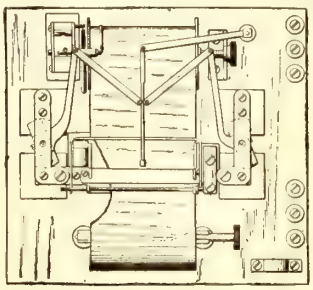


This invention relates to a method of detecting sound waves or pulses transmitted thru water and is attached to the surface of an under water mine, or submerged body, and either serves to operate a signaling device or cause the mine to explode. It only operates when it receives sound waves or impulses of a certain strength, and according to its inventors does not go off even if heavy explosive charges are detonated in its vicinity. A "dancing contact" is used, which responds to the sound waves, the entire case being filled with some liquid, such as oil. When sound waves of a certain pitch are received, the resistance between the electrodes varies, and the potential difference at the terminals of the condenser is varied, thus allowing a pulsating current to pass thru the device.

Telautographic Apparatus.

(No. 1,312,596, issued to George S. Tiffany.)

With this telautograph apparatus writing movements of the receiving pen are kept in unison with

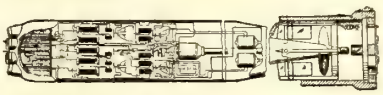


the transmitting tracer under which there is a system of tracer lines, affected by the movements of the sending pen. In this way, more or less, current is allowed to pass, and the movements of the receiving pen are affected by the magnetic coils, which are excited to a variable extent during the transmitting operation.

Sound Controlled Dirigible Torpedo.

(No. 1,312,510, issued to George Baker.)

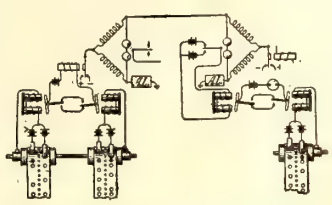
This invention seems very plausible. It consists of a torpedo which is discharged from a torpedo tube automatically; when it reaches the vicinity of some enemy craft the propelling mechanism is set into motion. The torpedo on becoming active, guides itself directly towards the enemy ship, due to the sound waves set up by the vessel. A plurality of microphones are arranged to the various circuits, so that when the sound, which comes in stronger at one microphone than at another, will affect the steering rudder in such manner until both sounds are of same intensity. The elevating rudder is likewise controlled in similar manner.



Secret Signaling System.

(No. 1,312,574, issued to Ralph E. Pierce.)

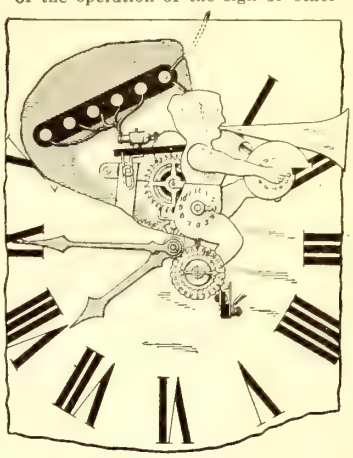
Many patents have been issued which have attempted to send secret messages by alternating or breaking up the current impulses into unintelligible signals by means of ciphering switches, all of which have some good and some bad features. A device which promises to become very popular is this one granted recently. It implies two systems of tapes which are run on a drum, the said tapes being perforated so that extra impulses may be sent, and the regular dashes or dots broken up by the action of relays operated by the tapes. At the receiving end another tape travels thru a like apparatus causing some signals to be inserted and others removed from the original message as transmitted over the line, as can easily be noted in the accompanying diagram. In this way, absolute secrecy is obtained by use of the key for ciphering and deciphering. Synchronizing devices are employed to control the speed of these keys.



An Automatic Sign.

(No. 1,313,757, issued to Samuel C. Swindler.)

This patent consists of a figure carrying a relatively stationary leg, a pivoted leg and a pivot body and is arranged in front of a dial. The pivoted body swings backward and forward during vertical movement of the plate. There is a spiral cam rotatively mounted between the arms carried by the body and which is provided with numerals, so that it may be moved under the indicating finger. In this manner the operator can regulate the duration of the operation of the sign or other

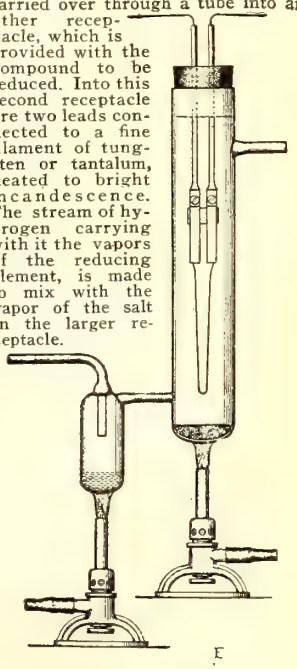


electric device controlled by the five or more circuits. For controlling another set of lamps another dial is pivoted on the body and still another at the foot. In this way a plurality of electric circuits may be operated.

Producing Pure Elements.

(No. 1,306,568, issued to Ezechiel Weintraub.)

This invention relates to a method of isolation of difficultly reducible elements, such as uranium, which were always very difficult to reduce. The reducing metal (sodium) is contained within a smaller receptacle, and it is heated and purified by a stream of hydrogen which enters at the inlet. When it is vaporized it is carried over through a tube into another receptacle, which is provided with the compound to be reduced. Into this second receptacle are two leads connected to a fine filament of tungsten or tantalum, heated to bright incandescence. The stream of hydrogen carrying with it the vapors of the reducing element, is made to mix with the vapor of the salt in the larger receptacle.





WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

The Editors desire to call to the attention of all owners of "Electrical and Chemical Laboratories" the fact that hereafter the MONTHLY PRIZE WILL BE $5.00 CASH, instead of $3.00. ALSO $2.00 CASH WILL BE PAID TO EACH "HONORABLE MENTION" ENTRY PUBLISHT. We have not received any "Laboratory Photographs" of late. So "go to it" and send us your photo, together with that of your laboratory. If they are particularly good we may list some new and bigger prizes. So get busy, Boys!!! It's up to you. Here's a way to earn some greatly wanted laboratory apparatus at no cost whatever. Don't be afraid to send in too many photos, Boys.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER— CHARLES AMBROSE YOCUM

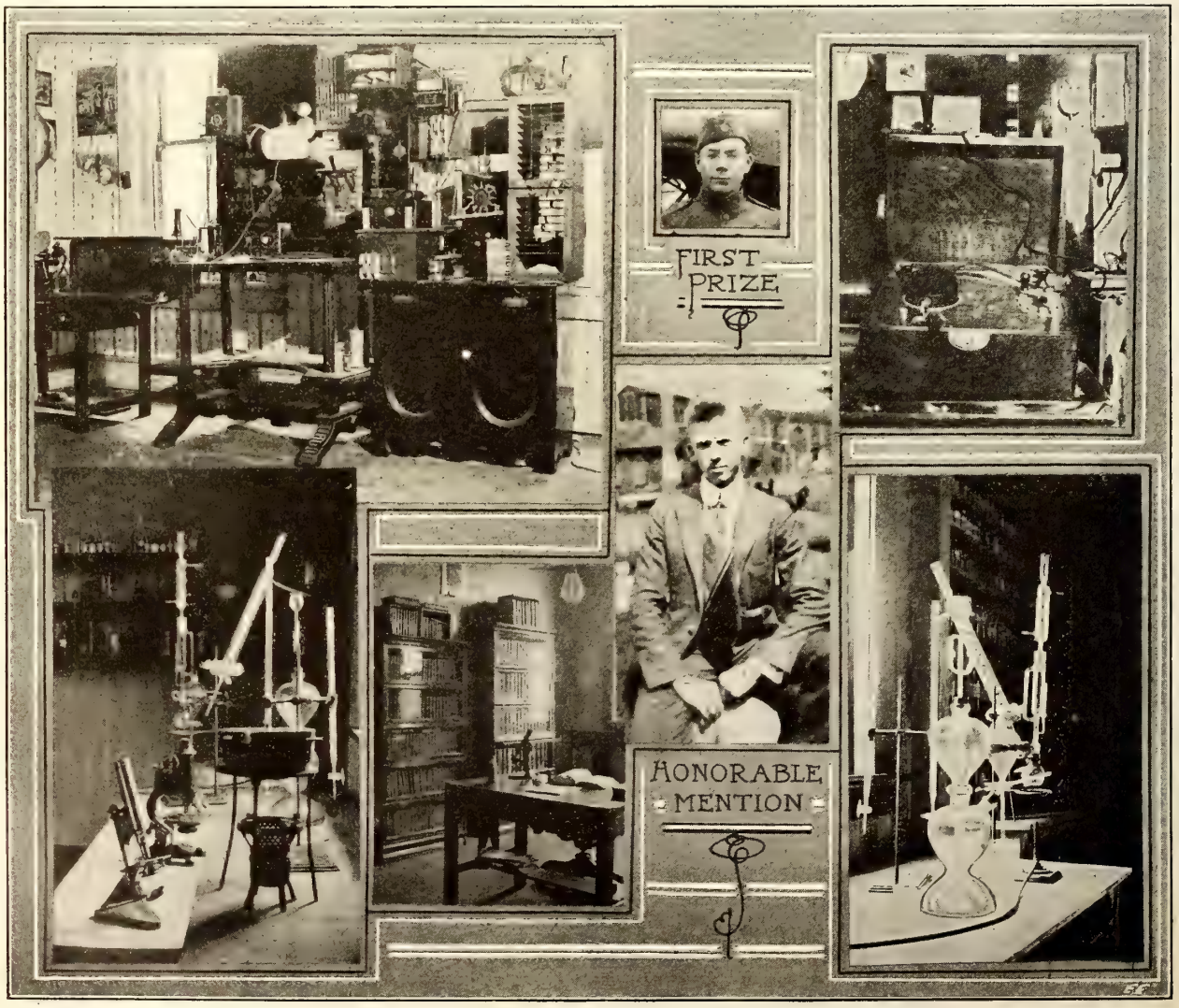
HEREWITH are a few photographs of my "Electrical Laboratory." I have a one-half kilowatt step-up transformer, a Tesla coil giving a six-inch spark, a one-inch spark coil, a water-power motor running a generator, a few small motors, rotary gap, 18" by 8" loading coil with 36 taps, step-down transformer, Brandes head set, 20 plate glass sending condenser, two mineral detectors, loose coupler of the navy style, telephone transmitter on swinging arm (in the middle of the switch-board), used for a speaking arc, which is also used on my telephone by utilizing a double-throw switch. I have electric meters, so I can always know how much power the apparatus consumes. There are two antennae, one 200-foot, two-wire, used for receiving, and one four-wire, 120 feet long for sending. I also possess a carbon rheostat, Murdock oscillation transformer, Murdock wireless key, with a shunt device under key, which shorts the detector when the key is pressed.

I have a good range in sending and with an Audion can receive about 2000 to 3000 miles. On top of the step-up transformer is seen a small box; it contains a small receiving and sending apparatus capable of transmitting one-half mile and receiving ten miles.—Charles Ambrose Yocum, 438 Fairview St., Pottsville, Pa.

HONORABLE MENTION—B. O. SHIFLETT—$2.00 PRIZE PAID EACH "HONORABLE MENTION"

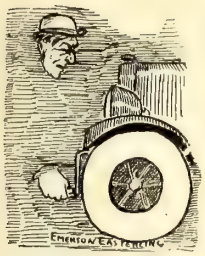
MY "laboratory" is in a large, well-aired, spacious room on the second floor on a corner facing northeast and southeast. While it is equipt chiefly for chemical and microscopical work, yet it has five electric light connections or sockets for 110-volt A-C. There are numerous pieces of electrical apparatus, such as induction coils, telegraph apparatus, small motors, transformers, static devices, etc. I have spent a great deal of my time in the study of phonographs, cameras, telescopes and microscopes—trying to make improvements on phonographic devices; and in the field of lenses, making adaptations of different forms to certain kinds of conditions, such as the projection of "microphotographs" and "microphotography." One of the pictures shows one corner, in which is a lavatory, to the right of which is a work table, covered with some equipment set-up, burettes, Leibig still, Soxhlet extractor, Kipp's gas generator, separatory funnel, water-bath, Bunsen burner and alcohol lamp and two high-powered microscopes. The other photos show one end of the chemical cabinet, the top of which contains shelves filled with chemicals and reagents, the bottom being filled with apparatus.

I have been reading the ELECTRICAL EXPERIMENTER ever since it first began.—B. O. Shiflett, 138 So. 55th St., Birmingham, Ala.



Science in Slang

By EMERSON EASTERLING



N the Fritzey again!" howled the chauffeur.

The benzine go-cart had just exhibited its muline instincts — or tendency toward inertia as far as locomotation was concerned.

The azurely, effluviated auto-engineer wandered into the depths of the unknown that lies beneath the hood and Punk turned to Jazz with:

"Say, Stazz Jokes, will you be so kind as to bust loose and put us ignorant honyots wise to the hidden mystery that most everyone knows about—but I don't——that makes the buses commence up the street without the herder pouncing out and doing the Henry Ford at the bow end of the land craft? I know how to jump on the self-beginner and how to keep the gas operated thumper rattling, after I do the fatal stunt —but what I crave is the *why* and the *wherefore*—dost thou getteth me, Sir Lunchalot?"

"The person spoken to doth," returned Jazz.

The story then runs something like this

"Once upon a time—in the first gray days of modern mechanical history, a boob sat at a pile of junk—we'll not give the guy away— waxing sore and emitting moisture under the hat. Ye olde inventor was working on a conglomeration of metal that was to furnish power by the expansion, or rather the concussion or pressure exerted from a series of explosions that were to take place in an enclosed chamber. But the question was to make the explosions in a true classical manner.

Juicing the Jazz Wagon

"Some score of bewildered brothers in the game had tried many means of bringing the probability into an honest possibility. But our hero—"

"You mean villian!" This from the besmeared driver who was—you know—up fore.

"But our ———," continued Stokes, "was working on another wise hunch. His graft was to harness the Goddess Electra along with the God. . . . (Editor, please insert here the name of some political enem . The writer is no political authority. Besides we might not agree. I'll take the blame of your choice—if blame falls. Enclosed in parenthesis is *not* intended for print.)"

"(Political enemy)?" wondered—out loud —Mr. Vote, our artist friend from Portland, "Why do you use him for some contribution God? What is he supposed to be god of?"

"Gas—along with hot air," smiled back Stokes.

"As I was about to say," Stokes went on, "our what-you-may-call-him, as he sat dripping over the model of his brain baby, thinking and sweating, doped out the spark ignition for gas engines. Before that the bums on the works had been using flint lock contraptions, flame, and everything.

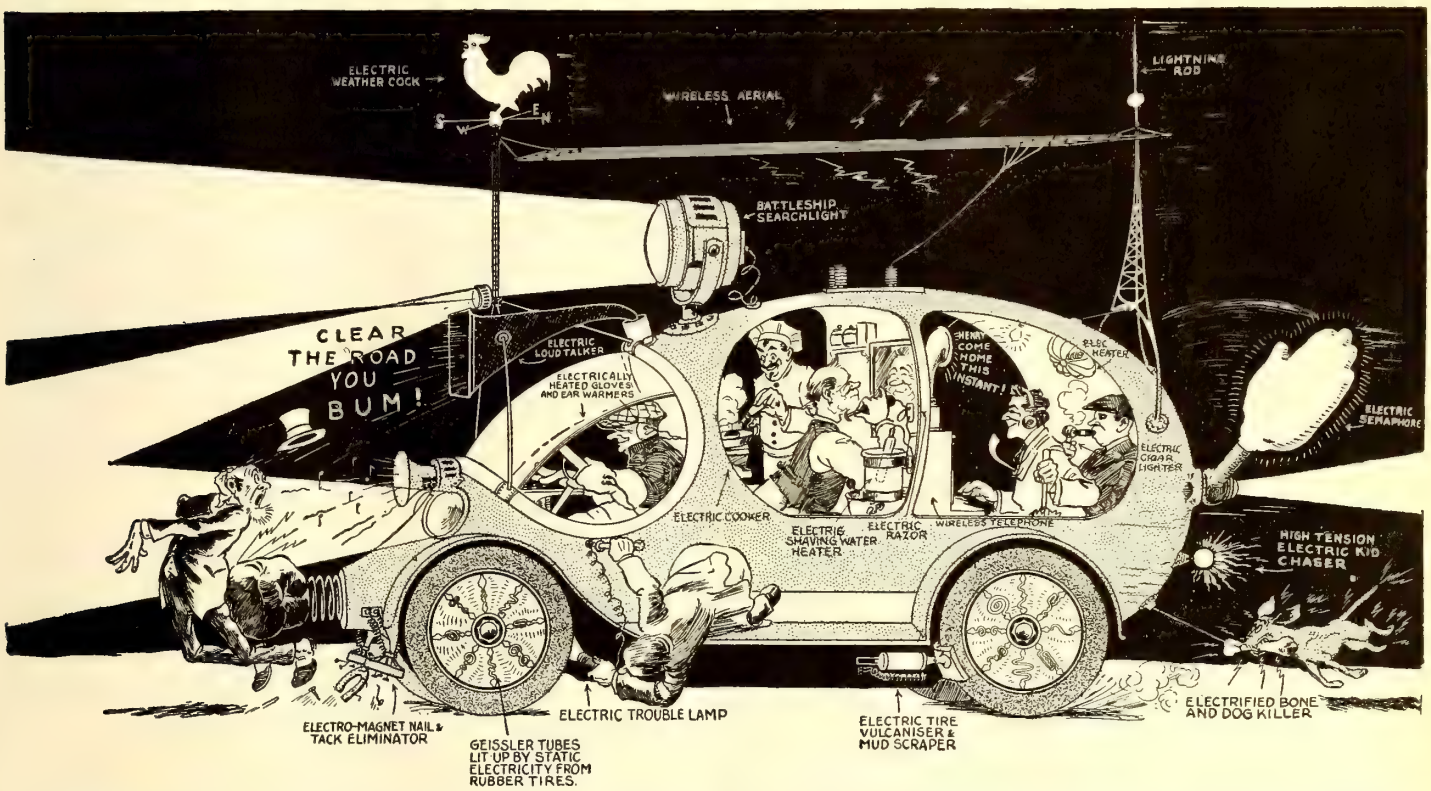
"The spark stunt proved to be *the* thing in the game. As time shapened out the ends —like Shakie averred divinity would do —spark plugs came into existence. If you care to see how far the inventors have wandered in the field, just meander into a spark plug emporium and gaze over the assortment. Every one is claimed to be a little better in some way or other for some purpose or other than the rest.

"Some manufacturers are not satisfied with one spark plug and jab in a couple—this is in the larger types of stationary engines. For the automobile engines *one* is a-plenty—at least *at a time*.

"To get down to the information of the situation: The thing is run like this: A source of juice, say a bank of batteries—a battery to be explicit, furnishes the V plus A for the induction—or spark—coil. The voltage—that's the capital V—up to a point where it is not hampered by a short air or gas gap, flashes right across and ignites the inflammable mixture in the cylinder chamber and does the same thing in a mechanical way that a lot of similar things do in a political way.

"Of course, the guy that uses the engine don't want the spark shooting across the gap steady, or at random, so the makers have devised all sorts of do-funny things they call timers and—you know, those cute lil trade names. All serve the same purpose—that of making the necessary arrangements to have the spark blaze away at the psychological, or rather the physiological moment. The revolving of the revolving parts of the motor cause the circuit to be opened and closed. As the engine speeds up it is more efficient to have the ignition take place a fraction of a second sooner than in the case of slow running or hard pulling. For this purpose there is installed on most cars the spark advance, or adjuster, with which we are all familiar.

(*Continued on page* 798)



If Your Flivver Has a Well Stocked Juice-Box Don't Be Bashful—But Go the Limit. This Being the Electrical Age—or Rage—Let's All Be Comfy. Take a Squint At the Above Portrait, But Don't Crack Your Lip Laughing. The Fact Is, There's Nothing Phoney About This 21st Century Buzz-Wagon. Step This Way, Boys, Right Into Any Automobile Confectionary Store. They Will Sell You All Your Electrical Rinktums—and Lots Besides. We Would Have Stuck a Few More Gross Onto Our Flivvernacular, Only the Artist Went Bluey and Struck for Less Art and More Pay.



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

ROGERS GROUND ANTENNAE.

(1030) H. I. Middleton, Hendersonville, N. C., asks several questions in reference to Rogers Underground Antennae:

Q. 1. If bare wires can be used as underground antennae (as per article in June, 1919 EXPERIMENTER), why can't waterpipes, etc., which are available and already buried, be used?

Q. 2. If a bare wire is used for underground antennae, how and why should it be connected to the regular "Ground" wire which diagrams in June article call for?

Q. 3. In what order of efficiency will the following styles of antennae rank, viz: Regular Tower Antennae, Tree Antennae, Underground Antennae?

Q. 4. Will the Tree Antennae and the Underground Antennae require specially constructed or sensitive receiving instruments (audion, etc.), or will they work just as well with the usual Amateur Receiving Sets?

A. 1. With reference to the Rogers underground antenna, and as to the reason why ordinary waterpipes, etc., cannot be used for aerials, would say that such piping systems buried in the ground have yielded very good results in some cases for the reception of radio signals, tho usually they do not correspond in efficiency to a well-laid Rogers antenna. Also in the case of the latter, there is an added advantage of high conductivity in the copper conductors as compared to ordinary waterpipes, and, contrary to the average opinion, common water is not a good conductor, but a very poor one, with a consequent high resistance.

A. 2. With respect to the connection of a bare wire Rogers antenna thru the receiving apparatus and then to the usual ground connection, would say that the Editor of the "Oracle" has personally heard signals coming in with a high audibility, using the antenna only, with no connection to the usual ground. But when the ground is also used in connection with one of these buried antennae, the signals come in somewhat louder. The whole philosophy of the Rogers underground aërial and its operation is, it would seem, based on the simple fact that the copper wires buried in the ground, whether bare or insulated, are many times higher in conductivity than the ordinary earth, and therefore due to this conductivity an appreciable radio current is induced and interpreted thru these conductors.

A. 3. The probable ratio of antenna efficiency would be (a) regular elevated antenna, (b) underground antenna, (c) tree antenna. The underground antenna does not always show as high an efficiency as some of the large elevated aërials in use at some of the Government stations, but it invariably has the advantage of the elevated antenna during periods when there is an appreciable amount of static, and signals can be copied on the underground aërial thru thunderstorms without the least danger, or without any interference from static.

A. 4. We cannot say as to the sensitivity required in the radio receiving instruments to be used with tree antennae as developed by Major General Squier, but would presume that any ordinary audion receiving set would give good results. The usual apparatus employing an audion detector may be used with great success with the Rogers underground antenna, and when the writer visited Mr. Rogers' laboratory he was using but one detector and amplifier, namely, an *audiotron* bulb. This bulb was connected up so as to oscillate when desired, in order to receive the undamped wave stations.

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New stations, both commercial, government, and private. Owners of private or amateur stations will find a special contest for these photos on another page of this issue.

And don't send us plate or film "negatives"; send unmounted or mounted "prints", preferably a light and dark one. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation.

Address photos to—Editor "Odd Photos", Electrical Experimenter, 233 Fulton Street, New York City.

You will find an interesting article on the tuning of underground antennae to optimum wave lengths, by J. Stanley Brown, in the "Radio Amateur News" for July, 1919.

DATA ON FIVE-COIL LOOSE COUPLER.

(1031) M. R. Smith, Winnipeg, Man., Can., writes the "Oracle":

Q. 1. What are the dimensions and what size wire is used in the construction of the "Five-Coil Loose Coupler" shown on page 74 of the May issue of your excellent magazine, which is used by Samuel D. Cohen in his "New Regenerative Vacuum Tube Circuits"?

A. 1. We are pleased to give herewith information you request on the five-coil loose coupler.

L_1, 10 inches long, 7½ inches in diameter, wound with No. 20 silk-covered wire.

L_2, 8¾ inches long, diameter 6⅛ inches, wound with No. 26 silk-covered wire.

L_3, 8¾ inches long, diameter 5½ inches, wound with No. 20 silk-covered wire.

L_4, 4 inches long, diameter 7½ inches, wound with No. 20 silk-covered wire.

L_5, 4½ inches long, diameter 5½ inches, wound with No. 20 silk-covered wire.

PHAROAH'S SERPENTS.

(1032) E. F. Rightsell, La Grange, N. C., inquires:

Q. 1. Can you give me the formula for making the fireworks novelty called Pharoah's Serpents? It is a small pill or cube which when lighted will burn and the ashes will extend outward in the shape of a snake.

A. 1. The formula for making Pharoah's serpents, altho very efficient, is not generally used in the house, inasmuch as when these chemicals are combined to form the serpents they cause a strong odor of burning sulfur.

The following formula, however, may be adapted to both indoor and outdoor entertainments:

Potassium Chromat.....2 parts
Potassium Nitrat.....1 part
White Powdered Sugar.....2 parts

Powder each ingredient except the sugar very carefully. Then spread the powders on a piece of paper, and by carefully working with a spatula insure a thoro mixture of the ingredients. Moisten with a little alcohol and work into a paste. Now form into pellets about the size of a pea, or, in fact, any size desired, and allow to dry. These should be very carefully covered with a layer of tin-foil or tin-foil wrapping and placed in a large box, so that accidental friction will be almost impossible. Do not use a box with a slide cover, as friction when the cover is removed might cause harmful results.





Will Captain Smith return to Floorwalking?

There are thousands of men like Captain Smith who, before the war, were occupying relatively unimportant positions in the business world. Then, in a few months after the call to colors, they were holding commissions in the army. Millions of others found their way from positions in all walks of life into the various camps, where intensive training quickly turned a nation of business men into the world's finest fighting machine. It almost seemed incredible—but what this array of business men and workers did as "their bit" is now history. What took Germany forty years to prepare for was done in a few months by America. This record was made possible only by INTENSIVE TRAINING.

Though Captain Smith may return to his old job of floorwalker, it will be only for a short while—time enough to complete a course of intensive training in some line or other that will make him mentally fit for a better paid and more responsible position. He knows that intensive training will do this for him just as surely as it qualified him for a commission in the army.

Intensive training made him a leader of men. It enabled him to give orders instead of taking them. It enabled him to think, act and reason for himself and do the thinking for those under him—often a matter of life and death. No! Captain Smith couldn't be content in his old job, because he knows how to get a better one.

The War's Great Lesson

Every man who stepped from his job in civil life into an intensive training camp has learned a valuable lesson—a lesson that will make him a better business man if he but has the will to win. These men have witnessed the wonders of intensive training—have seen the metamorphosis in their own individual lives as well as in those of others, and it is but natural to assume that, if intensive training in military matters performed such wonders, it must have the same beneficial effect when applied to business. The history of business and of business successes points unerringly to the assistance rendered by intensive training.

Since the armistice was signed, and more particularly since the American troops began to arrive home, there has been a noticeable increase in the number of enrollments for intensive business training in all lines of endeavor taught by the American School. Thousands of men who were simply "getting by" instead of "getting on" before they joined the colors, have learned a lesson and they are not going to be content with the poorly paid jobs they held in the past. This fact is proved by the great increase in students who are availing themselves of American School training. In a few months these students who are now applying intensive training as a solution of "how to get on," will be able to qualify for the goal they have in mind. The spare time hours they devote to this training will bring them rich rewards in the form of bigger pay checks, better positions and more congenial work. The result of such training cannot be otherwise, for trained men are the scarcest commodity on the market.

After seeing what a few months of intensive training did for him from a military standpoint, he, and thousands like him, are going to avail themselves of the same method as a means of self-betterment in business life. There's proof below that it's the only way to secure promotion and much better pay.

An Investment Without an Equal

If you think for a moment that there is another investment that can equal the time and small amount of money spent in intensive training—get out your pencil and do some figuring.

If a course of intensive training in your chosen line costs you from $50 to $100—and your spare time—how much would that money earn for you if invested in stock? From three to ten dollars per year would be the limit, wouldn't it?

The same amount invested in intensive training will double, treble or multiply your earning power several times, because it makes you a better business man and makes those who employ you aware of that fact. There's no sentiment in determining salaries. You get paid for what you can do—and that depends solely on what you know.

Your spare time does not earn you anything NOW—so you can't charge anything to a course of intensive business training but the actual cost of the course. If the result of this training only increased your earning power by ten dollars a week—and that is a conservative figure—you would net FIVE HUNDRED AND TWENTY DOLLARS a year from a small investment of cash and spare time. That is a small gain when compared with actual returns reported by American School students, but small as it is it serves to prove that there is no other investment in the world that pays so well as a trained brain.

Thousands Bettered by American School Training

It has been the privilege of the American School, a fully chartered educational institution, to prepare thousands of ambitious people for better positions in all trades and professions. For nearly a quarter-century it has been advocating intensive training and, today, there are thousands to testify to its efficacy—thousands who are now enjoying healthy incomes and congenial work as a result of the spare time they devoted to American School training. The same measure of success can be yours. Proof of scores of these successes will gladly be mailed you on request.

A School That Is Known by Its Guarantee

The American School believes that education, like merchandise, should be sold on a "make good" basis. Doing business strictly by mail demands some guarantee as a protection to the student. That is the belief of the American School—and it is on the basis of SATISFACTION OR MONEY REFUNDED that a student enrolls. All risk on the part of the student is eliminated. At any time during the first year of your enrollment we guarantee to refund your money in full if, after the completion of ten examinations, you notify the School that you are not satisfied with your course. Ten examinations will prove to you whether or not you are getting practical, money-making training. You are the judge.

Don't Dodge a Better Job

Whether you get a better position and better pay is up to you and you alone. The American School can help you get the position you want—just as it has helped its thousands of students. It will not obligate you to investigate what this training means to you. A Free Bulletin will be mailed you on receipt of the coupon. No agents will call on you—and it might prove the best thing you ever did. Check and mail the coupon while this matter is before you.

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.....Electric Light and Power Superintendent	.....Certified Pub. Acc'nt
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.....Wireless Operator	.....Sanitary Engineer
.....Architect	.....Master Plumber
.....Building Contractor	.....Heating and Ventilating Engineer
.....Civil Engineer	
.....Structural Engineer	.....Automobile Engineer
.....Mechanical Engineer	.....Automobile Repairman
.....Shop Superintendent	.....Airplane Mechanic
.....Steam Engineer	.....High School Graduate
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.....Lawyer	.....Common School Branches

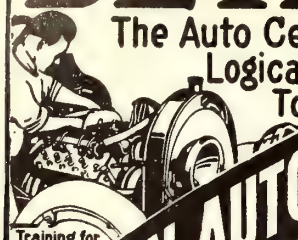
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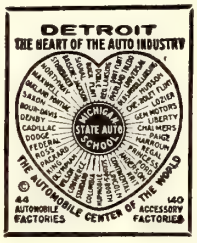
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The Electrical Machinist

By H. Winfield Secor

(*Continued from page 775*)

moving any commutator, to note and record its exact position on the shaft; a center punch mark should be made on the armature drum or core, and another corresponding mark on one of the commutator segments. Thus, when the commutator is being replaced these two marks should be lined up. This is very important from an electrical standpoint, and it also is the best from a mechanical standpoint for obvious reasons.

Small commutators are frequently driven into place on the armature shaft by means of a piece of pipe which fits over the shaft, and then this pipe is hit with a heavy hammer or sledge, driving the commutator on in this fashion. Where the commutator does not make an extra tight fit on the shaft this method is quick, it may be said, but it is very poor practise, except when applied by an experienced mechanic who can judge when this process is requiring too heavy a blow. On small armatures there is a danger of bending the shaft. It is best to upend the armature and shaft in a vertical position when attempting to drive on a commutator in this fashion with a sledge and a piece of pipe. The commutator may rest on a piece of fiber or in some cases an iron plate is used, but the latter is liable to damage the end of the shaft.

When a shaft becomes bent, for one reason or another, one of the best methods of straightening it, is to place it between centers on a lathe. Small shafts can be easily straightened without applying any heat, but large shafts two or three inches in diameter and more, should have heat applied to them before attempting to bend them straight. The first thing to know is the actual position of the bend, and pressure should be applied on the opposite side of the shaft or armature drum from which the bend springs. Pressure may be applied in several ways. In some cases, a lever or a piece of plank is used on top of some blocking on the lathe bed, while in other cases, pressure may be applied by means of the lathe tool carriage, utilizing the slowest hand-feed possible on the carriage. Considerable pressure can be obtained in this way, but it is not advisable for any large work, as it is liable to strain the lathe machinery and either break or bend some of the gearing and connecting shafts on the tool-carriage.

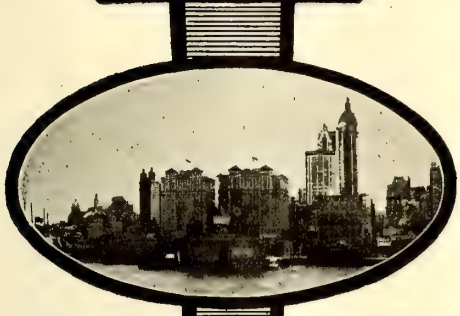
MISCELLANEOUS COMMUTATOR CONSTRUCTION HINTS.

At figure 4 are illustrated several practical hints in commutator construction. At A, there is shown a method of building up cone-shape mica rings used in insulating the ends of the commutator barrel or drum. These rings are usually built of *shellacked mica,* a standard form of this material in the electrical trade, and which comes in the form of sheets of various thicknesses and sizes. This shellacked mica sheet is first cut out in segments or other shapes of predetermined dimensions, such that when they are heated above a Bunsen flame, they may readily be bent to the exact size and form of the cone required. In completing such a ring, the segments are overlapped as shown by the dotted and full lines in Fig. A. The segments are shellacked as they are built up in the cone form. A wooden form of the proper taper may be turned up for the purpose, or else the commutator shell itself may be used for the purpose. Cement mica is widely used in commutator work, but mostly where flat position of insulation, such as commutator segments, are required.

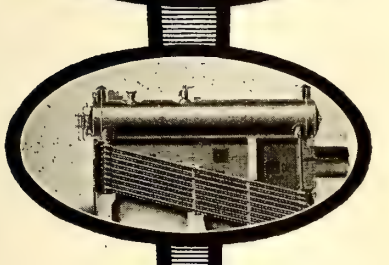
(*Continued on page 790*)



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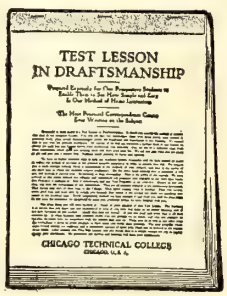
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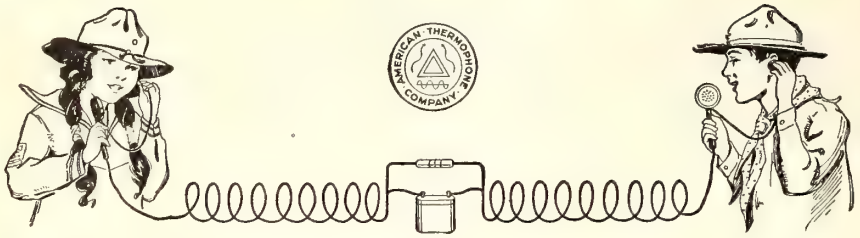
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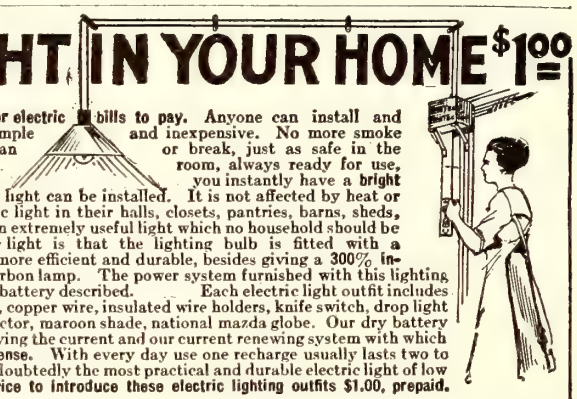
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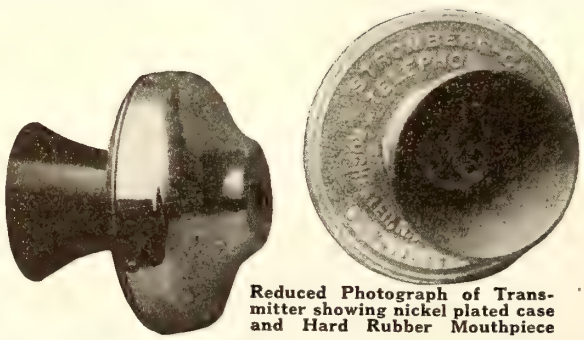
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THE ELECTRO IMPORTING CO., 231 Fulton St., NEW YORK

The Electrical Machinist

By H. Winfield Secor

(*Continued from page* 788)

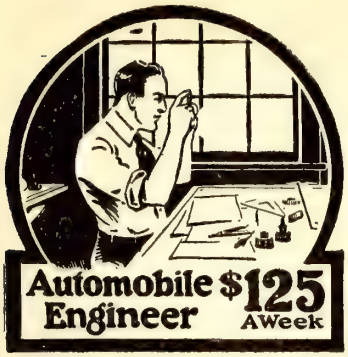
In small commutators the segment insulators are usually made of pure mica punched out by a large motor-driven punch-press. It is usual in practise to make up a commutator gage stick as shown at Fig. 4—F. The mica punchings are assembled in the saw slits cut in this stick, the saw used in making the slits being of the exact thickness of the mica segment desired. One large motor concern uses wooden sticks, but they can of course be made up of other material. Several rubber bands are used in assembling small commutators as the mica and copper segments are put into place. At C, there is shown the method of scribing out the exact shape of mica segment for large commutators by laying the copper segment on the mica. At D and E, there are shown respectively, the use of a steel snap-gage having a slot of predetermined width and also the use of the *micrometer* for gaging the thickness of mica segment in thousandths of an inch or mils. In tightening up commutators some form of compression is generally employed, such as that shown at B. This is a wrought iron ring, several of which may be used on long commutators, and steel set screws are threaded thru the ring all around its perifery. These set screws may be spaced about two segments apart, and under the screws and over the commutator segments there is placed a thin band of iron or copper. The segments are thus tightened up and at the same time the lock nut on the end of the commutator is successively and periodically tightened. The commutator must in any case be just as tight as you can possibly make it, within reason of course, before any attempt is made to place it in the lathe and machine its surface, or otherwise there will be commutator segments in every corner of the shop, before many cuts have been taken.

(*To Be Continued*)

MAGAZINICALLY SPEAKING.

An *American, Country Gentleman,* wanting some *Variety* in his *Life,* and desirous of becoming an *Electrical Experimenter,* purchased at the *House Beautiful* a copy of *Popular Mechanics,* which contained many *Popular Current Events.* The *Engineering* in this *Journal* enabled him to become a good *Judge* of *Aircraft,* and consequently his *Outlook* for a *Success* was due to the *Modern Methods* taught by this *System.*

This *Craftsman,* having read some *Live Stories* in the *Scientific American* about the mines in San Francisco, decided to make a *Motoring* trip to the *Cosmopolitan* City. On arriving at the western city he did not heed the *Call* of the *Mining* center, but visited the *Motion Picture* studios, where he became acquainted with the *Photoplay.* The splendid atmosphere in this *Town* aided him to improve his *Physical Culture. Every Week* he would take a *Yachting* trip on the *Pacific* and enjoy the beautiful *Sunset.* One evening while a *Spectator* of a new *Film* at a leading *Theater* he met a young lady of *Fashion.* The next *Day* while at the town *Post* waiting for his *Mail* he again met the young woman. He liked her very much and soon became the *Woman's Companion.* They were soon married and went to live at the *Countryside.* The couple lived very happily and while the young woman was engaged in *Good Housekeeping,* the old gent sang extracts from *Musical America.*—*Art Mayers in the "Everett Herald."*









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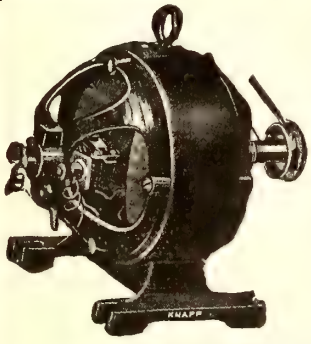
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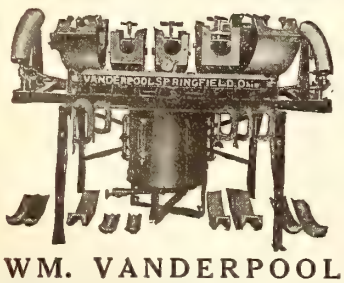


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Of iron and steel	40%
Of automobiles	85%
Of wheat	25%

and refine 80 per cent of the copper and operate 40 per cent of the world's railroads.

The Amateur Magician

By Joseph H. Kraus, Jr.

(*Continued from page* 771)

Again no movement on the part of the bell. "Well, I'll not fool any longer. The bell doesn't know." He was interrupted again by the "yes" ring of the bell. "How strange and yet—perhaps she does know. Was it a Diamond card?"

The bell answered in the affirmative.

Scratching his head the performer as tho choosing his words with great deliberation added, "Was it a picture card?"

The bell answered *yes*. "A King?" Two rings signified that this was correct.

"Not only does the bell tell me these things, but also tells fortunes. Now, bell, suppose that you tell me how many fellows that young lady down the aisle has. Four? Thank you."

In this way a long program may be mapt out and wound up in the following manner:

"The lady in the box there; yes, the married one. How many times has she been married?"

The hammer is seen to rise once, twice, but it only rises on the third occasion, not striking as it did on the previous occasions; while the magician watches with interest the next move, counting out loud.

"Twice, and almost the third time?" this with an inflection of the voice. "Here that will do." Separating the parts as before he bows to the audience.

THE CONSTRUCTION OF THE BELL AND STAND.

The stand consists of a long nickel-plated tube mounted on a tripod of the same material, with one wire running up each of two of the three legs, said wire connected to a large magnet made by winding eight layers of number eighteen doubl cotton covered magnet wire, on an iron core which does not extend all the way up the coil; but terminates within one inch of the end, a sleeve continuing the rest of the way. The coil is eight inches long and actuated by an assistant behind the scenes, a six volt current being used as the exciting force.

The hook is made of iron, nickel-plated, like the balance of the stand. When placed in position it acts as a core to the magnet concealed in the stand.

The bell is made of an ordinary electric light globe, which is fastened into a turned piece of wood (as shown in the illustration) with plaster of Paris. Thru a small opening in the ring on top is past a piece of soft iron bar, one end of which is connected to a lever-like piece of aluminum; the far end of this lever has a decorative piece of bone attached to its free end to act as a hammer.

(*Continued on page* 794)



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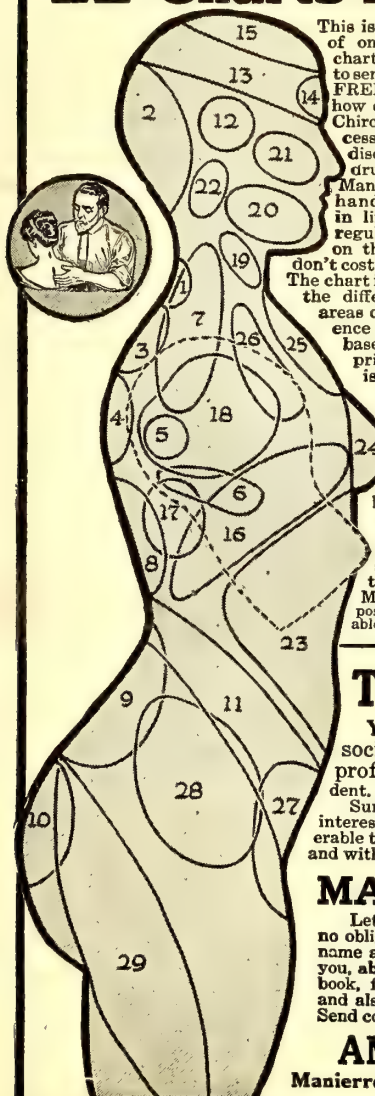
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There is today a demand for one hundred thousand Doctors of Chiropractic in this country, according to a recent statement of a man who is himself a prominent Chiropractor and has intimate knowledge of the Chiropractic situation throughout the United States.

Even if this demand remained stationary, it would require many years to fill it. But the demand is **constantly increasing** because more and more intelligent people—those who do their own thinking—are becoming convinced that Chiropractic is the common sense and really scientific way to relieve pain and disease.

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or in class. Our method of home study instruction places you under the personal direction of a splendid faculty of Chiropractic experts—men who have made notable records both as practitioners and instructors. There is no need for you to leave home or give up your present position. Your instruction will be thorough, practical and in accordance with the most modern methods of drugless healing therapeutics. From the moment you enroll we will work with you wholeheartedly, our one aim being to make you successful just as we have advanced the interests of thousands of others. In the shortest time consistent with thoroughness you can graduate with the degree of D. C. (Doctor of Chiropractic) receive your diploma **FREE**, and be ready at once to open your office. Your opportunities are as great as those of other ambitious men and woman. Why, then, shouldn't you be able to do as well as Doctors of Chiropractic who are today earning incomes of from

$3000 to $5000 a Year

and even more? What, for instance, is there to prevent you from doing as well as Dr. Condoluci, one of our recent graduates, who writes us that he earned from two to three times the cost of his tuition **as a student;** that immediately upon graduation he opened an office, began making money from the very start and is now earning **upwards of $12,000 a year!**

Another recent graduate, Allen Watrous writes: "Am contemplating opening a large office with 50 stretching tables. A man who is interested will put up $25,000 to make this possible." Dr. W. H. Wedell states that his practice averages ten patients a day and that he charges $25 for 13 treatments. At that rate he's making big money. Dr. M. D. Moore reports an income of $9000 a year; Dr. L. H. Roche, $5000. Dr. Hanna over $5000 yearly. Can you ask for more convincing proof that CHIROPRACTIC is indeed a **great** profession—a fertile field for men and women who feel that they **can and should** make more of their lives and are earnestly seeking broader opportunities?

Yes, the success of many Chiropractors has come so quickly as to be almost startling. And yet, it is not to be wondered at when you consider the scientific accuracy of Chiropractic methods, the constantly increasing demand for Doctors of Chiropractic and the comparatively few Chiropractors that are now in the field.

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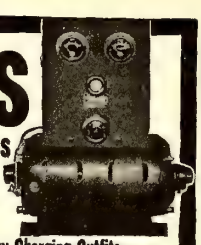
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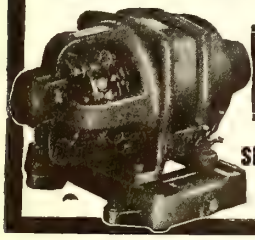
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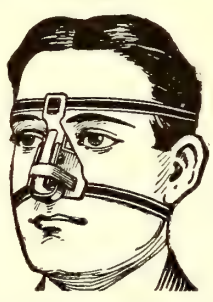




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The Amateur Magician

By Joseph H. Kraus, Jr.

(*Continued from page 792*)

Two wires lead thru the stand and down each of two of the legs, making contact with two plates concealed by the heavy rug.

When the stand is brought forward, it is carefully placed in position so as to make contact with the two plates, the bell then being tried before proceeding with the balance of the performance. The trial is made under cover of a little phrase, asking the bell to show how it answers. A typical magician's forcing deck of cards being used, the assistant knows exactly what cards will be given out and goes thru the procedure as a regular matter of routine; pressing the key for each sound of the bell and the gong ringing at each break of the circuit.

It will be noted that when the soft iron core is attracted to the magnet, the hammer is pulled away from the bell, but on its sudden release the weight of the hammer allows it to swing downward, striking the bell just once.

A FEW TRICKS EASILY PERFORMED BY THE "FIXT PACK."

This trick originated many years ago. It never fails to produce results. The cards are fixt in an orderly manner, and this order preserved—*the deck never being shuffled*. This order is very easily learned, and it is only necessary to see one card in the deck, either the top or the bottom card, to be able—in this manner, to tell the name or the position of any card in the deck.

First—the suits are learned in the following manner: Hearts, clubs, diamonds, spades, and then the following arrangement will be found very satisfactory. The cards are separated by three numbers; that is, one, four, seven, ten, thirteen, three, six, nine, etc., in which the King is thirteen, Queen twelve, Jack eleven and the Ace is one. In arranging the cards, they will follow this manner: Ace of hearts, four of clubs, seven of diamonds, ten of spades, king of hearts, etc. In this way you can easily tell what the twelfth card in the deck will be and read the cards off without looking at them; also by giving a person a choice of any card in the deck, you will be able to discover just what that card was. For the "Q" trick, the cards are arranged in a definite manner. Any number in the circle and the number of cards in the tail changed after each performance. A person is instructed to count a certain number of cards up the tail and around the left side of the circular portion of the "Q" to suit himself. Then taking that card at which he stopt as number one, counting just as many cards, retracing his course, (except that this time he does not proceed down the tail), continues around the circular position of the "Q," stopping in a similar position, i. e. There are eight cards in the tail—the person will proceed up the tail, around the left side of the "Q," stopping at, say, the 17th card. Taking this card as number one, he proceeds backward again, stopping at the seventeenth card again. The performer instantly tells him this card before he comes back.

So much for the effect. Its mode of operation is simpler than the description of the trick and all that is necessary, is that the performer know the number of cards in the tail. Using the card from where the tail starts, as his starting point, he stops at the same card as the number of cards in the tail. In the example mentioned above, it would be the eighth card (inasmuch as there are eight cards in the tail) from your centre position, that, is, where the tail joins the "Q." A simple trial will readily convince.

TAKING awkward angles out of the early Christmas morning atmosphere!



HOW that low-on-luck feeling will peel off *his* mind when the happy-handout-happens Christmas morning; and, his keen eye sights the stage all set with the pound crystal glass humidor of Prince Albert tobacco gowned in the glories of a radiant holiday rainbow! Turkey takes to the tall timbers compared with the all-star-feast *you* spread so temptingly before his smokeappetite!

PRINCE ALBERT, for Christmas, lands on a man's tank-of-thanks like a spill-of-snow when the sleigh-bells are rusty from lack of jingles! P. A. as a *man gift* is the high-sign, the last word, the directest route to his comfort, his contentment, his smoke-happiness! It's the touch-that-lifts-the-lid; that takes the awkward angles out of the evergreen-and-holly atmosphere and makes the whole family on both sides think and talk in one language!

YOU'LL enjoy seeing *him* fuss his old jimmy pipe, all-brimful with Prince Albert! Or, *getting his* "rolling his own!" Never was such a delightful makin's cigarette as P. A. supplies. He can smoke the limit with Prince Albert *for it can't bite his tongue or parch his throat!* Our exclusive patented process fixes that! He'll just want to get thirty-six-smoke-hours out of the legal twenty-four, *that's all!*

FILL his smokecup to overflowing! Prince Albert is the glad-gift, the holiday-hunch that will hum him a smoke te-de, te-dum long, long after Christmas is but a merry memory!

PRINCE ALBERT

the national Christmas joy smoke

PRINCE ALBERT is also sold in handsome pound and half pound tin humidors, in tidy red tins and in toppy red bags—wherever you buy tobacco.

R. J. REYNOLDS TOBACCO COMPANY
Winston-Salem, N. C.

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What could you do?

Once to every man comes a time when he must fight for his life or the safety of a loved one.

It may come in the dead of night in your own home, burglars for instance; or on a lonely road or deserted street after dark, or even in broad daylight at the hands of passing bullies.

Suppose it should come to you tonight, what could you do?

Can't you see that it would not be just a question of bravery or strength but rather a question of whether you know how to box, how to defend yourself against the vicious blows of your assailant, how to disarm him if he tries to use a blackjack, club, knife or pistol, how to break his grip on your throat, how to stop the kick he launches at your stomach, and finally how to cripple him by a jiu-jitsu or bone-breaking hold?

Wouldn't you like to know how to play a man's part? Wouldn't you like to learn boxing and self-defense easily and quickly *at less than half the cost* of a single term of lessons by the old method?

Marshall Stillman has developed a unique principle of teaching boxing and self-defense. Two weeks after taking the course boys of twelve and fifteen, and men up to even fifty and sixty have been able to defend themselves against bigger and stronger opponents. He teaches the fundamentals of boxing in five lessons before your own mirror, so that when you meet your first opponent you know how to hit him, what to expect in return and how to guard against it. He teaches you sixteen bone-breaking holds and releases in jiu-jitsu and standing wrestling so that you can quickly put your assailant at a disadvantage and overcome him. For instance: "When opponent tries to use blackjack or other weapon, grasp his wrist with your left hand and immediately slip your other (right) arm well up under his arm and, reaching up, grasp his weapon-hand from behind. Then with both of your hands force his forearm back, as illustrated above. You can break his arm if necessary."

And while he's teaching you these things, he develops you physically and makes your daily exercise interesting as well as beneficial.

It is the first time boxing and self-defense have been successfully taught by mail, and it is only possible because of the Marshall Stillman principle of instruction.

The complete course *specially bound for home study* includes:

5 lessons in boxing—how to hit, duck, guard, feint, clinch, and use foot work.

3 rounds of shadow boxing.

1 set of daily exercises for muscle building.

8 jiu-jitsu holds and releases.

8 holds in standing wrestling.

1 free copy of Professor Mike Donovan's famous book, "The Science of Boxing," containing all of the scientific blows and guards known to the ring, the rules of boxing, suggestions on training, diet, etc.

There are 175 illustrations in this course. The *special Introductory Price* for this in Home Study Edition is, *until further notice*, only half of our usual price—$5.00 instead of $10.00.

It is almost unbelievable that you can learn these things by mail, but we are willing to take all the risk of convincing you. We will send you the complete course on 5-day approval. If you keep it send us $5.00 in full payment; if not, return it on the 5th day. Fill out the coupon *now*.

FREE APPROVAL OFFER

Marshall Stillman Association,
461 Fourth Avenue, Suite E-12, New York.

Send on approval the Marshall Stillman Course in Boxing and Self-defense including 5 lessons in the principles of boxing, 1 set of daily exercises, 3 rounds of shadow boxing, 8 jiu-jitsu holds and releases, 8 holds in standing wrestling, and a free copy of Prof. Donovan's book "Science of Boxing." I will either return them or remit $5.00 on the 5th day after I receive them.

Name .....

Address .....

"Slow Movies" Analyze Motion

(*Continued from page* 751)

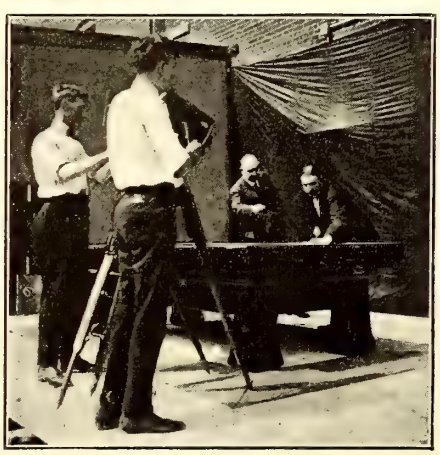
er in the light. This is so because our eyes can only perceive and analyze those movements which do not travel at a greater speed than sixteen times per second. Let us illustrate with an example: Suppose we look out thru a window at a man walking. If that man makes sixteen steps from the time he enters the left space until the time he leaves at the right margin of the window, we will be able to clearly perceive and count each one of these steps. However,



Taking a "Slow Movie" of a Motorcycle Race at 200 Pictures Per Second.

should that man travel at a greater speed than sixteen steps per second, his step movements will be blurred. Hence, when a camera takes pictures at such an extremely rapid rate, and projects them at the normal speed, it means a slowing down of the picture and the slow movement. Hence the twitch of all the muscles is instantly noticeable. If you have ever been to a theater which has exhibited a Novagraph production of diving, you will more than wonder at the gracefulness of the girl in this scene, as she executes some of the most difficult and wonderful dives. Compare these with the expert male swimmer, going thru the same dives—a striking contrast of his muscular movements with the gracefulness of the girl.

Hundreds of uses for this machine have already developed and suggested themselves. Aviators in flight have been photographed while executing tail spins, nose dives, etc. A movie of Ralph de Palma in his record-breaking Packard, moving at the rate of 130 miles per hour, produced a negative which even rendered the buttons of his uniform visible.



"Slow Movies" Permit of Accurately Analyzing Fancy Billiard Plays, Airplane Tail Spins, Etc.

HERE IT IS

Final Solution of the Vibrator Problem Absolutely Astonishing

NEWEST and Greatest Invention



You know that Vibration means new life, power, health, beauty. You know it is Nature's way to banish pain and to give you new energy and vitality. You know all this, but do you know that the BIG problem of science has been to devise a hand vibrator that would be absolutely satisfactory in every way? That problem has vanished. We solved it. Our NEW, wonderful Vitapulser is GUARANTEED to effect ALL the astonishingly beneficial results made possible by this approved method of treatment.

THE VITAPULSER

Is practical. It requires no connection with electric wires—supplies its own power. Safe, light, compact, easy to handle and cannot get out of order. It is the modern choice of physicians and thousands of careful buyers.

EVERYONE CAN AFFORD This Marvelous Instrument

If you have not been able to afford a Vibrator on account of the high price, here is your opportunity to own one. *No income too modest to afford The Vitapulser:* sells for a fraction of price of others. Don't be dull, weak, mentally or physically depressed. Learn about the Vital Impulse; how to gain real health and Natural beauty. *The Vitapulser will make you over.* Give us a chance to prove it!

SENT ANYWHERE ON APPROVAL

for testing purposes. No obligation to buy. Write today for FREE remarkable book, "The Vital Impulse" and Special Approval offer.

Commonwealth Electric Mfg. Co.
731 Rialto Bldg., St. Louis, Mo.

Buy Clothes From Maker, Save 30%

That's one sure way to cut the cost of living. Every year thousands of men buy their suits and overcoats by mail, direct from the makers, thereby saving fully 30 per cent. of the cost, at the same time getting the same quality of cloth and workmanship they are accustomed to buy and with the added advantage of having all their clothes hand tailored to their individual measurements.

There is a successful concern in Chicago which has been making men's high-grade, made-to-measure suits by mail for over 15 years, and now has thousands of satisfied customers throughout the country. It would probably surprise the average man to go through their records and see the number of men, even in the big cities, who buy their clothes by mail from this concern.

If you send a postal card to the Ruby Tailors, Department 842, 329 South Franklin St., Chicago, Ill., they will send you free of charge their latest up-to-date Fashion book, containing a number of actual samples of woolens—Fashion plates showing different styles of suits and full instructions for measuring and ordering.

Their long experience in dealing with thousands of men by mail has put them among the leaders in their line and enables them to guarantee to refund the full purchase price of any made-to-measure suit which is not perfectly satisfactory. A number of their customers annually earn substantial sums taking orders among their friends for Ruby Tailored Suits, and the concern makes a very attractive offer to men who desire to add to their income in this way, in addition to saving money on their own clothes. Lose no time in writing for their free Fashion book and complete outfit.

MONEY *for* YOU

Add to your Salary—Make extra Pin Money, Start a lucrative business of your own

Spend an hour each day taking subscriptions for the "Experimenter." We'll pay you well and you'll enjoy the work. *Write for full particulars.*

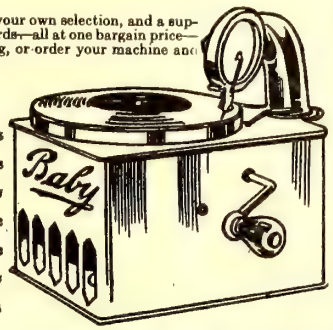
ELECTRICAL EXPERIMENTER
Circulation Dept., 233 Fulton St., N. Y. City

TALKING MACHINE Complete Outfit $5.98

With Three Double Face Emerson Records and Package of Needles

A real talking machine, not a toy. Plays real disc records just like expensive machines. It is constructed entirely of steel, with a wonderfully easy running motor. You'll like its clear, loud tone, particularly bringing out, as it does, the full charm of the music it plays. It can be adjusted to play fast or slow, soft or loud, as you prefer, but, above all, it has been so strongly constructed that it will stand lots of rough handling. A fine machine for indoors or to take with you outdoors, camping, canoeing, dancing—whenever you need music.

We include, FREE, three double faced records, your own selection, and a supply of needles. You get the machine, needles and records—all at one bargain price—**$5.98.** In ordering, select records from the following, or order your machine and select your records after complete list reaches you.



Select Your Records

I'm Forever Blowing Bubbles **By the Campfire**—Duet		7485
Dear Old Pal of Mine—Solo **Some Day I'll Make You Glad**—Solo		7486
If It Comes from Dixieland **Rose of My Heart**—Teno Solo		7497
Peter Gink—One Step **Some One Step**—One Step	Band Band	7472
How Ya Gonna Keep 'Em—One Step **What's That**—Fox Trot	Band Band	7492
How You Goin' t' Wet Your Whistle? **St. Louis Blues**—Character Song		7477
In the Land of Beginning Again **Oh, Promise Me**		7464

GENUINE GILLETTE



$4.59

The story is all in the headlines—this is a standard $5.00 razor, silver plated—with 12 Gillette Blades—the best money can buy. Order it either in leather case, or vest pocket pattern, at this very special price of **$4.59.**



Gillette Blades

These are standard Gillette blades—**40c** in ½ dozen pack—**79c** in dozen pack.

MUSCLE BUILDERS



Attach these easily to your wall and use them regularly. Watch your muscle grow. These splendid exercisers for developing muscles have extra coil springs, with Japanned handles, cut to fit the hands. They can be adjusted readily to the floor or wall, at all angles, and will be of enormous value in developing the muscles of the chest, back and arms.

$1.49

Men's Raincoat

Guaranteed Rainproof

$7.49



This is a sporty looking substantial raincoat at a price so reasonable no man can afford to risk getting wet, by going without one. It comes in a snug fitting model, becoming to young and old, with big patch pockets, adjustable military collar and a belt at the waist. Made of rubberized fabric, in olive drab color. An unusual value.



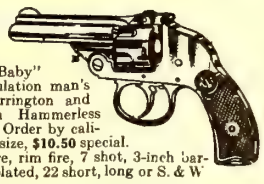
Automatic Cigarette Case, 25c



Hands them out one at a time. The slickest thing you ever saw. Case is nickel-plated, in fancy design, strongly built to last you for years. Men find it most convenient style of cigarette case. Keeps cigarettes in good condition.

HAMMERLESS REVOLVER

$10.50

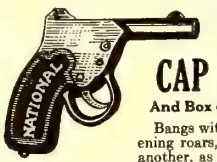


Not a "Baby" but a regulation man's size. Harrington and Richardson Hammerless Revolver. Order by calibre, either size, **$10.50** special.

22 calibre, rim fire, 7 shot, 3-inch barrel nickel-plated, 22 short, long or S. & W cartridge.

32 calibre, centre fire, 5 shot 3-inch barrel, nickel- plated, 32 S. & W. cartridge.

38 calibre, center fire, 5 shot, 3½-inch barrel, nickel-plated, 38 S. & W. cartridge.



50 Shooter Automatic

CAP PISTOL

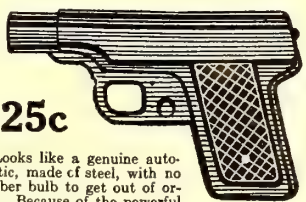
And Box of Ammunition

Bangs with 50 deafening roars, one after another, as quick as you can pull the trigger. **REPEATING CAPS,** to fit this pistol, come in rolls of 50 shots each at **5c** a box. Pistol alone without ammunition, **25c.**

29c

SOAK 'EM

WATER PISTOL



25c

Looks like a genuine automatic, made of steel, with no rubber bulb to get out of order. Because of the powerful air pressure of the cylinder it will squirt a large stream of water to a great distance. Can be carried in the pocket and used when the other fellow is not looking. Great for fun or self protection.

Catalog FREE With Every Order

With every order received, we will forward, FREE, a copy of our new 1920 catalogue containing many pages of valuable articles at bargain prices. Remit full amount of your order in currency, postal or express money order or 2c stamps. We prepay all postage and express charges.

Satisfaction guaranteed, or money back

Handy Man Combination Pen Knife $1.69



Knife, screw driver, bottle and can opener—all in one. The handiest pocket knife a man ever had. Ideal for camping, outing and every-day convenience. Made of finely tempered steel, brass lined and contains one large blade, screw driver, bottle opener and can opener. Has a stag handle, with ring for attaching to your key chain.

Jack Knife, 69c



An inexpensive, sturdy knife, built to stand constant use. Stag handle, one large and one small blade, both made from the best Wardlow English steel, with keen edges. It is lined with brass, and has nickel silver bolsters. A splendid knife at our special bargain price of **69c.**

Wrenches

10 In 1



These wrenches come with five nickel plated end wrenches, that, with the aid of the thumb bolt in the centre will fit ten size nuts. You'll find them compact and convenient, ready for any job, when you want them. **89c Per Set.**

STURDY ELECTRIC

MOTOR



99c

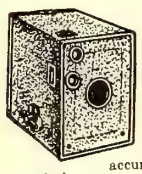
You'll find this a strong, sturdy, two terminal electric motor, just the thing for operating light running models and electrical toys. Can be run with one or more dry or wet cell batteries, depending upon the power desired.

Novelty Knife and Bottle Opener 98c



This knife is bound to appeal to the men. The handle is in the shape of a leg, with the shoe end forming a bottle opener. The two fine steel blades open easily, and fit back in the handle when not in use.

Genuine CAMERA



EASTMAN BROWNIE.

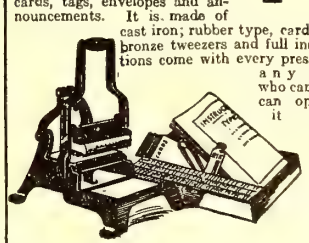
$2.86

Makes pictures 1⅝x2½. Is accurate, reliable, efficient and economical to operate. Anybody can make good pictures with it. Has the automatic shutter for snapshots and time exposures. Carefully tested lens and view finders, for vertical and horizontal exposures. These simple and reliable box cameras have stood the test of years and proved a delight to all who have used them.

Complete PRINTING PRESS

$1.50

Every man and boy will find this printing press both useful and instructive. It will print cards, tags, envelopes and announcements. It is made of cast iron; rubber type, cards, ink bronze tweezers and full instructions come with every press and any child who can read can operate it.



HUNTING KNIFE 60c



A great knife for hunting, camping, fishing and all sorts of outdoor work. It comes with a 4-inch heavy steel blade, finely tempered, with ebonized handle, fitted to your grasp. Every knife comes in a genuine leather sheath, with slits in the end through which to slip your belt.

Luminous WATCH

Shines in the Dark



The only cheap thing about this watch is the price, for you'll find it the all-round handiest timekeeper imaginable. It has the luminous dial that makes it easy to see the time, no matter how dark the night, and a nickel-plated case that will stand the hardest sort of usage. It is fully guaranteed, of course.

$2.75

Pocket

Flashlight 39c

Very Special



A flashlight that fits in your vest pocket, all ready for service, when you need a good, clear light. Comes with nickel plated case, equipped with a very bright bulb and a 2-cell battery. The price of **39c** is a very special one—for this occasion.

GIANT RAY

FLASHLIGHT

Very Powerful

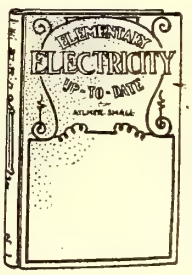


This is a genuine Tungsten flashlight, five inches long, with a powerful light, in a lightweight, vulcanized fibre case. It flashes on with a pressure of the button and will stay lighted by using the slide switch with which it is equipped. Carefully packed, complete for..... **99c**

LEARN A TRADE

With the Help of one of these Books

$1.00

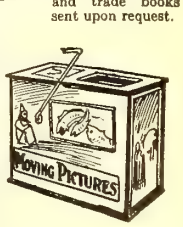


Modern Electric Illumination.
Elementary Electricity.
Wireless Telegraph and Telephone Handbook.
Telegraphy Self Taught.
Automobile Handbook.
Gas and Oil Engine Handbook.
Machine Shop Practice.

A complete catalogue of mechanical and trade books sent upon request.

MOVING PICTURES!

Great Fun

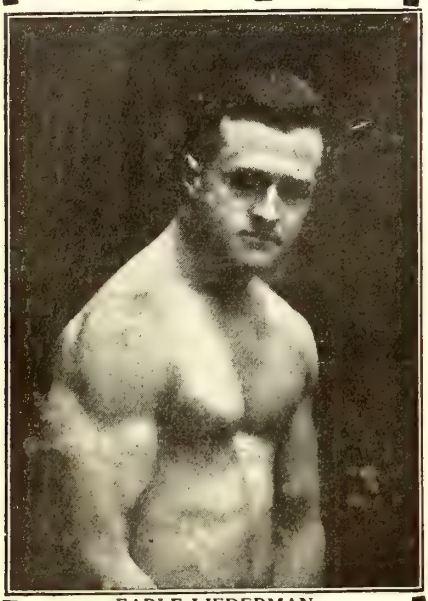


Turn the handle, look through the slot and see the moving pictures. No end to the amusement it will furnish. Great fun showing these moving pictures to your friends. Price, **29c.**

GET OUR FREE PREMIUM OFFER

Baltimore Mail Order Co. Dept. 101 Howard & Baltimore Sts. Baltimore, Maryland

A Powerful Physique!



EARLE LIEDERMAN
The Acme of Physical Perfection

A 48 inch chest and 16½ inch biceps!

I HAVE THEM. HAVE YOU?

Hundreds of my pupils have obtained these measurements, and many of my pupils have exceeded them.

Why not let me do the same for you?

My methods never fail to produce results quickly.

I BEGIN WHERE OTHERS LEAVE OFF.
I PRACTICE WHAT I PREACH.

MY NEW BOOK
"MUSCULAR DEVELOPMENT"
will explain all about my system and will interest you.

It is illustrated with 20 full-page photographs of myself and of some of the finest developed atheletes whom I have trained. If you have not as yet read this book by all means get a copy.

Simply Tear Off Coupon Below and mail to me with 10c (stamps or coin) and you will receive your copy promptly.

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Dept. 215, 203 Broadway, New York City

TEAR OFF COUPON

DO IT NOW before you forget it

EARLE E. LIEDERMAN,
Dept. 215, 203 Broadway, N.Y. City.

Dear Sir:—I enclose herewith 10c for which you are to send me, without any obligation on my part whatever, a copy of your latest book "Muscular Development." (Please write plainly.)

Name .....

Street .....

City ..... State .....

El. Ex. Dec., 1919

HOW DID IT WORK?



This is a Portion of the Film of the Famous Rabbit Described in Our November Issue Who Stood Half a Million Volts, Never Batting an Eye-Lash. Can You Explain This Strange Film? The Editor Will Pay $20.00 for the Best Answer.

Turn to page 633 of our November issue. We told you last month how we electrified a rabbit with 500,000 volts, and how he never batted an eye-lash. Well, sir, the Gaumont Film people who got wind that we were pulling off a stunt were duly on hand with their trusted film cameras and while we made the experiment, the operator cranked away merrily. Of course, we wanted to see what the film looked like and we had our wish. The very mysterious sample slightly enlarged from the original film is printed along side here. At first we were somewhat puzzled and could not quite make it out how the long streamers after the third picture died away into a mere brush and in the fourth picture had almost entirely vanished only to bloom forth in a wonderful corona effect, showing the rabbit very plainly, in the sixth picture. In the seventh and eighth, however, nothing can be seen. Now what do you think happened?

500,000 volts at 20 kilowatts with a frequency of 200,000 was used in the film printed here, which is absolutely authentic. **We will pay $20.00 for the best answer explaining this phenomenon.** Anyone familiar with alternating current should have little trouble in solving the problem. The contest is open to all and will close promptly on February 1st, 1920. Not more than 300 words should be used. Answers will be publisht in our March issue. Address all replies to Rabbit Editor, care of this publication.

RADIO PROTECTION FOR CAMERON.

Citizens of Cameron parish are asking the government to locate a wireless station there, so that storm warnings may be given and farmers may have a chance to give whatever protection they can to their crops.

Cameron is an outpost of Louisiana for Gulf storms, and has suffered severe losses half a dozen times in the past 20 years. It has no railroads, no telegraph or telephone lines to the coast on account of the expense and difficulties of construction across the lowlands, and no method of receiving warnings.

The people of Cameron are industrious and enterprising. They have voted a heavy tax on themselves to construct roads. They have fertile lands which will produce valuable crops. As one of the storm outposts, the Weather Bureau needs to be in touch with Cameron, for the protection of the rest of the country.

Science in Slang—Juicing the Jazz Wagon

(*Continued from page* 785)

"The big idea is that when the piston reaches the proper point in the cylinder chamber the contact is made which closes the circuit that sets up a magnetic flux in the core of the coil, that attracts the vibrator arm and breaks the circuit and sets up an inductive reactive flow in the secondary, which breaks down the resistance—being the weakest place—between the points of the electrodes on the spark plug, which in turn ignites the gas in the chamber and causes the explosion that turns the motor over, that finally takes the joy rider to the court house or Police Headquarters. Whoof!

"Give 'em air boys"—this from Bender—"his carbureter leaks!"

"Such guys as Atwater-Kent have deviated from the old trodden paths and have rigged up an apparatus that is worked

(*Continued on page* 800)

AMPLIFY YOUR RADIO SIGNALS

ONE of the greatest drawbacks since the invention of wireless telegraphy is the receiving of weak signals at the receiving station. Many devices were proposed to improve this condition, but without success, on account of the mechanical difficulties encountered in these amplifying devices.

However, this was recently solved by the introduction of an exceedingly sensitive microphone transmitter, which is known to detect sound waves with great accuracy and magnify them through an intermediate telephone circuit.

By the employment of the new DETECTAGRAPH-TRANSMITTER, the amateur can amplify the radio signals to such an intensity that he can hear the signals about his station without the need of the telephone head set.

By the addition of a loud talking telephone he is able to hear the messages many feet away from the instrument. He is also able to demonstrate the operation of his wireless apparatus to his friends.

The super-sensitive DETECTAGRAPH-TRANSMITTER herewith shown is two and three-eighths inches in diameter, five-eighths of an inch thick and weighs less than three ounces. It is the most sensitive sound detecting device ever brought before the public.

The manner in which the amplifying process is attained is by attaching with tape the DETECTAGRAPH-TRANSMITTER to the regular wireless receiver as indicated in the diagram.

SUPER-SENSITIVE **Detectagraph** MICROPHONE DEVICES

Practical Instruments for Commercial and Scientific Purposes.

NOTICE

Although prices of raw material and labor have increased greatly in the last four years, we have continued selling our instruments at the pre-war prices, due to the fact that we had a large stock of material on hand. That material is now almost exhausted and we will be compelled to renew our stock at an increase in price, but for a limited time you can still get the benefit of the present low prices.

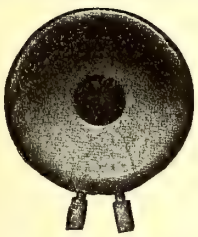


Our Super-Sensitive Detectagraph Transmitter. Price, $7.00 Complete

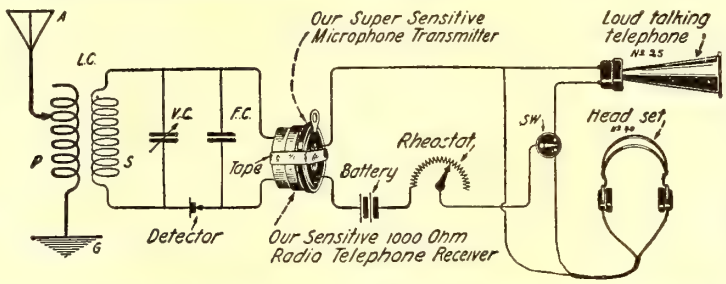
Other Uses

Not only is this instrument applicable for amplifying radio signals, but it can be used with equal satisfaction for magnifying other sounds. Phonograph music can be transmitted from one place to another by means of this instrument, and those who are afflicted with deafness will find enormous benefit by using this transmitter.





Our Special No. 25 Loud Talking Receiver Price, $4.50 Complete



It is the greatest device for building your own loud talking telephone, detectagraph and other devices. Can be used for any purpose where a sensitive detecting instrument is required.

Adjusted Model "B" Horn, with No. 20 high grade loud Talking Receiver. Cord Plugs and Desk Stand Base. Price, $12.00 Complete



Adjusted Model "C" Horn, with No. 20 high grade Loud Talking Wall Receiver. Price, $12.00 Complete

DETECTAGRAPHS

FOR THE EXPERIMENTER FOR DETECTIVES FOR THE DEAF

DETECTAGRAPH

This detecting instrument of marvelous sensitivity can be used for detecting secret conversations. Outfit consists of Sensitive Transmitter, 25-ft. Black Cord, Receiver, Headband, Case and Battery. **$15.00 Complete**



DETECTAGRAPH JUNIOR DEAF-PHONE

The outfit consists of a Super-Sensitive Transmitter, with a cord connector; Super-Sensitive Ear Piece with small black cord; Black Single Headband; Black Case and two small Batteries. Transmitter 2⅜ inches in diameter, ⅝ of an inch thick, and weighs less than three ounces. **$15.00 Complete**





Detectagraph Rheostat, especially made for amplifying circuits. Complete $2.00



Super Sensitive No. 40 Receivers to be used in connection with Detectagraph Transmitters. $10.50

Order direct from ad. Or write for free descriptive circular. For your convenience use the coupon.

G. BOISSONNAULT COMPANY

26 CORTLANDT ST. NEW YORK CITY

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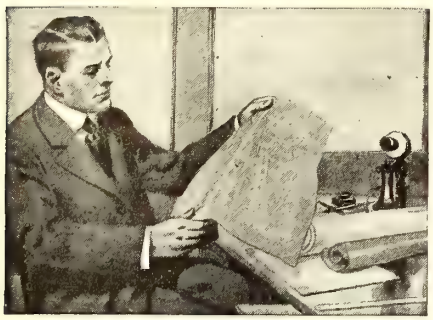
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Science in Slang—Juicing the Jazz Wagon

By Emerson Easterling

(*Continued from page 799*)

like this," continued Jazz. "The contact on the distributor touches for an instant as the movable one passes over the stationary one. This makes a closed circuit. As the circuit is broken by the parting of the contacts the same thing happens that does when the vibrator arm flops up against the core—really, it don't touch the core. That would cause it to stick. A sort of anvil stops it just before it gets there.

"Some time back some bird stumbled onto the idea: that if generators could furnish juice for other purposes, why not stick one on the bus to squirt juice into the plugs? Since then we have had generators, generators, and some more generators, good, bad, and otherwise. In the Ford, Henry incorporates in the fly-wheel an A. C. revolving field generator. He must have run short of junk when he came to this part of his endeavors.

"In the old—I don't think it is the same in the newer types—Overland the self-starter, generator, and fly-wheel is one and the same.

"It was sure some ease on the autoist when the self-commencer came around. It led to other fine features, too. For one thing the electric lights have crowded the old carbide type off the boards.

"To-day we have our gas go-cart all rigged up with an electric self-starter that is operated from a storage battery. The battery is recharged in turn by the generator—sometimes the motor-generator, single unit; sometimes the two unit, one generator to charge the battery, and a motor to start the engine. Then, the lights, horn, cigar lighter, trouble lamp, spot light, and what else the general public care to stick on the layout, are run from the battery—and from the motor when it is running."

"What is this high frequency spark stuff I heard about?" spoke up Bender.

"It is some of James E. Seeley's and Lodge Brothers' ravings. It is just the employing of high frequency currents, like Nick Tesla has fingered around with, for the spark. The advantage is that the spark energy increases with the gas pressure—opposite from that of the other type—and carbon does not bother the ignition, as the spark is of short duration and the flash is not choked up by carbon.

"But getting back to magnetos—they are alternating current generators for the ignition. There are two kinds, low and high tension. The low tension is virtually an alternating current dynamo, and the high tension is a dynamo and step-up in one. The Bosch is one of the best—and it is not *bosh* either."

At that point the engine began to purr—like an angry sewing machine. Conversation somewhat dies away—especially on the part of the chauffeur. But Stokes had gas engines on the brain:

"You know the stationary engines that spat and spit and then hit once in a while? It is an automatic spark affair that is operated by the governor that causes that. When the engine attains a certain speed the governor cut-out stops the ignition. If it wasn't for that the thing would do the Bolshevik ———"

"And don't forget the electrically gear shifted and braked cars," interrupted Bender, "The kind where an electro-magnet jerks 'er from high to me'jum, an' so fort' —an' th' electro-magnetical tire burners—"

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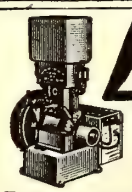
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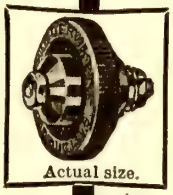
SKINDERVIKEN TRANSMITTER BUTTON

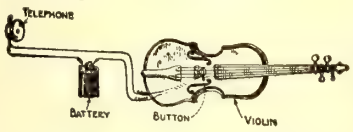
MOST SENSITIVE MICROPHONE

FOR $1.00

YOU can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

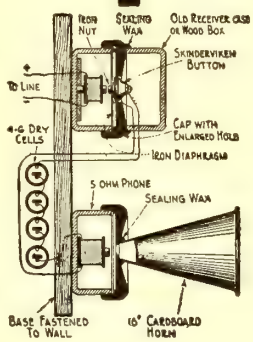
You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *This outfit was used by secret service operatives during the War. It is being used on the stage.*


Actual size.



So much for its commercial adaptations! *You* can procure apparatus of the same type.

One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons cannot be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.



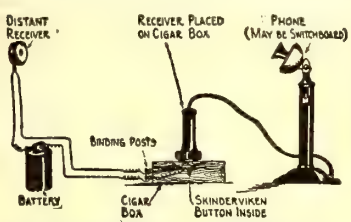
Full directions for connecting up the button for use as a detectophone are given in booklet which is sent with each button.

The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.



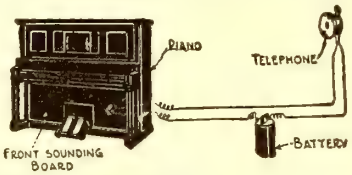






AMONG electrical experimenters the button has created a sensation. It is not uncommon to receive unsolicited letters like these: "I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

"I have been using one of these transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimenting." "I have been using one of these transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"

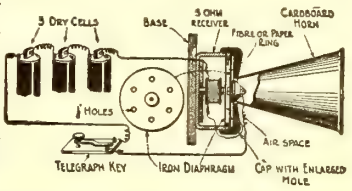


Mr. H. Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In the writer's opinion, obtained by actual elaborate tests, the Skinderviken Transmitter Button is probably the most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

We have the utmost faith in this transmitter button. We guarantee satisfactory service or we will refund the purchase price. Boys —Young and old—send in a dollar bill RIGHT NOW! You can't lose. If you're not satisfied, you receive your dollar back. Isn't that fair?



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Thomas A. Edison Speaks to You

By H. Gernsback

(*Continued from page* 750)

few years he has worked more in the chemical laboratory than in any of the others, which are located in different buildings about the great Edison works.

I MEET THE GREAT INVENTOR.

Together we entered the laboratory, the first impression being mostly green fumes. A half dozen of Mr. Edison's assistants were to be seen busily engaged in performing various chemical experiments under the direction of their chief. Mr. Edison himself was nowhere to be seen. Advancing to the rear of the laboratory, I finally discovered Mr. Edison sitting at a little table busily engaged in writing notes upon a yellow pad, using a small pencil. To the right of Mr. Edison on the table was a big chemical dish containing some green solution, presumably copper nitrate. The table, which was rather small, measured perhaps four feet in length by three feet in width. Mr. Edison was seated on a simple wooden chair. Altho the inventor is 73 years old at the present time, I was surprised at his vigorousness and apparent strength. The first impression at close quarters is a kindly face of ruddy complexion, from which peer two light blue-gray eyes of unusual intelligence. There is an enormous broad forehead, over which falls some silver white hair, giving the characteristic Edison curl. The jaw as well as the ears are well formed, both denoting character and a strong will. Like all great men, Edison has a big and massive nose, which denotes the thinker and philosopher. The lips are rather thin, around which a smile is constantly hovering.

Mr. Edison rose and we shook hands. I was startled somewhat, for I expected a large, hard hand. On the contrary it was as small and soft as a woman's hand, and white except for green stains upon it caused by chemicals. There is perhaps no more famous right hand in the world than Edison's. *If the world were called upon to make an inventory of what Mr. Edison's hands have actually wrought in enriching this planet, there would not be gold enough to pay him.* This is not a mere figure of speech or written in order to make this review grandiloquent. It is the unvarnished truth, as anyone with a clear mind and a pencil can easily figure out to his satisfaction. There certainly has never been one man since the dawn of history who has contributed so much to the world's progress as has Mr. Edison. While of course the mind is supreme, Mr. Edison's hands are the tools that achieved his success, and that is why I place so much stress upon this phase.

Mr. Edison spoke and welcomed me—a curiously high-pitched voice, unusual for one who has never heard it, but characteristic of the famous man.

MR. EDISON ANSWERS SOME IMPORTANT QUESTIONS.

Mr. Edison in late years has become hard of hearing, and it is necessary to speak quite loud in order that he may understand you. There being no second chair around, and Mr. Edison having seated himself again, I leaned against the laboratory table, being careful not to sit in the chemical dish, and taking other precautions not to disturb anything. After a few pleasant remarks on both sides, I immediately launched into the object of my visit, namely, to put up to Mr. Edison certain questions which had been in my mind, and which I knew would be of great interest to our rising generation and the world at large. I said to Mr. Edison:

(*Continued on page* 804)

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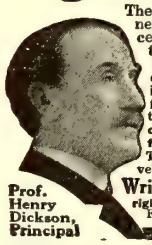
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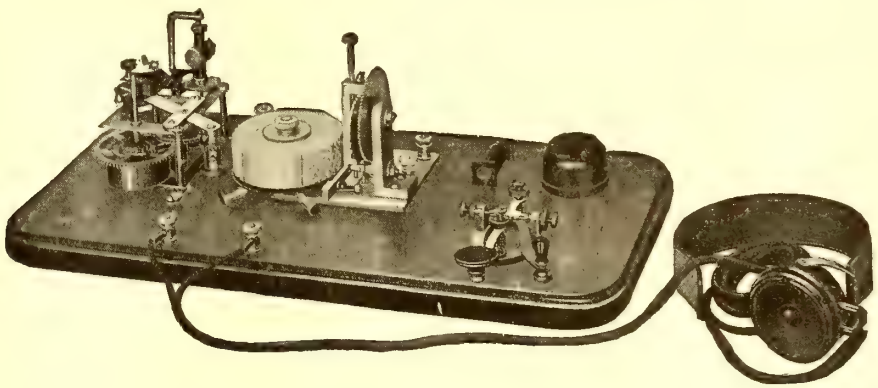
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BATTERY CHARGING PAYS BIG PROFITS

YOU CAN MAKE $100 to $350 EXTRA PROFIT EVERY MONTH

You can have from $100 to $350 profit monthly from charging batteries, in connection with your present business, by establishing a battery service recharging station. Users of HB Charging Equipment are earning big profits every month with almost no extra effort.

Practically every car today is equipped with storage batteries, which require recharging outside the car at least every two months. Ford cars are now being equipped with electrical starters and storage batteries. **Now** is the time to get into this work. Build up a profitable and ever-growing business.

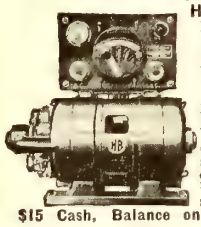
You can readily handle a battery charging business, as no special electrical or mechanical knowledge is required. You can get an HB Charger in any size to suit your requirements, insuring maximum profits for you, whether the outfit is large or small.

An HB Battery Charger for Every Size Business

All HB Chargers are sturdy, dependable and absolutely reliable. Built of practically wearproof materials. Nothing to burn out, no expensive renewals or repairs. Plain, honest, profit-producing service 24 hours a day. No electrical or mechanical knowledge required to install or operate. No attention except occasional oiling. Uses power from your lighting lines. Big, quick, clean profits, easily made.

CHOOSE THE SIZE YOU NEED

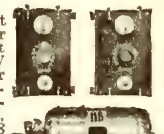
HB 500-Watt Charger



Recharges 1 to 8 6-volt batteries or their equivalent at a time. Charger is 27 in. long, 26 in. high, weighs 280 lbs. Furnished complete with clear, black, electrical slate switchboard, with mountings of ammeter, field rheostat, voltage lamp, two controlling switches. A big money-maker for a small battery business.

$15 Cash, Balance on easy monthly terms

HB 16-Battery Charger

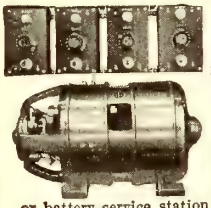


Recharges 1 to 16 6-volt batteries at once or their equivalent in 12 or 24-volt batteries. Motor 1 KW capacity. Operates on 2 or 3 phase current only. Furnished complete with 2 independent charging panels, each with a capacity of 8 batteries. A splendid machine for any live, energetic garage owner wishing to get big profits.

Small cash payment

Balance on easy monthly terms

HB 32-Battery Charger



Recharges 1 to 32 6-volt batteries or equivalent at a time. Motor 2 KW capacity. Operates on any current. Four separate charging lines, each capable of charging up to 8 batteries. Permits individual attention to batteries on charge. Ideal equipment for big garage or battery service station. Will make as high as $250 to $450 a month Clear Profit.

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Sold on Trial Under HB Absolute Money-Back Guarantee

All HB Equipment is sold under our absolute guarantee of complete satisfaction. You run no risks. If not satisfied after using any HB Equipment 10 days, you may return it and receive all you pay us. The HB monthly payment plan is an additional guarantee.

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Mark on this coupon the HB Charger you are interested in. Tear it out and mail TO-DAY. This is your BIG CHANCE. Let us help you start your own money-making business. Be the first in your town to have an HB Charger. Don't delay. Act now.

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Your Name .....

Address .....State.....

Thomas A. Edison Speaks to You

By H. Gernsback

(*Continued from page* 802)

"Do you believe that the young man who embarks on his electrical studies today, has the same chances and opportunities which you had at the beginning of your career?"

Mr. Edison was very emphatic when he replied: "He has far greater opportunities than I had—infinitely more. There is absolutely no comparison to be made, for the world has grown larger, and therefore the opportunities have multiplied."

This prompted my second question: "In what branch of electricity, in your opinion, can the young man of today accomplish most—where is he most desired?"

Mr. Edison looked squarely at me and said: "There are thousands of men wanted in every branch of electrical engineering and hundreds of new branches based on new discoveries are being created continuously. The field is being enlarged every day and keeps growing. It would be difficult to pick out any one branch, since all are still in their infancy, and all have wonderful futures."

My next question was: "What training should the young man undergo? Should he acquire practical experience first in the shop or laboratory; or should he take a correspondence course or go to college; or all two or three?"

After a few seconds reflection, Mr. Edison replied: "I think one of the correspondence schools at Scranton, Pa., is the more available for most young men. After passing an examination, I think he should specialize in one branch and study it real hard. Then he should get busy and get a position. Any boy can be a success, providing he is willing to pay the price, which is continuous hard work. The trouble with a large number of young men today who are given positions is that they refuse to pay the price, and thus become a drag on the industry. Our young men today do not wish to work as much and as hard as they did when I was a boy. They want shorter hours and more pay, and too many amusements, the same as all workmen do; but I think this condition will be rectified when people come to their senses. It certainly cannot last."

"BE SURE YOUR IDEA WORKS, BEFORE PATENTING IT," SAYS MR. EDISON.

"Mr. Edison, what constructive advice can you give to our young and rising inventors? Is it worth while to patent every idea, or only certain ideas? How can the young inventor differentiate between good ones and bad?"

After a few seconds of meditation Mr. Edison answered: "I suggest that if the young inventor has an idea he had better reduce it to actual practise and be sure that it *works* before applying for a patent. Ideas are easy, but working them into commercial shape is generally a long, tedious and expensive job. After successful operation and the results warrant it, a search of the United States Patent Office should be made to learn if it has not been previously invented or patented by others. Here is where the young inventor will have his greatest disappointment. He will find many a time and, as a matter of fact, in a majority of cases, that the idea has been patented already in one form or another. But disappointments show the salt of the inventor. Only by such disappointments can he triumph finally."

This brought about my next question: "You have patented over one thousand inventions, Mr. Edison. How many of these have been actually worked?"

(*Continued on page* 806)

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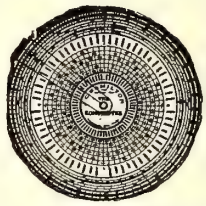
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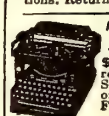
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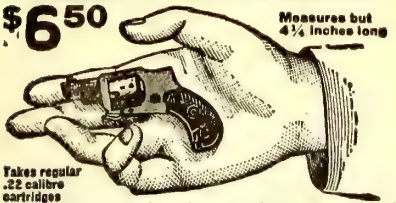
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A HANDSOME AND MOST EFFECTIVE WEAPON

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Measures but 4¼ inches long



Takes regular .22 calibre cartridges

The new **Baby Double Action Hammerless Revolver** has been produced to meet the ever increasing demand for a revolver that would combine small size and light weight with the essential features of **Efficiency and Practicability.** It is small in size, yet is just as effective and serviceable as the more expensive weapon you can buy. Every lady should have a revolver and should know how to use it, and there is no safer or better one made than this. A great feature is its safety action that guards against accidental discharge, making it quite safe for young men and ladies. The illustration gives an idea of its appearance, but it must be seen and used to be thoroughly appreciated. The ammunition used is the standard .22-calibre (short) cartridge obtainable anywhere, or you may obtain the cartridges from us (cartridges can be shipped only by express). The revolver will fire six shots in one loading. The operation of the charging mechanism is extremely rapid and absolutely reliable; any well aimed shots can be fired in as many seconds. The revolver is very well constructed, with finest nickel plated fluted barrel of cylinder, and it weighs only 4½ ounces. **The Price of the Baby Revolver is only $6.50, sent by mail postpaid to any address.**

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SHARPENS EVERY KIND OF SAFETY RAZOR BLADE

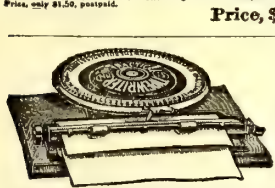
Sharpens the Gillette and Durham Duplex both edges at one time

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By using the SHARPEN-M ALL STROPPER you will not only get BETTER SHAVES, but you will SAVE MONEY on blades, as you will be able to get from 150 to 200 shaves from one blade, and the last shave will be as good as the first. The construction is simple and will last a lifetime. There are no parts that can possibly get out of order. Any novice can use it just as well as the most expert barber. It is operated by simply turning the lever or handle as shown in the illustration. It has two spiral rollers that travel from heel to point as they are revolved, giving the CORRECT DIAGONAL STROKE. There are no screws, adjustments, or any kind of tinkering necessary to operate the machine. The rollers are made of a special material that STROP AND HONE the blade at the same time. The rollers turn only one way, so there is no fear of damaging the blade or the stropper. The SHARPEN-M-ALL is packed in a handsome case, 4x2½x1½ in., with three holders and full instructions. The weight of the complete machine is but eight ounces. Price, only $1.50, postpaid.

Price, $1.50 postpaid.



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Cheap But Good. So Simple a Child Can Use It. We Guarantee the Writing.

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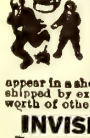


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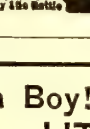
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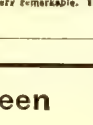
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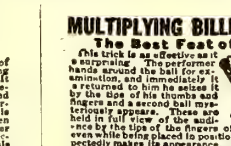


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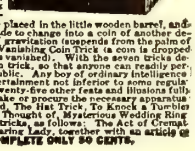
This trick is as effective as it is surprising. The performer hands around the ball for examination, and immediately it is returned to him he seizes it by the tips of his thumbs and fingers and a second ball mysteriously appears. These are held in full view of the audience by the tips of the fingers of the left hand, and even while being placed in position, another ball unexpectedly makes its appearance. Finally the magician apparently suffers from some kind of spasm and yet another ball is the result. The feat can then be reversed, the balls disappearing one after another until none remains. It is a very interesting trick that is quite easily performed by following the directions that accompany the apparatus. **PRICE 25 CENTS.**

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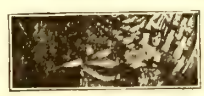
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Thomas A. Edison Speaks to You

By H. Gernsback

(*Continued from page* 804)

MR. EDISON HAS 1400 PATENTS.

Mr. Edison thought for a while—"Of the fourteen hundred patents which I have obtained, about four hundred were actually worked. This figure may be taken as proportionate for inventors. It is seldom that an inventor makes a success of his first invention. Usually he finds that altho he obtains a patent, for some reason or other the idea did not prove to be successful commercially, or could not be exploited otherwise. I have made it a rule in my later years, not to patent anything for which I knew there was no actual demand. Merely collecting patents is a waste of time, money and energy."

This answer of Mr. Edison's was of more than passing interest to me, and at the spur of the moment, I sang out: "Which is your pet invention?"

Mr. Edison smiled broadly, and it seemed to give him much pleasure when he said: "My pet invention I think is the phonograph first—and moving pictures second. Somehow or other these two inventions have taken hold of me more than my other ones, as I have probably spent more time upon them than upon any of the others." This naturally brought me to the next question, which was. "Are your inventions perfected first in your mind or perfected in your models? Or by actual experiments?"

Without hesitation Mr. Edison continued: "I always start out with a definite idea of accomplishing a certain result. I collect all the data possible, both scientific, commercial and otherwise. I then proceed to sketch out every possible and probable way of attaining results and carry it to success by experimenting. In other words, first plan—then act. I usually find that the first model is not at all what I had in mind when I conceived the idea first. Any inventor knows this of course. I have found it necessary for this reason to build many models, and only in the exceptional case is the first model a success."

MR. EDISON TELLS WHAT WORLD MOST NEEDS.

Knowing that Mr. Edison was perhaps one of the greatest authorities on what the world needs most to-day, I asked him: "What inventions does the world need most to-day?"

Becoming reflective, Mr. Edison thought for a few seconds and answered: "Automatic machinery, and systems for the quantity production of one-family houses so cheaply that every man can possess his own home. These two are the world's greatest and most pressing problems today. Take a city like New York, for instance. Conditions there are indescribable. There are too many people in New York at present, and but little new building can be done there. I am in great favor of a law being passed that no additional factories should be built in the city of New York after 1925. This would mean that the housing as well as transportation facilities would not be continually overtaxed as they are now. In other words, the city should be forced to spread out either towards Long Island or to the north."

At this juncture I mentioned to Mr. Edison a plan that was advanced some years ago, whereby it was advocated to build the so-called road house, i. e., a city running thru the country by having a single line of houses built one next to the other with a subway underneath. This would give us a city as well as country at the same time. There would be a sidewalk and roads on each side of the house running continuously without interruption and paralleling the houses.

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"I do not think this idea is very practical," vouchsafed Mr. Edison. "I think it would be too expensive and would make the traveling distances uncomfortable."

While discussing the printers' strike, which just then had started in New York, paralyzing the entire printing industry, I put the question: "What known substitute is there for white print paper when our raw materials give out during the next twenty-five years?"

Mr. Edison's answer was surprising: "Print paper will never give out as long as wood grows in the Amazon and Congo river basins. It is simply a matter of transportation, and that, I believe, will soon be solved, as soon as the world is upon a peace basis once more."

I have always had a pet idea on the subject of *cold light,* so I ventured my next question. "Over 99 per cent of the energy is lost today in useless heat in our incandescent lamps. How near are we to 'cold light,' and do you think it will be invented at all?"

"I think we are slowly advancing in increasing the efficiency of light production," replied the inventor. "Any moment a discovery is liable to be made that will advance the efficiency of our present lighting methods enormously. The time is surely coming when 'cold light' will be a matter of fact. What shape this invention will take, it is impossible to predict today."

"On which of our dormant and unworked sources of energy should our coming generation work most intensely, Mr. Edison?" I asked. "In your mind, is the exploitation of the following sources of energy chimerical or are they within the realm of possibility from the standpoint of modern electrical engineering:

Power derived from the earth's internal heat.

Power derived from the earth's atmosphere.

Power derived from the tides.

Power derived from the sun's heat."

"UTILIZE EARTH'S NATURAL VOLCANIC HEAT," SAYS MR. EDISON.

"Volcanic power to the extent of 5,000 H.P. is utilized already in Italy, and 20,000 H.P. more is being arranged for," explained Mr. Edison. "Italy probably has more in her volcanic regions to work all her machinery and heat every house, carry on every metallurgical process and in fact make coal unnecessary in that country. My impression is that in Nevada and the Yellowstone region there is available volcanic energy greater than that given by all the coal mined in the United States. 'As to solar energy' we are getting there step by step. It is a long and weary road we have to travel, but we are making it slowly. I am an urgent advocate of water power. We are using already too much coal without adequate returns. Water power in the United States is not at all developed as it should be, and I see a great future in its proper development. I have advocated many times that the coal should be burnt at the mine instead of shipt by cars over long hauls. Electric power can be sent much cheaper thru electric wires than over the railroads; in other words, first hauling the coal which is then burnt at the destination."

This prompted my next question: "What are your ideas, Mr. Edison, as to atomic energy?"

Mr. Edison smiled broadly and, with a twinkle in his eye, said: "You know, Mr. Gernsback, I am an inventor, and as such I do not concern myself overmuch with philosophical research, and altho I have my own ideas on atomic energy I am not at present making them public."

My next question was: "What shall America do to prevent Germany from flooding the world with its cheap goods, and winning the war commercially twenty years hence?"

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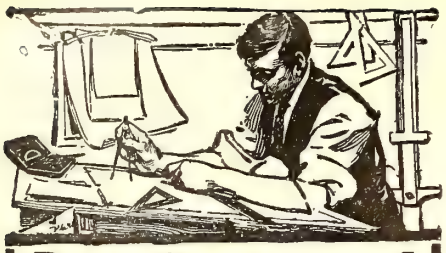
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Here, too, Mr. Edison's reply was surprising as well as illuminating: Germany never has and never will flood the United States with cheap goods or undersell us if we make up our minds to beat her at that game. Out of thousands of articles, she is only efficient in two, to wit: chemical dyes and toys. This is due to our indifference to going into these lines of manufacture. I am happy to note, however, that American manufacturers are beginning to see the light, and are protecting themselves adequately."

We then discust various other subjects, and it soon became apparent that Mr. Edison thought that every prophet is honored save in his own country. Mr. Edison was of the opinion that before the war, and particularly during the war, American inventors had not received their due credit, most of the fame having gone across the water. Mr. Edison felt particularly strong about a recent patent decision, where the honors of the vacuum tube used for radio purposes went to an English inventor. It is an incontrovertible fact that the "Edison effect" was known years before the Fleming valve was discovered, having been publisht in American and foreign scientific papers. Mr. Edison was certainly right in his contention that the honors for the invention of the vacuum tube should go to America, and there seems to be no doubt as to this.

My final question to Mr. Edison was, "What is your hobby, and how do you relax from your work?"

GREAT INVENTOR'S HOBBY IS "EXPERIMENTING."

"Just now my hobby is 'experimenting.' I like experimenting better than anything that I know of. As for my relaxation, I like to camp out in the mountains, which I do every summer. This makes me fit for another winter's hard work."

Mr. Meadowcroft by this time was beginning to look at his watch, which I took for a gentle hint, and shaking hands with Mr. Edison, I took my leave.

While shaking hands I was again imprest with Mr. Edison's hand, and I subsequently made a special request of Mr. Meadowcroft to let me have a photograph of the great inventor's hands for publication. I was much astonished to learn that no photograph of Mr. Edison's hands existed, none having ever been taken, the inventor feeling rather sensitive about this. I had seen many sketches of Mr. Edison's hands, but I only then remembered never having seen an actual photograph. It took several weeks to secure permission from Mr. Edison, but finally the photograph of his hands was taken, and it is here presented to the readers of the ELECTRICAL EXPERIMENTER for the first time.

I also made another discovery, namely, that there was no oil painting in existence of Mr. Edison. True, several of these had been made by certain artists after Mr. Edison had patiently sat for them, but he was more or less displeased with the result, and on one occasion did not hesitate to put his foot thru one of them. After securing Mr. Edison's permission, I charged Mr. Howard V. Brown with the delicate mission of making an oil painting of the famous man. It is reproduced on the front cover of this magazine in full colors. It is the only oil painting in existence of Mr. Edison today, and the inventor, who inspected it, was very much pleased with it, declaring it a perfect likeness.

As I past out of the laboratory I caught a last glimpse of Mr. Edison. He had risen from his chair, making his way to a little room containing delicate scales and apparatus. The tall, white-haired figure, somewhat stooped under its 73 years' load, clad in a duster, bespotted with chemicals, slowly faded out of view into the adjoining room.

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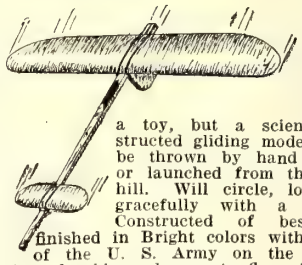
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Submarines to Salvage Sunken Ships

(*Continued from page* 745)

light projectors, which would be of inestimable service to the divers, while they were engaged on the wreck and also a better supply of air can be supplied them owing to the shorter hose necessary. If it is not desired to submerge the pontoons for this part of the preliminary work in the salvaging operation, it would be economical and feasible to provide a small submarine which can sink to the level at which the wreck was lying, and by providing special air-locks on the submergible, divers can walk right out on the watery bed. It may be mentioned here, that in such a case, and provided the divers do not have to stay away from the submergible too long at one time, that they would not have to be tied fast to it with a rubber air-hose, for there is now available an independent oxygen and air-diving apparatus which can be carried on the diver's back.

HOW THE DIVER GETS OUT UNDER WATER

An interesting problem here arises, and that is—how are we going to get the divers in and out of the pontoon-submersible or any form of sub-sea craft when it is closed and under the surface of the waves? The illustration herewith illustrates one form of air-lock chamber which can be employed for the purpose. With the arrangement delineated the operation of getting out of a submarine by means of this air-lock is as follows:—the diver dons his costume in the inside pontoon quarters, where the crew is lodged. He then passes thru the right-hand water-proof door, into an air-lock chamber, which chamber has its outer door closed, rendering it dry. The cabin compartment door is closed, and the sea-cocks opened and the water allowed to rush into the air-lock chamber. The diver adjusts his oxygen apparatus and prepares to pass thru the outer door when the chamber has become full of water, this door then opening easily. As he passes out into the stair-well, he locates the usual air-hose terminal by means of a red electric light marking its position, and connects it to a valve on the top of his helmet. He tries the air, and ascertaining that everything is all right, he proceeds to climb up the iron ladder to the deck of the pontoon. He is then ready to descend down a steel cable to the scene of the wreck. The air-hose, as he descends, unwinds from a reel placed in a water-tight compartment underneath the stair-well in the manner here illustrated. And here is the way the divers can come back into the pontoon for lunch. They climb up the steel cable or ladder which is sometimes used, and once they arrive in the stair-well in the pontoon, they disconnect the air-hose and the water is prevented from entering the diver's suit by means of automatic valves in the helmets. The diver then walks into the air-lock chamber and closes the outer door. By

(*Continued on page* 819)



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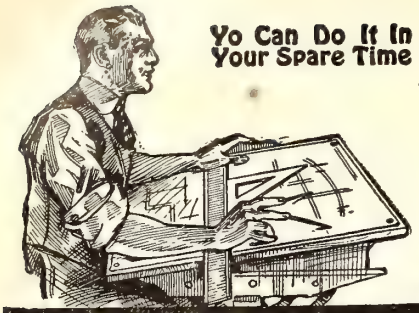
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Statisticians say that ninety per cent. of all the electricity supplied by central generating stations is alternating current.

40 M. P. H. PONY DIRIGIBLE COMING.

The advent of a new kind of aircraft called the "Pony Dirigible" was announced recently at Cleveland, Ohio, at the reception given for the special commission of the Aero Club of America and the Aerial League of America which is organizing the first aerial derby around the world.

Mr. Upson said an Akron company was about to put on the market a small two-passenger dirigible balloon equipt with a forty-horse power engine which will attain a speed of forty miles an hour and will be so easy to pilot that anybody can do so on short instruction.

Mysteries of Stage-craft

By H. Winfield Secor

(*Continued from page 752*)

one of the three platforms can be moved either into or out of its position before the foot-lights.

WATER, SNOW AND RAIN EFFECTS.

The "Disappearing Divers" have long proven a complete mystery to most patrons of theaters such as the New York Hippodrome. In such productions, as the reader probably is aware, a considerable mystery is evolved by having several people (sometimes as many as 20 or 30) dive into a large water-filled tank and they disappear completely, not coming up again for a space of twenty minutes or more. There are several ways of accomplishing this trick, and two of them which have been successfully adopted are illustrated herewith at figure 4. The first is that utilizing *diving bells.* These diving bells, one or more of which may be used as required, according to the size of the tank, are made of steel and must be air-tight. They act on the same principle that when you place a drinking glass or cup into a basin of water, the water will not rise all the way up in the glass, due to the compression of air within the glass. Thus, when the divers plunge into the water, they are enabled to see the position of the bell, owing to the fact that it has electric lights inside of it, which lights up the water at the bottom of the tank, and indicates the hulk of the diving bell very plainly. When they reach the bottom of the tank, they swim towards the bell and pull themselves up inside of it, under the rim. Comprest air is forced into the bell thru a pipe in order to keep the

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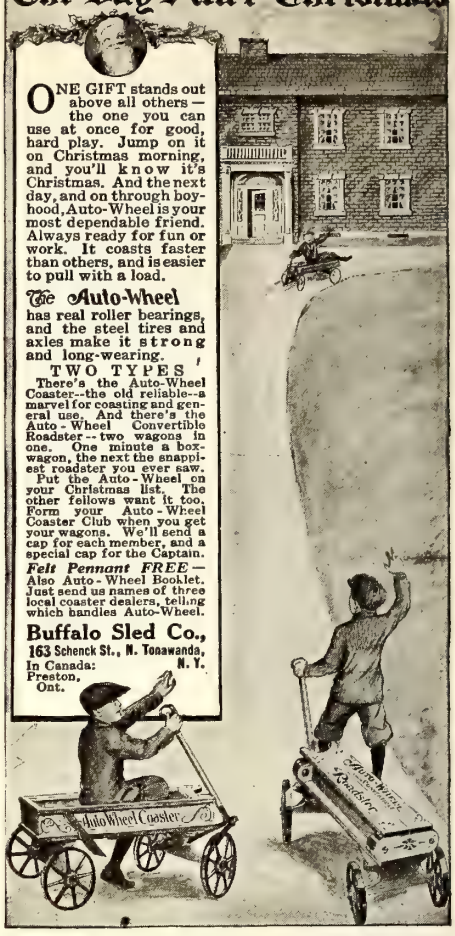
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water at as low a level as possible within it, and where a number of swimmers have to remain in the bell for any appreciable time, proper air outlet and inlet pipes have to be provided, so that an exchange of air is made possible within the bell chamber. For a shorter period, and when not many people breathe the air within the bell, they can get along without fresh air being supplied. With fresh air under pressure being pumped into the bell, some of the air and its products, such as carbon dioxide gas, will bubble out thru the water and thus help to refresh the atmosphere within it. Mirrors are arranged inside the bell so that the fair swimmers may adjust their hair and clothes.

Another stunt for accomplishing the "Disappearing Diver" trick is that employing one or more tubes leading out from the tank to a place on the rear of the stage. The position of the tube running into the tank is either known to the swimmers, or in large tanks they are lighted up by blind bullseyes or lamps, which only the divers can see, and by holding their breath for a few seconds, they manage to swim for the tube-opening as soon as they dive into the water, up thru which they crawl by means of ribs on the wall of the tube, to the stage floor level. As is well known, the water in the tube will not rise higher than it is in the tank. When it is time for the divers to appear, they pass down thru the tube and, Wonder of Wonders! they come popping right out of the water as fresh as a daisy. In the case of the diving bell, they simply hold their breath, slip out from under the bell, and swim to the surface of the tank. In one of these productions a Viking ship slowly rose to the surface of the water on which the swimmers, about 20 in number, stood, as the deck eventually cleared the water. Truly a wonderful spectacle! To produce this astonishing display, the ship has wheels running on an inclined track up to the surface of the water. A gripping tackle is provided at the bottom of the tank to pull the ship up at the desired moment. The masts which are quite high are made telescopic and these are raised under the control of one of the men in the diving bells. Then, when the masts have been raised about half-way out of the water, all of the swimmers pop out from under the diving bells, holding their breath and stand on the deck of the good ship "Viking". The captain of this mysterious craft pulls the lever releasing the clutches, and the ship rapidly rises to the surface, the heads of those standing on the deck appearing thru the water first, the water running from their clothes and shoulders as they emerge from the watery depths.

At figure 5 is shown an interesting snow scene in the production of "Way Down East", the play that has successfully "held the boards" for many years. The snow in practically every show is produced in the form of small bits of cut up white paper. The "snow" is spilled down from the fly gallery 40 feet above the stage, or in some cases, it is simply thrown from the stage floor level by some other means. At figure 5 it is shown being dumped from trays along the fly galleries and as it reached a point several feet above the stage floor, it was caught by the breeze from powerful electric fans placed between the wings on either side of the stage, which caused it to be blown out on the stage in a very realistic manner. At the same time the "wind" noise is caused by the whirring of the fans.

A very realistic rain and river scene with real water was produced several years ago in a traveling or road production, with which the writer had some experience—in fact he had the pleasure of "controlling the rain," and that is some pleasure, "Believe me, Xantippe!" Well, to cut short the suspense, the rain was made by simply having a pipe extend across the front of

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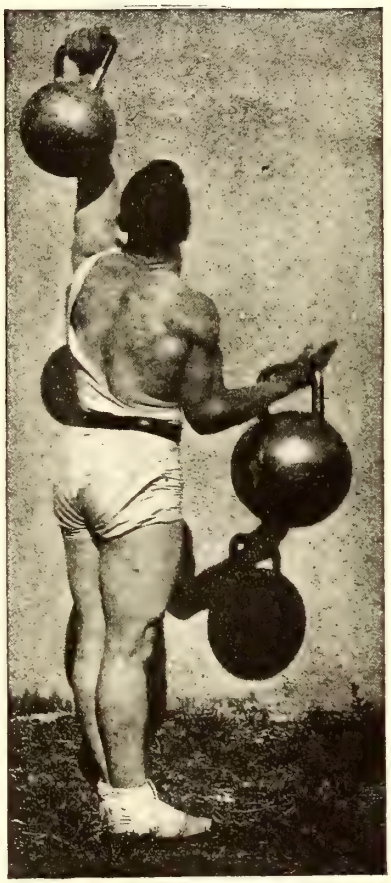
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the stage, and which pipe was perforated with several dozen small holes. This rain-making pipe was then connected with a hose to a water pipe at one of the fly galleries, where the person controlling the rain is standing. When he gets the cue from the stage manager, to "let 'er go", he immediately opens the valve and the water descends from the openings, dropping to the tank or rubber apron below, in the form of "sure enough, honest-to-goodness" rain! This forms a sheet of rain and for most purposes gives a very satisfactory effect.

This show had a most exciting water scene, and the method for staging it was one of the most wonderful that the writer has ever come in contact with. The production carried a large flexible rubber tank, the full length of the stage and about one foot deep, which would thus hold enough water to float row-boats or a small launch. In the center of the tank there was a deeper pocket, measuring about 10x7 feet which projected down into a wooden frame under the stage, and into which the hero proceeded to dive in the second act in order to save the beautiful blonde heroine. If the "villiun" had felt real interest in, or had been jealous of the affection of the hero for the heroine "off stage", he could move the "phoney" canvas-covered "rock", and if our hero dived he would then make a miscalculation and end by dropping into one foot of water, instead of ten. With this improvised and somewhat shallow tank of water, a very exciting melodrama was "put-on"; the scenery was hung over the sides of the tank so that just the water line appeared to the audience, and in fact no part of the tank whatever. A band of counterfeiters floated up the river in a launch, while the police boat, chasing them, fired several dozen revolver shots thru a phoney machine gun. It was some exciting plot and very realistic.

SUN, MOON AND STAR EFFECTS ON THE STAGE.

In the "Garden of Allah", one of the most pretentious scenic productions put on in New York in several years, there was a very realistic *desert sand storm.* Real sand was used in producing this storm scene and as shown in figure 7, the sand was caused to be blown upward, and then caused in turn to whirl in eddies by means of electric blowers placed at the proper points about the stage. These electric blowers were camouflaged under small stage props, which were colored and arranged to fade in with the sand of the desert. The twinkling stars were created by a large number of tiny electric lights being hung against a dark blue background, the various circuits of lamps being rapidly switched on and off by an automatic flasher. As the lights were staggered and placed in an irregular formation, and as the lights in different levels were alternately illuminated and extinguished, no regular coherence of effect could be gathered and the audience was thus charmed with the display.

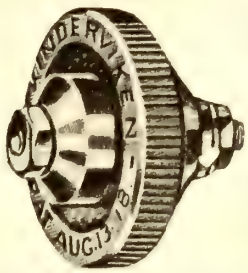
At figure 8 is shown an arrangement in use for producing the best type of moon or sun-rise, or also the setting of the moon or sun. In the ordinary production no attention is paid to the well known fact that the moon or sun is always larger when down near the horizon, growing smaller in diameter as it mounts to the heavens. The moon effect, for instance, is produced in the following manner:—a powerful lamp, such as 1,000-watt incandescent gas-filled bulb, is placed in a light-tight box. In the front of this box there is arranged a slide in which colored screens can be placed to give a yellow or other tint to the light, and across this opening there is mounted an iris diafram, similar to that used in camera shutters. This diafram is fitted with a lever extended from the side of the box, and from which a cord depends downward. The box is now carefully elevated by means of a rope, or two ropes, such as will allow

it to be pulled upward in a slow manner. At the same time the operator controlling the moon-rise slowly closes the iris diafram, causing the "moon" to gradually grow small as it mounts up from the horizon painted on the scene.

Figure 9 shows how *open fire place* effects have been produced as well as *blazing fire* from other stage mountings. It is seldom that a real fire is used on the stage, both because it is not necessary and also because it is somewhat dangerous where there is so much canvas scenery about, altho these are fire-proofed as best they can be. The *flame* of such fires is produced by thin red silk ribbon or else by pieces of red silk. An electric blower or fan is so placed as to blow these silk strands and cause them to resemble a flame, especially when lighted from behind or beneath by means of red lamps. Figure 9 shows also how windows in small houses, appearing in the back of the settings in certain scenes, are lighted up. In a recent Belasco production, "Dark Rosaleen", all such stage effects as this are very carefully worked out so as to produce an exact and true scenic setting. The electric lamps for lighting up the windows are shielded by a canvas flap in the manner shown, so that no light flashes up above the frame of the house or reflects back onto the scenery, which would, of course, spoil the scene. The windows are made of celluloid or similar material, either colored or painted. Where scenery glass is required, and unless some desperado is to do the "business" of jumping thru a window to the accompaniment of crashing glass, then ordinary window screening is used. In one of these large windows containing about 20 openings, it was surprising to note how well this screen resembled glass, and moreover it had been painted around the edges so as to give the effect of a long accumulation of dust and dirt. Flags are often used in spectacular productions, dramas, etc., and of course the best effect is created by having the flag wave. This is usually done by placing an electric fan near the flag and just behind a piece of scenery so that the fan is out of sight with respect to the audience.

MISCELLANEOUS STAGE TRICKS.

Some of the more elaborate stage productions carry with them a portable electric switch-board of their own, as shown at Fig. 10. One of these switch-boards which the writer recently saw, contained a whole battery of dimmers (rheostats) for controlling the lamps of various border and spot lights—this portable switch-board rolling about on wheels, and being connected to the electric supply mains by means of a flexible rubber covered cable. At Fig. 10, there is also shown the three stage revolving spot-light platform which is used in some of the spectacular productions produced on large stages. The spot-light operators are located on the different stages



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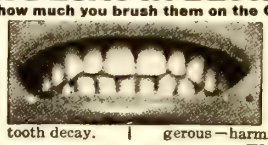
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of the platform which has a total height of thirty feet or more. Flexible rubber covered cables supply current to the spot-lights from the stage floor pocket. Arc lamps for stage spot lights are rapidly going into disfavor and the new 500- and 1,000-watt gas-filled tungsten lamps are taking their place. At Fig. 11, there is shown a motor-driven scene raising and lowering mechanism installed in one of the New York theaters. All large theaters today have what is known as a grid-iron, and fly gallery above the stage, the height of the grid-iron being about 80 feet above the stage floor. Large drops, ceilings of rooms, house roofs, and all such scenic effects are hoisted by means of ropes and suspended from the grid-iron, so that they hang about 40 feet above the stage, and just over the particular setting which happens to be in use. Sometimes 40 or 50 scenes may be seen hanging from the grid-iron and above the Actor's heads. In the usual theater, these scenes are correctly balanced by heavy iron weights, so that they can be raised and lowered by one man, without undue exertion. At this particular theater, however, an electric motor drives the shaft which runs along one side of the fly gallery. The ropes coming down from the various pulleys up on the grid-iron, and by means of which the scenes are raised, pass down to this motor driven shaft, each rope being secured to a suitable winding drum. By means of a clutch attached to each rope hoisting drum, it is possible to quickly raise or lower any scene desired, the electric motor doing all the work. By throwing in several clutches at once, as many as four or five scenes can be raised simultaneously. When the scene is raised to its proper height and in order to prevent breaking the ropes and dropping the scene, an automatic electric cut-off is fitted to the hoisting ropes which stops the motor if the scene is raised too far up.

SCENE PAINTING

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Figure 12 shows a scene painting bridge at a large New York playhouse. The colors are made up in large quantities in dishes and bowls placed on long tables along the bridge,—this bridge being 40 feet above the stage floor and having no rails on it. The canvas on which the scene is to be painted is mounted on a large and fairly heavy wooden frame, which is swung on ropes from the grid-iron 40 feet above the bridge. By means of ropes on either end of the bridge, the scene painters can raise or lower the canvas as desired. Large scenes measure about 85 feet long by 40 feet high. All of the scenes, no matter of what building or other view they may represent, are invariably laid out on the canvas with chalk lines and scaled off from a miniature scene, in much the same manner as a house builder constructs a house from the architect's plans. Room scenes where elaborate sets are used, are sometimes provided with heavy wooden doors and framed windows; these are also constructed at first in miniature, even down to the tables and chairs and the vases and clock on the mantle. These parts are scaled off and constructed to exact detail and size by the stage carpenters from the scenic artist's master model. These models are generally but a few feet in length and some of the miniature views, from which back

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drop scenes like the one shown at Fig. 12, are painted, are no larger than an 8x10 inch photo. Photos are often used to paint scenes from or to help the artist in depicting correctly certain foreign views, such as Chinese buildings, et cetera.

Stage scenes are painted in strips, i.e., when several painters are working upon the bridge, they all work across the canvas at an average height of say 6 feet. After this 6 foot strip across the canvas has been painted, the frame is lowered this amount, and a new six foot strip across the scene is painted, and so on, until the whole canvas is finished.

A new departure in scene painting is that involving the use of a large *air brush* which is shown at Fig. 12. One of the most successful scenic artists who was the first to make use of the air-brush in painting scenes on such a large scale as this, is Mr. D. M. Aiken of New York. The beautiful and truly magnificent color effects known only to the air-brush artist, have been available for a number of years in connection with small photograph retouching; and now that these wonderously beautiful color creations are available to the stage scene painter, we can expect to see some extraordinarily entrancing stage settings.

New York Electrical Show

(*Continued on page 761*)

brush at the front of it, which was rubbing the soap suds and water thru the rug faster than Aunt Jemima ever thought of doing it in her palmiest house-cleaning days. The gentleman in charge of this exhibit asked us to come right up and inspect the operation, and we did. The rug was quite dirty where the machine had started, but the path over which it had slowly past and washed, as well as dried, was astonishingly clean. Now, thanks to this invention, rugs and carpets in large hotels, theaters and dwelling houses can be cleaned right on the floor *without removal.*

All kinds of electrical kitchen utensils were exhibited, some of them in actual operation, from electric toaster up to gigantic five horse power dough mixers in the electric bakery, which cuft and swatted the 100-pound batch or bread dough, as if it had been only as big as a finished loaf of bread. The bread was baked in this bakery in electric ovens and served with "current" jelly to the hungry crowd. The bread was good, we tried it, and we did not feel any ill effects from the "current" jelly, altho we did expect a shock or two. See Figure 5. The new electric reflection heaters, composed of a small electrically heated coil placed in the focus of a copper reflector, were displayed at many spots. You can feel the blast of heat reflected from these, even when the heaters are at a distance of 10 to 15 feet, whenever you pass one of these heaters. Shown at Fig. 6.

One of the electric washing machines of particular efficiency, and which appeared to be extraordinarily "full of pep," is that illustrated at Fig. 7. This was called the "Locomotive" Washer. The glass tank rushed back and forth with startling velocity, forcing the hot soapy water *thru the clothes* with a natural pressure and in a way which would not injure them.

Passing on, we finally arrived at the corner where the electrical "Docs" held forth. The air in this region was surcharged with high tension electricity as the powerful Coolidge X-ray tubes shot forth their penetrating rays, while now and then a crashing spark jumped across a one-foot gap on the transformer exciting the tube, not to mention the crashing of several dozen small high-frequency machines, which were being



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demonstrated by experts for the benefit of a "long-suffering" public. This exhibit also included electric lamp heat baths in the form of cabinets of various shapes and sizes fitted with mirrors and several dozen high candle-power lamps inside of them, as well as nifty, small-size X-ray outfits for dentists. You know, now-a-days, they say a patient knows as much about his tooth as a dentist does, unless the "Doc" has an honest-to-goodness X-ray machine and can examine the "interior" of your roots and jaw bone to see whether or not you have any tumors or abcesses sprouting there. So, this year, more than ever before, everybody that was up on the technique of modern denistry, was particularly interested in this display. One of the special tooth-jerkers' X-ray tooth analyzers, is illustrated at Fig. 9.

WIRELESS HOLDS SWAY AT THE ELECTRICAL SHOW.

At one corner of the radio exhibit we ran into the latest thing in wireless, the radio-goniometer or wireless direction finder. See Fig. 10. This comprises a coil of several turns of wire mounted on a pivoted frame, so that the coil can be turned around to any degree of the compass. The shaft is fitted with a pointer and scale, so that the exact point of the compass to which it points can at once be determined. Thousands of these devices were used during the war to locate enemy wireless stations, when the latter were fired on by our artillery, sometimes when they were many miles away and out of sight. Wireless telephony was demonstrated at the Electrical Show, also, as shown at Fig. 15. Audion bulbs were used in practically all of the wireless instruments exhibited both for transmitting and receiving. A new and interesting "direct current" wireless transmitter, giving a musical note without a rotary converter, was demonstrated.

As before mentioned, a complete electric dairy was exhibited, with several choice cows which were milked with an electric vacuum milker several times a day, for the edification of the cityites, who occasionally manifest the idea that our lacteal products come from so lowly a source as the country roadside milkweed. Some extremely interesting and clever "coin-in-the-slot" dispensing machines were exhibited. The company supplying these machines have made them as nearly human and fool-proof as possible. Not only do these machines dispense everything imaginable—from a "cootie-proof" hair brush to a theater ticket to see a Mary Pickford six-reeler, but they are fitted with one of the most marvelous scientific coin rejectors ever conceived. They are guaranteed to refund your money unless you feed them with guaranteed solid U. S. coin, and this coin must not have any holes in it; no smoothed out edges and no figures or designs missing. Also, the weight must be right, the composition must be right, and the size must be correct. Apparently, this machine has got the eagle-eyed bank cashier backed off the map when it comes to telling a "counterfeit" from a "real" coin. See Fig. 12.

Electric sirens were exhibited (see Fig. 13) in various sizes, some of which can be heard for several miles, and which are used with great success by fire departments. Many electric devices and attachments were shown to aid the seamstress and tailor and a new line of cloth-cutting machines were demonstrated. One of these machines, in the hands of an experienced operator, will cut thru a hundred thicknesses of cloth at once. One style has a motor operated steel wheel which does the cutting, while another larger type has a knife shaped like a razor blade which is oscillated vertically several hundred times per minute. See Fig. 14.

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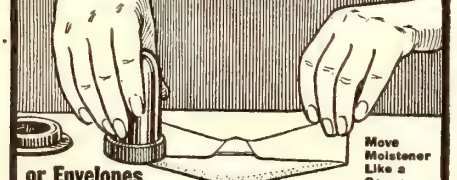
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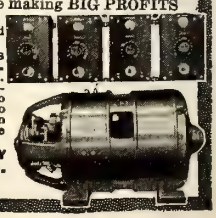
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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

Automatic Non-Leak Oil Can.

(356) L. Scales, Tusla, Okla., asks our advice on an automatic self-closing spout for oil cans. When the bottom is prest, a rod fastened to it opens and closes a plug or valve in the tip of the spout.

A. We have looked over your drawing carefully, showing your suggestion for an automatic oil can, and it would seem to have several good merits, particularly from the fact that no oil can leak out of the can when it may happen to be knocked over or upset. There is only one weak point which you probably have or can overcome in the design or manufacture of this oil can, and that is the small metal bar or pear-shaped plug at the spout of the nozzle, which has to be screwed on to the light rod secured to the bottom. It would seem that after the can had been used for a while, that the wear and tear on the thread, etc., would lower the efficiency of the device, causing it to leak oil when upset, in spite of the attempt made to overcome this objection.

If you can, however, overcome this weak point and provide a sufficiently heavy rod to make the oil can reliable and suitable for constant usage, we believe you have a very good device and one worth applying for a patent on.

Thermometer.

(357) John Schmidt, Long Island, N. Y., writes: "Having read in the current issue of ELECTRICAL EXPERIMENTER of the patent advice you give to readers, I submit to you the following: I have perfected a thermometer constructed by winding a spring made from a certain metal called by some thermostatic steel. The spring is wound, one coil on top of the other, similar to a watch main-spring. A shaft of a predetermined height is soldered to the spring. Next a bearing is fastened to a case of suitable size for the shaft to lay into (the top bearing is merely a hole drilled into the dial of the instrument). The dial is properly calibrated, with which I am thoroly familiar. As you will notice by the sample which I sent you, one side of the metal is nickel, which makes it expand with heat and contract with cold, which in turn rotates the shaft to the end of which a pointer is fastened. This determines the correct temperature of the room into which it is hung. I have constructed a model which has stood up with any mercury thermometer that I hung along side of it. To my knowledge there is not another instrument built along these lines. Please advise if a patent can be obtained on this invention."

A. To our mind this is a very good idea, and we are inclined to think that a patent can be obtained on this invention. Providing a large temperature range can be had on such a thermometer, we should think that it would be quite a practical instrument and one that would commend itself readily to the public.

Protected Switch.

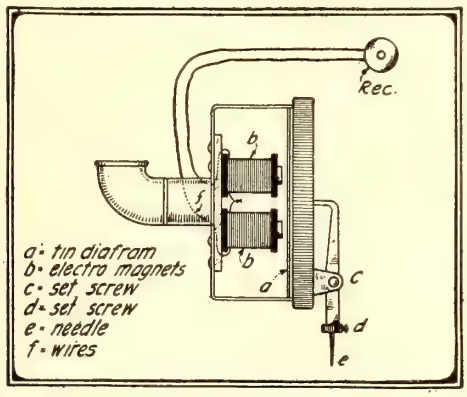
(358) Onni Koskin, Dollar Bay, Mich., says: "It is claimed that a large share of the accidents from electric shock are caused by open knife switches. I think that this could be prevented by insulating all the exposed metal parts, except the contacts with some material such as the enamel used on some electric wires. I would like to know if this idea could be patented."

A. Switches of this kind are in use now. For this reason we do not think that you could obtain a patent.

Electric Recorder and Reproducer.

(359) Marion W. Taylor, Buechel, Ky., submits an idea, shown in the illustration, which works as follows: The recorder and reproducer works as a telephone receiver. A person speaking in a transmitter connected to this instrument causes the vibrator or diafram to vibrate, thus making the impression upon the record. Then, when run over the second time the same will be reproduced in a pair of receivers, this being done by having a direct current between recorder and phones, so that when the diafram vibrates it breaks the lines of magnetic force producing sounds. He wishes to know if this is a patentable feature and if we think that the idea is valuable.

A. This seems to us as a good idea, and we think a patent can be obtained on it, altho we do not see the exact use of the instrument, but, of course, there may be some uses for it, such as for transmitting phonograph music at a distance, etc. You seem to think that it is necessary to have a battery in connection with this device, but this is not necessary, providing the electro-magnets have a steel horseshoe magnet. Then, in that case, no battery is required, as the music or words



from the phonograph would be transmitted "electro-magnetically"; the same as when you take two receivers and connect them together without a battery. This arrangement, as is well known, will then "talk." The coils, however, must be mounted on soft iron pole-pieces, not on the steel magnet frame proper. These pole-pieces or cores are then securely clamped to the steel magnet.

Wireless Device.

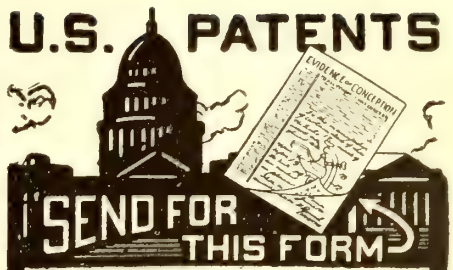
(360) W. J. B., Philadelphia, Pa., sends in a description of a design of a new system for wireless telegraphy, and would like to know if a patent could be obtained upon it and, particularly as it requires no aerial, what its advantages are. Several other pertinent questions are asked.

A. We have carefully looked over this invention, but we fail to see how it could possibly work, as no circuit is provided for the secondary discharge of the spark gap; hence we feel certain that it could never work successfully.

Scale Dividers.

(361) Elmer Knitter, Cleveland, Ohio., writes: "I submit herewith a sketch of an idea on which I would like to have your opinion along such

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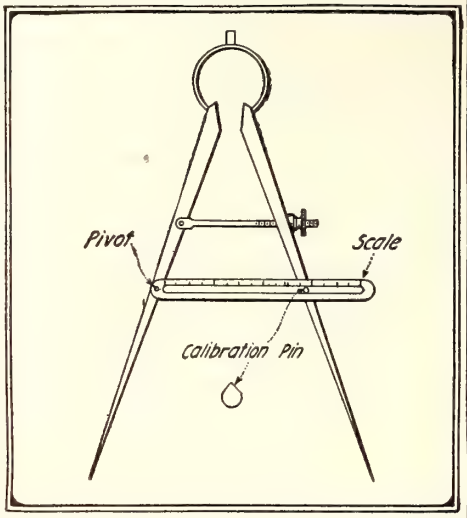
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lines as you publish in the ELECTRICAL EXPERIMENTER. The idea contains a provision of a scale on dividers, calipers and similar instruments so as to obtain quicker measurements than we do now, for the simple reason that it does away with the slow method now in use. I would like to know if this device could be patented."



A. This seems like a good idea, altho we think we have seen a similar device once before. Of course, it would be necessary to make the calibrations so that the scale would read in inches for the distance at the end of the dividers, but this, of course, is a mere detail. Our advice is to have a search made in the Patent Office for patentability.

"Perpetual Motion."

(362) Werner Kretschmer, Demarest, N. J., submits a scheme whereby a motor is connected to dynamo with a belt and with wires attached to the brushes. It is first started by an outside source of current, such as a storage battery. The motor then works the dynamo thru the belt and a current is generated in the dynamo. Then the outside circuit is broken and the dynamo supplies the current to run the motor, which, in turn, runs the dynamo. If there is nothing fundamentally wrong with this plan, the apparatus would work indefinitely. Of course, some energy would be lost thru friction and other resistance, but I see no reason why that could not be overcome by using a powerful, yet easy-running dynamo. If this plan were possible, I believe it would do a great deal toward making the electric automobile more of a success. Only a weak current would be needed to start the action.

A. This scheme is just as feasible as lifting oneself up in the air by one's own boot straps. This idea is a favorite one among young inventors, and it crops up every once in a while. The idea, however, is entirely fallacious, as you cannot possibly obtain energy for nothing. Too much energy is lost in friction and other losses, making it impossible for such a scheme to come even near working.

Fly Swatter.

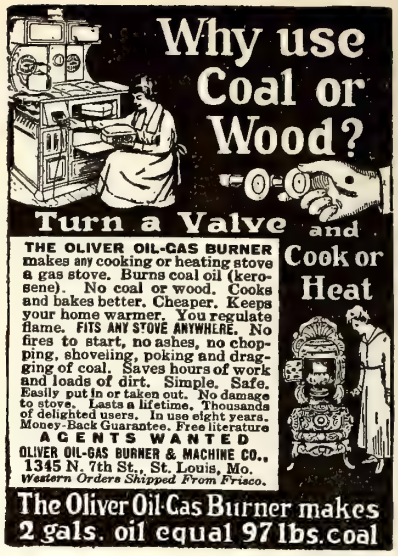
(363) John F. Carlson, Irwin, Pa., sends us a sketch of a new fly swatter, which is made of a piece of screen with a soft rubber frame molded around the edge to protect scratching the furniture, etc. The wooden handle could be cemented into the rubber. He would like to know if a patent can be obtained on this article, and if there is such a swatter on the market.

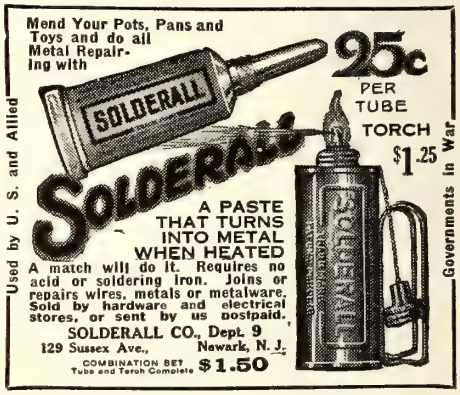
A. There is nothing new whatsoever in this invention, and you can buy such swatters in many stores handling household goods. They sell for about fifteen or twenty-five cents. It is quite an old idea.

Ignition Device.

(364) Clyde Stewart, Beldenville, Wis., says: "I submit herewith a drawing of a supposed ignition outfit. The drawing is almost self-explanatory. The secondary coil, which could be similar to the one used on wireless spark coils is fastened firmly to the cam shaft C. The magnets N S are, of course, rotating all the time the engine is in operation. When the engine is on the compression stroke the cam shaft moves up, carrying the coil with it. On account of the magnetic field set up by the rotating magnets a high tension current would be set up in the coil. I am rather in doubt as to how much current could be produced, but I should think if the secondary were larger than most secondaries on gas engine coils enough current could be induced. The device could also be applied to automobile engines by means of a special device, which I have. The question of timing the discharge could be solved by moving either the coil or magnets. Do you think the device would work? Could a patent be obtained on such a device?"

A. This seems to us a good idea, altho it should be tried out first in practise. We are also afraid that more magnets than shown will have to be used in order to get a sufficiently strong spark. We also are afraid that unless the magnets are very powerful little current will be realized. When it is considered that even a small spark coil takes as much as five or six amperes it will be realized that in order to get sufficient electro-magnetic flux the permanent magnet would have to be exceedingly powerful.





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Submarines to Salvage Sunken Ships

(*Continued from page* 809)

means of a push button he gives the signal to the crew and comprest air is admitted to this chamber which forces or blows out all the water in it. Owing to the high air pressure, about 150 pounds to the square inch, a large opening can be used for blowing out the water, as with this heavy air pressure the water can be kept out of the chamber even with the valves left open to the sea. If this high air pressure was left passing into the chamber, once the water has been blown out of it, however, and then the inner compartment door opened, the diver would be quite likely forcibly ejected into the pontoon quarters. A better procedure is to close the sea-cocks as soon as all the water is blown out of the chamber. The comprest air would then be shut off, and allowed to lower itself to atmospheric pressure, or a pressure corresponding to that within the pontoon, if a higher one than normal happened to be in use at the time. The inner or right-hand door can then be opened, and the diver can pass into the regular quarters, remove his ponderous suit with its 100 pound, lead weighted shoes, undo his massive steel helmet, and sit down to a bowl of steaming clam chowder.

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Assuming that a large number of steel cables have been past around the wreck and that the time has come to attempt to raise it, the action is as follows:—When it is time to begin the raising operations, the pontoon sections are submerged to a reasonable depth and when everything is ready and the signal given by means of under-water sound telegraph or otherwise, the water is blown out of the submerged tanks of the pontoon and their buoyancy is re-established. Providing they have sufficient lifting power to raise the sunken ship, then they will slowly begin to rise, bringing up the wreck with them. In a great many locations advantage is taken of the rise and fall of the tide where such salvaging operations are undertaken and when the wreck has been raised a certain amount above the bed of the harbor or bay, the pontoons or vessels supporting the wreck by means of cables and so forth, steam toward the shore, so as to lodge the wreck on the sand in a more shallow location. The pontoons are submerged when they are favored by the low tide of the day, and they then draw up all cables tight. By submerging during this period for a certain depth they can then raise the wreck for another appreciable amount, and as the submarines can propel themselves along at a speed of several miles per hour, they can carry the wreck still further into more shallow water, etc., etc. Such a device as this would at least be a great help in salvaging operations, in conjunction with regular salvaging vessels and derricks, to say the least.

In some cases a sunken ship could be caused to almost (and in some cases) actually float itself by pumping comprêst air into the hull of the wreck. Naturally, it is necessary to effectually close up any holes in the particular sections of the hull which are to be blown out by air and this is the work of the expert divers.

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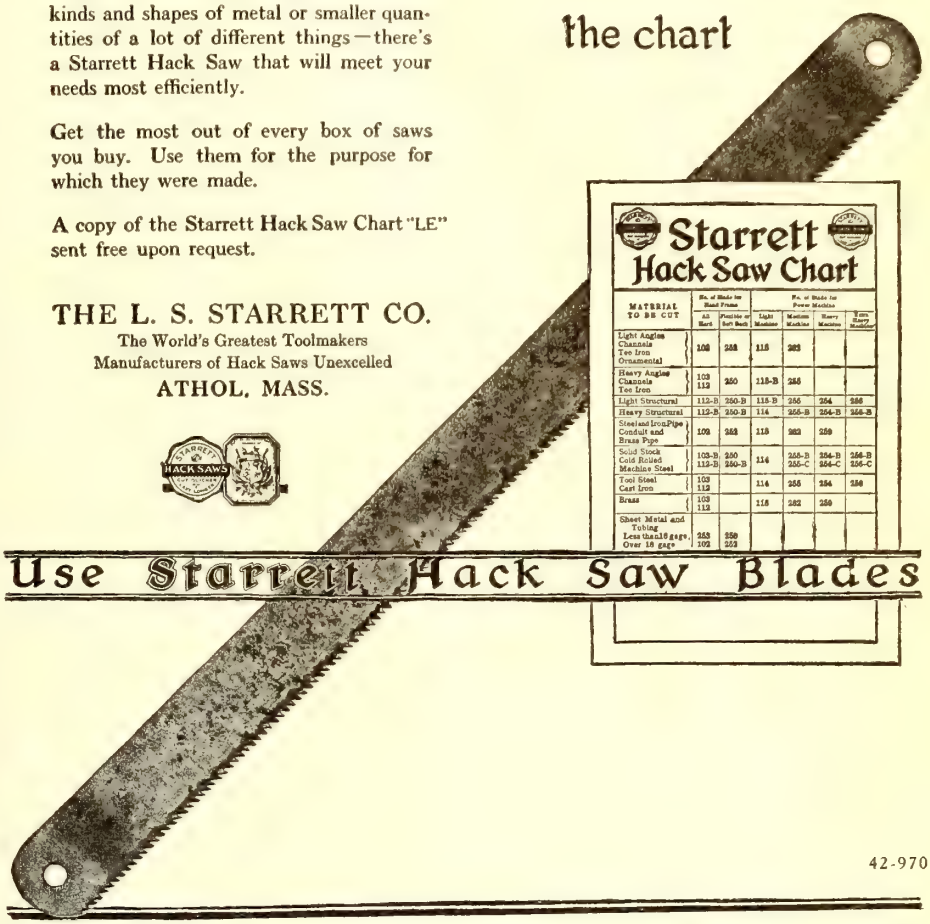
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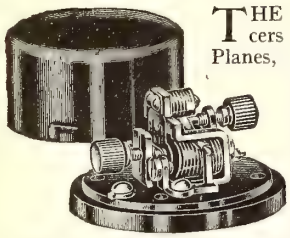
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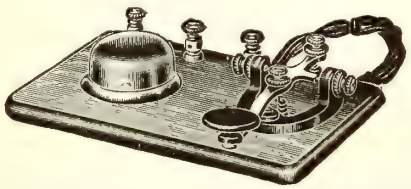
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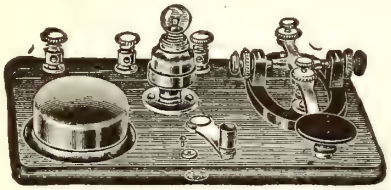
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By Charles M. Ripley

(*Continued from page 757*)

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Popular Astronomy

By Isabel M. Lewis, M.A.

Is the Moon Dead?

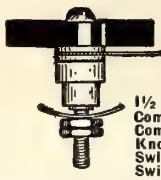
(*Continued from page 768*)

delicate clefts or rills, also in the appearance of dark spots from time to time and the darkening of the floor of craters as the altitude of the sun increases which cannot be shadow effects since at lunar mid-day when the darkening is most pronounced there are no lunar shadows.

The only plausible explanation of this periodic darkening during the lunar day is that it is due to the growth of some form of vegetation.

One of the most interesting and most convincing evidences of change in lunar markings is associated with the noted Ariadaeus and Hyginus cleft system which we note particularly since it is so well shown in the accompanying photograph taken at the Mt. Wilson Observatory. These two clefts in the lunar surface can be seen just above the northern edge of the photograph. The Ariadaeus cleft or rill originates well over to the west at the small crater Ariadaeus faintly visible in the lunar shadows and runs first north east then north to the edge of the photo. It will be observed that it cuts directly thru all craters and ridges in its path, a peculiar characteristic of all clefts. A careful examination of the photo will show that it is connected with the coarse Hyginus cleft to the south east (so named because it passes in its course directly thru the depression known as Hyginus, four miles in diameter) by a much fainter canal-like cleft. It is this connecting cleft that has shown evidence of change. Gruithuisen, a diligent lunar observer, detected this connecting cleft in the early part of the nineteenth century and noted that at times it appeared perfectly straight and at other times very irregular altho observed under the same conditions of phase and definition. Lohrmann and Mädler who later observed this region frequently never saw a trace of it. It was rediscov-

(*Continued on page 822*)



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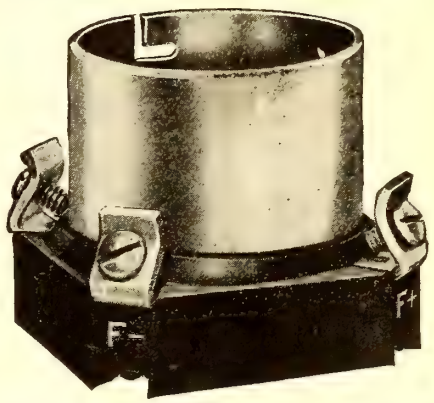
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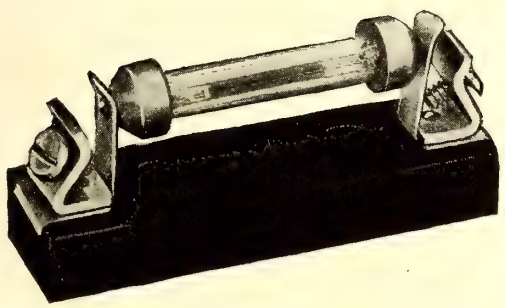
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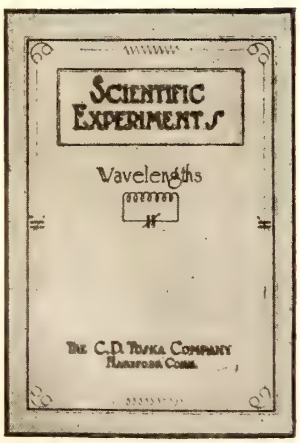
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Popular Astronomy

By Isabel M. Lewis, M. A.

IS THE MOON A DEAD WORLD?

(*Continued from page* 820)

ered by Schmidt in 1862. Klein, later, saw this cleft very clearly at times and again looked for it in vain under similar observing conditions. Elger found it an easy object with a 4-inch telescope. The latter observer, a noted selenographer who has also observed changes in the appearance of other clefts queries whether these are not instances of recent change difficult to "explain away." He says in part—"The more the study of minute detail is extended the stronger becomes the evidence that in spite of the absence of an appreciable atmosphere there may be something resembling low-lying exhalations from some parts of the surface which from time to time are sufficiently dense to obscure or even obliterate the region beneath them." Of the nature of the lunar clefts or rills he feels we are "supremely ignorant." They are generally regarded as huge cracks in the surface due to shrinking and contraction of the moon.

A most interesting rill system, partly traceable in this same photograph, is known as the Triesnecker system. It can be found to the southeast of the Hyginus cleft and west and north of the conspicuous ring-plain Triesnecker which can be seen about an inch above and a little east of the northern rim of the photograph.

Photographs fail to show the great complexity of this remarkable system. In studying all the intricate detail of the lunar markings the human eye is vastly superior to the photographic plate. Moreover, all these minute details are only revealed piece-meal, as it were. A cleft or rill that is very distinct under a low sun will usually disappear entirely under high illuminators.

The best time to study the details of the lunar surface is therefore *not* at or near the time of full moon, but when the object in question is illuminated by a low sun.

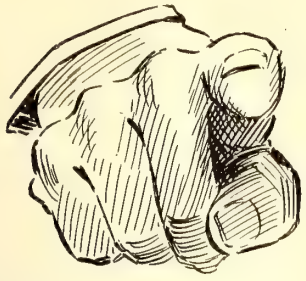
Changes of tint in the interior of the Hyginus cleft were noticed by Klein. At some points the reflected sunlight was decidedly yellowish, at others white as if the cliffs were snow covered.

Tho on the whole the lunar atmosphere is comparatively rare it is by no means impossible that certain dense and heavy gases may exist locally in considerable quantities, in fact that carbon dioxide and water vapor so essential to the growth of organisms may occur within the lunar cracks, crevices and numberless pits and depressions in even greater quantities than they are found in the earth's atmosphere of which they form a relatively small proportion, the amount of carbon dioxide in the earth's atmosphere at sea level being only three hundredths of one per cent.

If certain forms of life do exist on the moon it is certain they would be found on the low-lying maria and within the gigantic cracks of the lunar surface and all of its pits and depressions rather than upon the high snow-covered plains and ramparts of the southwest quadrant.

That a sort of vegetation may exist in the deeper seas is not so improbable. Elger noted a decided sepia color in the Mare Foecunditatis and within certain ring-plains and craters and many observers have recorded that some of the seas are darker than others and that all show local changes of tone. Networks of streaks intermingled with dark spots and minute brilliant points of light have been observed on the maria under good atmospheric conditions and many have noted in addition that certain of the "seas" appear yellowish or green.

(*Continued on page* 824)

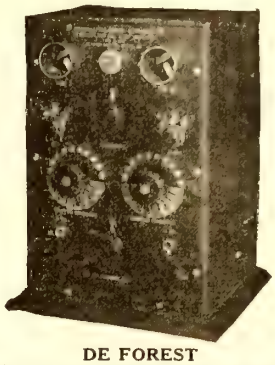


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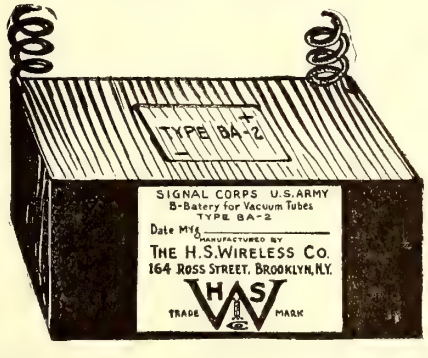
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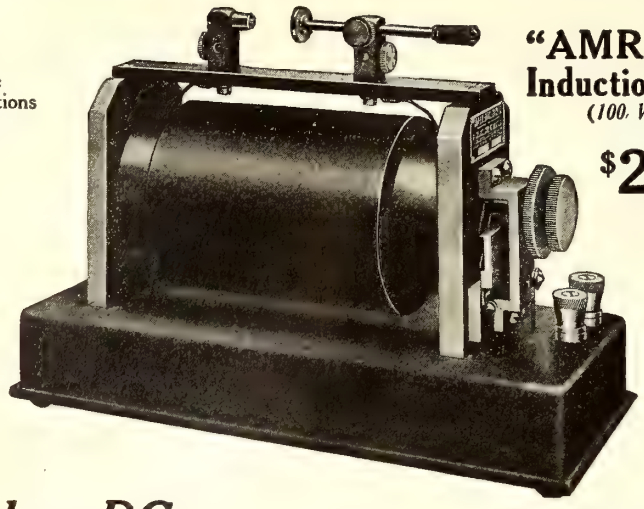
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Popular Astronomy

By Isabel M. Lewis, M. A.

IS THE MOON A DEAD WORLD?

(*Continued from page 822*)

The Mare Crisium containing about 70,000 square miles and considered to be the deepest of all the seas appears a light green under certain conditions. The central part of the Mare Humorum which is well shown in the accompanying photo taken by Ritchey with the 40-inch Yerkes refractor (see just south of the center of the eastern edge of the photo with the conspicuous ring-plain Gassendi on its border) has been described as a dusky green under good seeing conditions. This "sea" contains 50,000 square miles and is therefore about equal in area to New York State.

A class of lunar objects apparently very subject to change are the crater-cones that appear so frequently on the floors and walls of ring-plains and craters. Under high illumination they usually appear as white spots and the fact that they are associated with light streaks on the floors of craters seems to imply that they are volcanic vents. The lunar observer Klein firmly believed them to be volcanic and more recent observations substantiate this belief.

In October, 1916, Maggini observed reddish shadows spreading over part of the floors and walls of the crater Plato hiding temporarily one of the minute craters that dot the floor of this crater.

If active volcanic vents do exist on the moon we have here a source of supply of carbon dioxide and water vapor for the growth of lunar organisms in low-lying regions.

The blanketing effect of the carbon dioxide and water-vapor in our own atmosphere is well known and would tend there as well as here to mitigate the extremes of heat and cold at low levels.

A most interesting region of the lunar surface is to be found just north of the Hyginus cleft (see Mt. Wilson photo near center of the north edge). Here a mysterious black spot was discovered in 1877 by Klein which he described as a dark depression without a rim and one which he was sure he had never seen before tho he had scanned this region frequently during his twelve years of lunar observations. This spot was later observed by others under various solar altitudes appearing to many as "an ill-defined object with a somewhat nebulous border." In its vicinity lie two small craters and several low ridges. Whether this is really a new lunar marking is uncertain tho the evidence of change seems very strong.

Prof. W. H. Pickering, one of the chief selenographers of the present day, has recorded frequently many observations of lunar changes and his photographic atlas of the moon is well known. His observations are in accord with those of a number of other selenographers in indicating that activity upon the surface of the moon has not entirely ceased and that in fact our satellite may support certain forms of vegetation and even presumably of animal life in low lying regions where a comparatively dense gaseous medium whose chief components are carbonic acid gas and water vapor may well be found.

The high plateaus in the south west quadrant of the moon and the walls and peaks of the walled plains, ring-plains and craters that are massed there in the greatest profusion, most all observers are agreed, owe their dazzling brilliancy to a perpetual mantle of snow. The same dazzling whiteness also exists in the north and south polar regions of the moon.

On the whole, we may say that evidence that the moon is not an absolutely cold

and lifeless world is accumulating from many sources.

The most powerful telescope and the best seeing conditions are necessary to settle many of the questions of suspected changes as they are associated largely with the more minute markings.

Yet there are markings wherein changes are suspected that lie well within reach of very moderate instruments.

A four inch refractor or a six or eight inch reflector will show a number of lunar features not yet recorded on lunar maps.

There are many excellent and valuable lunar maps, in fact, the surface of the moon has been more carefully and accurately mapped than certain terrestrial regions, and there are in addition excellent photographic atlases obtainable so that the amateur who wishes to become acquainted with our nearest neighbor in space will find much helpful and valuable material at his disposal and if he pursues this line of study systematically and carefully he may find that his observations are of real scientific value.

The unsolved problems of the moon are many and perplexing and the true nature of its rays and rills, its craters and its maria still remains very uncertain in spite of many conflicting theories and so a wide field of investigation lies open to all.

QUESTIONS AND ANSWERS.

Question 1. Are the Pleiades the center of our stellar galaxy?

Answer 1. There is absolutely no foundation for this belief.

The Pleiades form what is known as a "loose moving star cluster" that cannot be, at the most, more than a few hundred light years from the solar system.

According to the recent investigations of Shapley the center of our galaxy lies, most likely, among the star clouds of Sagittarius at a distance of more than sixty thousand light years from the earth.

Question 2. Is the sidereal universe fathomless?

Answer 2. So far nothing is known to the contrary. We have as yet no reason to believe that the most powerful telescopes have penetrated to the limits of the universe and even if we were able to say definitely that we had reached the limit of our own particular sidereal system and that all the stars, star clusters and nebulae visible in our telescopes were units in one vast organization we would still be in doubt whether other systems might not lie beyond the confines of our own hidden from our view by some absorbing medium.

Question 3. What are "irresolvable" nebulae?

Answer 3. In small telescopes nebulae and star clusters cannot be distinguished from each other. As the magnifying power of telescopes increased it was found that many formations that had been formerly believed to be nebulae could be "resolved" by powerful telescopes into star clusters. Some astronomers then jumped to the conclusion that all nebulae could be resolved into star clusters in sufficiently powerful telescopes.

When spectroscopy was applied to astronomical research and the light of the irresolvable nebulae was analyzed, it was evident that some of these formations were truly gaseous and so never could be resolved into star clusters. The term irresolvable nebulae therefore has no special meaning at the present time when nebulae are classified as gaseous or continuous according to the type of spectrum they show. The continuous type to which the spiral nebulae belong might still be considered irresolvable to a certain extent since they have never been resolved into the stellar components of which they doubtless largely consist. Their true nature and relation to the stellar system is not yet definitely known.

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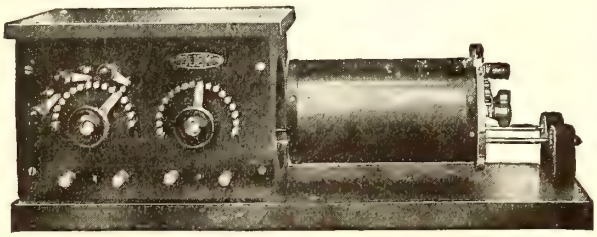
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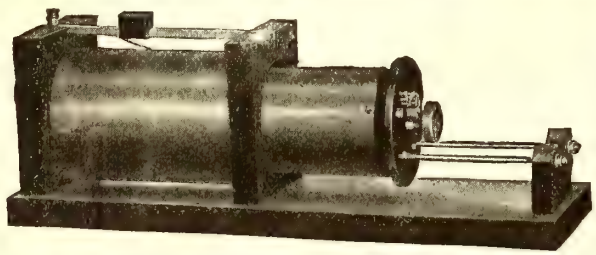
We regard this catalog as our greatest effort. It embraces everything in wireless worth while. 172 pages with no waste space devoted exclusively to wireless instruments. Your amateur friend will tell you that there never has been any wireless catalog to take the place of catalog of this company and above all that you can absolutely depend on our goods. There is no need for any other catalog when you have this big catalog.



A big improvement over our former model. Primary divided into four sections, with three dead end switches, greatly improving selectivity.

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NEW MODEL 5BB. NAVY TYPE RECEIVING TRANSFORMER



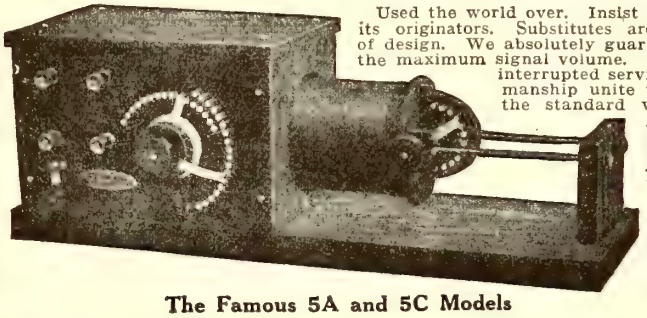
The secondary on our new type Arlington is divided into two sections with one dead end switch eliminating dead end effect and harmonic and giving greater selectivity. The end support similar to that on our Navy type permitting a looser coupling. It is a beautifully finished instrument and will be sold by us at the same price as the old model. $9.00.

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THE WILLIAM B. DUCK CO., 230-232 Superior St., Toledo, Ohio

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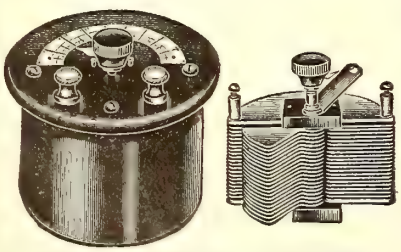


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BEEKO VARIABLE CONDENSER
Size, 3¼x4¼ inches.
Price each
Mounted (postage weight 2 lbs.).....$5.40
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HIGH GRADE
Amateur Wireless Apparatus
Send Stamp for Catalog 40E
J. H. Bunnell & Company
32 Park Place
New York City, New York

Rohlfs Flies 34,610 ft.—New World's Record

(*Continued from page 760*)

never perfected until recently, and which practically *doubles the efficiency of an airplane engine at high altitudes.*

"In the future," said Chance M. Vought, Chairman of the American Flying Club Contest Committee, "airplanes equipt with these super-compressors will be able to attain heights hitherto regarded as impracticable; levels at which are found constant trade winds. These winds at various high levels can be found following courses suitable to almost any international trade route and can thus be utilized to tremendous advantage in aerial commerce. The airplanes equipt with this super-charger device will fly at greater speed at high altitudes than is now possible, and will have almost the same performance of speed and climbing power as at around sea level. Among the technical experts this invention is called 'a constant power device.'

"The Lepere biplane, equipt with a Liberty motor, which Major Schroeder used in the altitude flight, has a horizontal speed at sea level of 136 miles an hour. At an altitude of more than 20,000 feet this speed, owing to the rarity of the atmosphere and the decreased engine power, falls to 105 miles an hour. Equipt with the supercharger device, the horizontal speed at 28,250 feet was maintained at more than 130 miles, or almost equal to the best possible at sea level. Major Schroeder found the compressor consumed only 5 or 10 per cent of the engine's horse power, while at 15,000 feet altitude it added 40 per cent to the power-plant's effectiveness. At 20,000 feet, 48 per cent was added and at 28,000 feet, 60 per cent was gained.

"The super-compressor is a device to utilize the waste exhaust gases of the engine itself to operate a small centrifugal air-blower which forces an air stream into the engine at a constant pressure about equal to the normal suction of the motor at sea-level pressure and thus maintains engine functioning approximately the same as under the best conditions at sea level.

"Major Schroeder and his passenger wore electrically-heated clothing and oxygen helmets. The record shows that the temperature at 28,250 feet was minus 29 degrees centigrade.

Carnarvon Radio Station

(*Continued from page 778*)

transformers connected to each power line transform the current down from 10,000 volts to 440 volts at which power it appears on the main switchboard.

The main switchboard is of the Ferranti type and consists of 12 panels. From the feeder panel cables are taken to the main switch panel on which is mounted a hand-operated oil switch provided with *no volt* and *overload time limit* releases, a voltmeter, ammeter, kilowatt meter, power factor meter and frequency meter. The remaining panels on the board are equipt with switches and gear for the control of the motors driving the high tension direct current generators, the motors driving the alternator sets, the motors driving the low tension D.C. auxiliary machines, the high tension alternators, direct current motors, and of all the lighting, heating and various other circuits.

There are three distinct types of transmitters installed (1) the synchronous alternating current sets; (2) Marconi

"timed-spark" continuous wave machine; (3) the arcs.

The synchronous A.C. sets are in duplicate and are of 300 k.w. capacity, each consisting of a 450 B.H.P. 440 volt 3-phase asynchronous motor driving a 300-k.w. single phase alternator, the working voltage of which is 1,750 volts. An extension of the alternator shaft drives the disc discharger thru an insulating coupling. The primary condenser bank has a capacity of 2.5 mfds and is charged by step-up transformers, the field of which can be adjusted so that the studs on the disc discharge the condenser at each peak of the alternation.

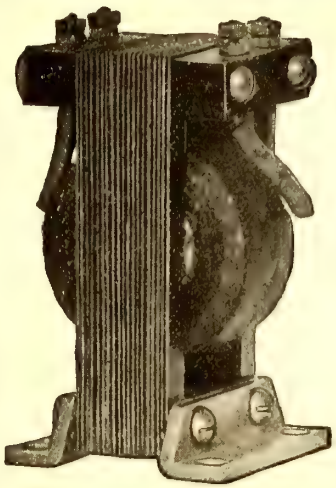
The timed spark continuous wave transmitter has two distinct primary circuits tuned to the same frequency and coupled to the aerial circuit. The condensers of these primary circuits are charged by 5,000 volt D.C. dynamos and discharged alternately by means of a special form of disc discharger so arranged that the trains of oscillations produced in the aerial by the successive discharges of the two condenser banks take place in phase with one another. This timing of the discharges is controlled by a trigger circuit which at a given instant ionises the gap between the studs and electrodes of the main circuits and enables them to discharge, special adjustments being provided for determining the moment of discharge. Signaling is effected by making and breaking the charging current of the trigger circuit, and as this current is only .5 amp. a very high rate of working is possible.

One of these transmitters of 300 k.w. capacity, capable of working at 200 words per minute, is already installed at the station and a duplicate set is in course of erection.

The 200 k.w. arcs are of the horizontal type and are fed thru choking coils and starting resistance from an 800 volt D.C. dynamo. The field of the arcs is separately excited from an auxiliary 110 volt D.C. dynamo which also supplies current for the pump motors, cathode motors, and spirit relays. Methylated spirit is automatically fed into the arc chamber which, with its lid, anode and cathode, is water cooled, a relay being provided in the water circuit to cut off the current to the arc should the water supply fail.

A special receiving station at Towyn is intended for all the receiving and operating work, and is provided with apparatus for duplexing the service. At Carnarvon, however, for special war purposes, receiving apparatus has been installed with a range of from 3,000 meters to 16,000 meters. The aerial is inductively coupled to an intermediate circuit which in its turn is coupled to an amplifying and self-heterodyning valve circuit. By means of magnifiers in the telephone circuit arrangements are made for either automatic reception at high speed, or to enable the operator to receive without wearing telephones. The signaling key for operating by hand is placed in the receiving room, where there is also a Wheatstone automatic transmitter capable of working at a speed of 200 words per minute. For this high speed working high tension signaling switches worked by a Creed comprest air engine is used for slow transmission. Galvanometer type signaling switches are provided, but both types can be operated from relays, either by the hand key or by the Wheatstone transmitter.

Altho the Carnarvon station is primarily intended to work to America it has successfully communicated with Sydney, Australia, thus proving that it is powerful enough to cope with any distance up to the limit of possible long-distance transmission on the earth, it being understood that modern receiving apparatus is employed at the Antipodes.—*Photos courtesy Marconi's Wireless Telegraph Company, Ltd.*



Vacuum Tube Socket
(Type Triode F)

The base of this socket is bakelite dilecto and will not crack and break like the moulded material of the usual socket.

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Type P

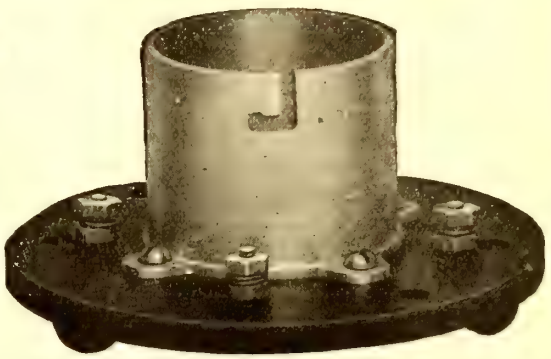
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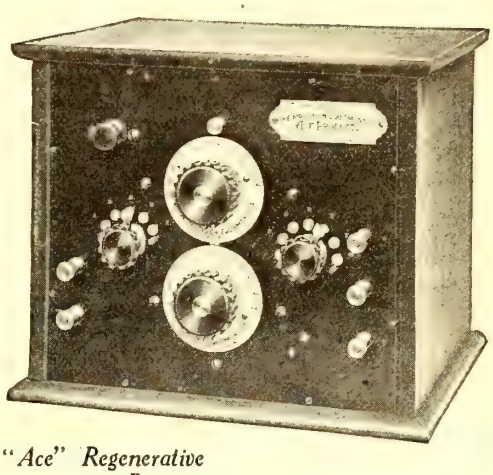
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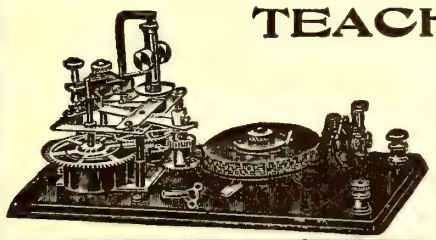


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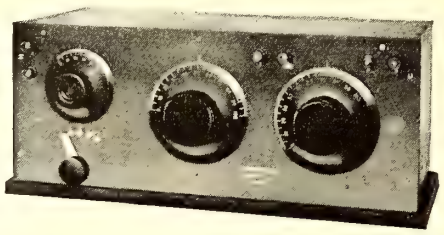
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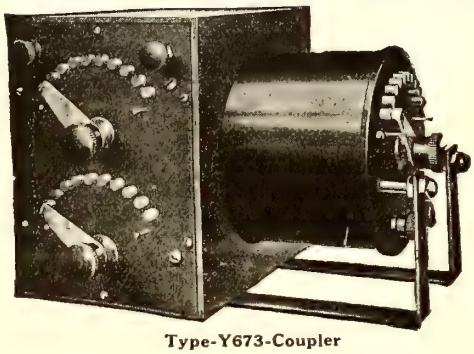
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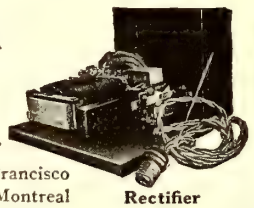
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DORON BROS. ELECTRICAL CO. Hamilton, Ohio

Modern American Radio Apparatus

(*Continued from page 779*)

In this new system the machine that generates these electrical oscillations is known as the *Alexanderson alternator* which has the advantage of giving a *pure wave* by virtue of which messages sent by different stations do not interfere with one another. There is just as much improvement in this new system over the older method as there is between the modern balanced telephone line and the old single-wire telephone on which the cross talk of neighbors could be overheard.

A new device known as the magnetic amplifier is employed as a modulator of the electric oscillations. This new device has no moving parts and this fact, coupled with its magnetic properties, renders it so quick as to make possible the transmission of telegraph messages at the rate of several hundred words a minute and also enables the amplification of the modulations of the telephone currents into oscillations sufficiently powerful to carry the human voice across the Atlantic. In all the different radio systems the radiator is called the antenna and up to the present time the antenna has been very inefficient, the useful energy radiated amounting to from 5 to 10 per cent. In the Alexanderson system a multiple tuned antenna is an important feature and increases the radiation efficiency from 20 to 50 per cent.

The company has developed such high frequency alternators for radio work in capacities of 1, 2, 50, and 200 kilowatts. It was one of these 200 kilowatt machines that did such good work at the New Brunswick station during the war, so it is interesting to note that a unit of this size *radiates approximately 250 h.p. of energy into space when it is sending a radio message*. The peculiar advantages of this type of generator is that it gives out an undamped wave and puts such a large amount of energy into the antenna; factors which led to the rapid extension of the use of radio communication during the war, and also led to the building of so many new transmitting stations as well as the use of this means of communication for spreading propaganda.

Over and above the radio work referred to the company's radio developments were many and varied. A description of all the work done seems impractical, so to give a general idea of some of this work that had been completed or was nearing completion at the time the armistice was signed, it will be well to classify it as follows:

(a) Large size vacuum tube apparatus
(b) Medium size vacuum tube apparatus
(c) Small size vacuum tube apparatus
(d) Receiving apparatus

All these new developments were carried out under war-time conditions, at high pressure, and under numerous difficulties caused by the rapid change of requirements.

The term "vacuum tube apparatus" may need a word of explanation: it refers to that type of transmitter and receiver which makes use of the vacuum tube as an oscillator, amplifier and receiver. Such tubes are usually made of glass and generally contain three electrodes. The tube is exhausted and the Research Laboratory at Schenectady has done much notable work in producing a tube of higher voltage and greater power output than hitherto had been found possible. The physical properties of the tube, which is termed a "pliotron," are dependent upon the motions of the electrons set free from the heated filament in a nearly perfect vacuum. We shall refer at greater length further on to this subject.

Most radio apparatus, previous to the development of these tubes, employed what are commonly termed "damped waves," which means that for a portion of the time there was no activity. With the vacuum tube undamped waves are used in which there is no period of inactivity; this results in a higher efficiency.

In pre-war days the advantages of the undamped oscillations were well recognized and apparatus of this description had largely displaced the older damped apparatus on the score of greater efficiency, the ability to use the lower voltage, small size, and also because of certain advantages in reception; but this new type of apparatus had not been used to any large extent in the smaller radio outfits.

The war-time requirements of both the army and the navy were of a very special nature and called for a great number of small sized, short range radio sets of light weight and small cubic capacity; these features being particularly valuable in aircraft outfits. To meet these requirements, the vacuum tube apparatus was developed and was applied in several unique ways to the aircraft service, particularly in its application to telephonic communications. All sets developed by the company were arranged for telephonic communication on the continuous wave and telegraphic communication on both continuous and "chopt" wave.

Aircraft are of various sizes and therefore several different types of apparatus were designed to meet the differing requirements, but finally the design settled down to three types, each particularly suitable for a certain class of airplane. Thus the large size vacuum apparatus was primarily intended for bombing planes, flying boats, and balloons; the medium size for such craft as seaplanes and biplanes; and the small size for the smallest class of flying machines, which usually carry only one aviator.

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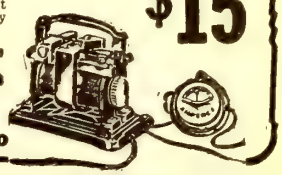
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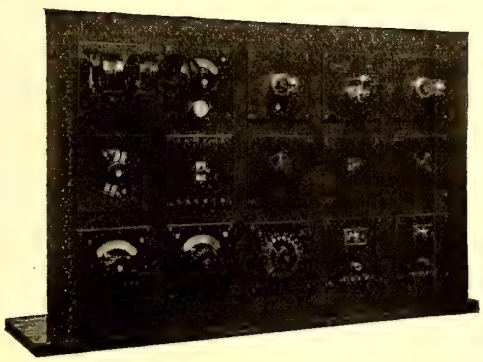
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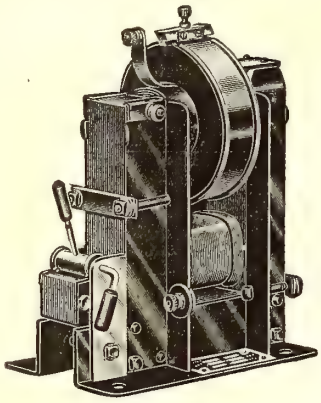
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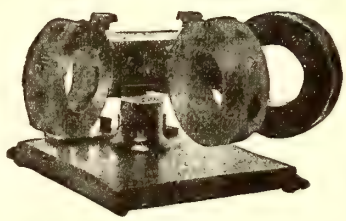
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The large size vacuum tube apparatus uses the largest type of pliotron that the company has developed and is adapted for use at fixt land bases for controlling the fleet movement of a large number of planes by telephone. Such sets radiate about 1½ horse power of energy and are capable of giving telephonic communication with a flying boat at a distance of at least 200 miles. Similar units were designed for installation on army tractors for field operation. These also had a range of 200 miles, and at the time the armistice was signed a number of orders were under way for radio telephone sets for this service. An aircraft unit using this large vacuum tube was designed which only weighed 70 pounds, exclusive of the storage battery.

An aircraft radio telephone unit using the medium size vacuum tube was developed, and is now being produced in large quantities. It has a telephonic range from plane to ground of a hundred and fifty miles and weighs only about 40 pounds, exclusive of the battery.

A great amount of work was done on a radio telephone set using the smallest size of vacuum tube and the weight had been brought down until the complete transmitter, exclusive of the battery, weighed only 25 pounds. This set had a range of 60 miles from the fixt station and communication was obtained over a distance of ten miles between two similar planes.

The vacuum tube, commonly called the *pliotron,* and mentioned so often in this story, deserves many chapters to cover the fascinating story of its development; particularly the truly wonderful scientific laws which govern its action and the almost unbelievable amount of work that was accomplished by this concern in supplying the needs of the army and navy with these tubes. The amount of progress that the world owes to these tubes is a source of just pride to the workers of the Research Laboratory at Schenectady where so much of the development work was done that led to their present highly developed state. But owing to there being so much that is of interest, we shall have to confine our remarks to one or two brief paragraphs.

The practical long distance telephone really owes its development to the pliotron, and the advances it has enabled to be made in wireless telegraphy are great and far reaching.

These tubes depend for their action on the emission of electrons from a heated cathode which crossing a gap arrive at the anode, thus conveying an electric current across the gap. The ability to produce high power tubes depends on many factors, but the most important is to obtain a very high degree of vacuum.

As soon as America entered the war and the requirements of the government were learned, two lamp factories were started on the wholesale production of the vacuum tube and provided equipment to turn out 20,000 per week. This concern supplied the army and navy with many thousands of pliotrons for the airplane and seaplane service and many hundreds of the complete wireless outfits already described.

Men talking across the broad expanse of the Atlantic ocean without a wire is romantic enough of itself, but what of an "Ace" with his radio set controlling the fleet action of a mighty host of flying battleships engaged in deadly battle miles up in the air.

It seems fanciful, but it is real that today we send men miles up into the air to obtain meteorological information of distant points and have the information telephoned back to us on earth. These are indeed messages from the ethereal blue.—*Photos courtesy General Electric Co.*

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Ships Guided by Electrified Cable

(*Continued from page 746*)

to the experts of the navy who have tested it, and recommended its use, is fool-proof and as reliable as the telephone. It will work in all conditions of water and weather and no amount of electricity in the air or power of the wireless can affect it in any way.

Earl C. Hanson, who is only 28, has been granted basic patents on the system. During the war he donated to the government all his inventions.

Gen. Pershing directed Col. John H. Parker to secure the use of the device for communications in the first battle lines and trenches, and only the signing of the armistice prevented its universal use in the American Expeditionary Forces, it is said.

The cost of installation will be much less than the installation of lighthouses, buoys, lightships, and other fog signals, with the added advantage that the system works without interruption from storms or fogs or other atmospheric conditions, claims the inventor.

It is difficult to estimate the economical saving that will be brought about by the universal installation of the Hanson system, which is applicable to any type of harbor. It may be considered as a refining feature of the *radio compass* which was developed under the direction of Capt. S. C. Hooper, of the radio division, bureau of steam engineering, Navy Department. R. H. Marriott, expert radio aid of the Navy Department, has conducted tests using the audio system for guiding ships in tests on the Pacific Coast with gratifying results.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of Electrical Experimenter, publisht monthly at New York, N. Y., for October 1, 1919.

State of New York, County of New York—ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the Editor of the Electrical Experimenter, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations:

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher, The Experimenter Publishing Co., 233 Fulton St., New York City; Editor, Hugo Gernsback, 233 Fulton St., New York City; Managing Editor, H. W. Secor, 233 Fulton St., New York City; Business Manager, R. W. DeMott, 233 Fulton St., New York City.

2. That the owners are: Experimenter Publishing Co., 233 Fulton St., New York City; Hugo Gernsback, 233 Fulton St., New York City; Sidney Gernsback, 233 Fulton St., New York City; H. W. Secor, 233 Fulton St., New York City.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is —(Required only of daily publications.)

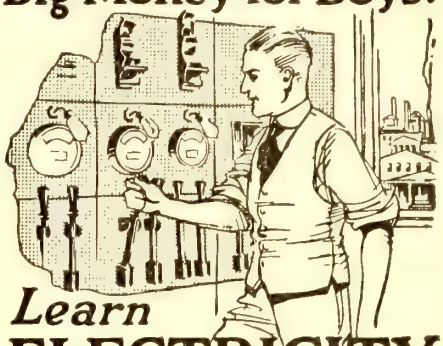
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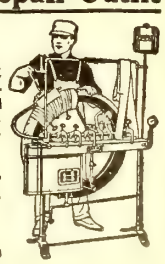
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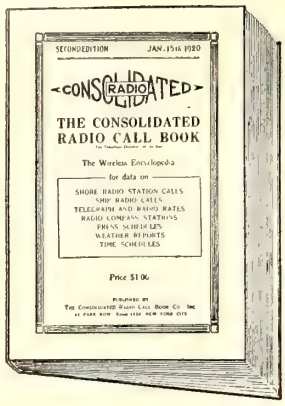
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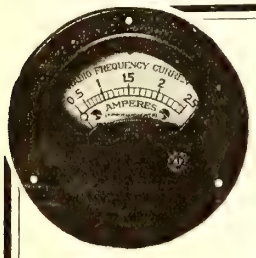
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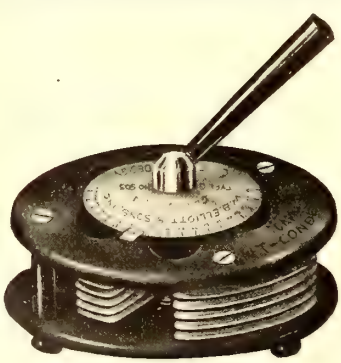
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FOR RADIO OPERATORS.

An S. O. S. call for radio operators has been sent out by the United States Shipping Board.

All Shipping Board vessels carry one or two wireless operators. During the war many radio operators were trained. Any who desire employment, Shipping Board officials recently stated, have only to secure a radio operator's license, which is issued by the Department of Commerce after passing the required examination.

Under the new wage scale of the Shipping Board the first operator, who is in charge on vessels where two operators are employed, is paid $125 per month and the second operator $100 per month, *in addition to all expenses.* The radio operator is considered an officer and is provided superior accommodations.

All radio men who are qualified radio operators and who desire to be considered for the service should communicate with the Radio Department Division of Operators, United States Shipping Board, Washington, D. C.

Did the Romans Have Wireless?

(*Continued from page* 747)

Solaro, 1,980 feet. Signals were probably not sent from here, but from the eastern headland. The Pharos was about 1,000 feet above sea level. A line drawn from the Pharos to Monte Circeo, on the Campanian coast, just grazes the Island of Ischia; but the line of sight would be well above the island, as the summit of Circeo is 1,775 feet.

"A suggested line of stations with no range more than 44 miles long is submitted to those of a speculative turn of mind. (See illustration herewith.) Rome to Monte Cavo, in the Alban Mountains, 18 miles; thence to Monte Circeo, 39 miles; thence to Monte Massico, 44 miles; thence to Capri, 44 miles. A Pompeian fresco of quite recent discovery shows Monte Cavo as being very conspicuous when viewed from the Palatine Hill. The clear summit is boldly visible. Perhaps the Palatine Hill was the 'sending' station in Rome."

Sound and Flash Ranging in the A. E. F.

By Prof. Augustus Trowbridge

(*Continued from page* 759)

A survey by means of sound is based on the assumption that sound travels from the gun in a spherical wave at a known rate (about 1100 feet per second) in still air at a given temperature; an increase in temperature increases this rate by a known amount; if the air is not still but blowing with a known speed in a known direction the apparent speed of sound under these conditions may be calculated. If the *time of arrival* of the sound of a gun is measured at three surveyed points on the ground, the position of the gun can be calculated as will be evident from the accompanying diagram in which G is the gun, P_1, P_2 and P_3 any three surveyed points within the friendly lines at which instruments are placed capable of indicating electrically on a recorder at a central station the times of arrival (t_1, t_2 and t_3) at them, of the sound of the enemy gun.

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If the sound arrives at P_1 at time t_1 and at P_2 at time t_2, then the interval t_2-t_1 must be the time necessary for the sound to travel the distance r_2 where $r_2 = V\ (t_2 - t_1)$ if V is the velocity of sound in still air at some standard temperature. Also $r_3 = V\ (t_3 - t_2)$. One can of course reverse the above reasoning if the intervals $(t_2 - t_1)$ and $(t_3 - t_1)$ be known, by drawing circles of radii r_2 and r_3 around P_2 and P_3 respectively and drawing tangent to these circles and through the point P_1 a third circle $P_1\ Q_1$, at the center of which the gun must lie if there be no wind or temperature corrections; if these have to be made a slight and calculable shifting of the point G results.

The method just described would be an entirely correct graphical one to employ in calculating a gun's position from the observed time intervals, but it was found too slow and slightly too inexact for practical use, and therefore *plotting boards* were prepared by a method involving the principle of that just described but which permitted the use of strings in place of lines drawn on the board; also in practice six instruments P_1, P_2, P_3, P_4, P_5, P_6, were used instead of the three theoretically necessary in order to insure greater accuracy and to allow of work being carried on while one or two of the instruments might be temporarily out of order because of the electrical connections to "central" being cut by shell fire.

One of the accompanying illustrations gives an idea of the character of the photographic records from which sound ranging locations were made; the six horizontal lines between the two rows of perforations are the records of the six instruments P_1 — P_6; the heavy short vertical lines, the rather faint long lines and the very faint long lines are respectively half-seconds, tenth seconds and hundredth seconds recorded by the means of a very accurate tuning fork. When the sound of a gun reaches the instrument P_1 (for example) the top element of the record shows a "nick" in the line, and as the sound reaches the other instruments "nicks" appear in the corresponding lines and the time intervals $t_2 - t_1$, etc., may be quickly read off by counting the number of tenth and hundredth seconds between the "nicks."

An idea may be formed of the accuracy of sound ranging locations from the accompanying diagram in which the actual gun positions are plotted from a survey made after the position had been captured by our troops; this survey was made by army topographic officers who were not themselves interested in proving or disproving the accuracy of sound ranging. The surveyed gun positions are marked with a small square. The locations made by the sound rangers had been rated when reported to the artillery according to the actual probable error as follows: A location reported "P" (none in the case of this battery) was probably accurate to within fifty yards; a "Q" location (marked with a small circle) accurate to within a hundred yards; an "R" location, 150 yards and a "RR" location, 200 yards, marked respectively as dots and crosses. Had the estimate of probable accuracy been correct, all the crosses should have been *outside* the outer oval figure; all the dots should have been between the outermost and the next oval; the circles should have been in the next region, etc. It will be seen that the estimate of accuracy was much too conservative. The triangle marks the average of all the sound ranging locations on this battery and is less than 20 yards in error. The scale of the drawing is such that the large square represents a square kilometer. The sound ranging instruments were about eight kilometers (five miles) distant from the battery.

Sound ranging was also used to direct the fire of the friendly artillery on invisible



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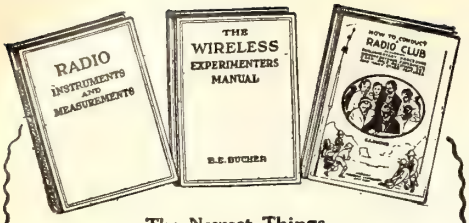
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targets; the method was similar to that employed for the location of the enemy guns but with the difference that it was the report of the burst of the friendly artillery's shells that was recorded instead of the report of the enemy gun. When the target was an enemy gun which had recently fired and been located by the sound rangers, the accuracy obtained in ranging the friendly artillery was extremely great, since no uncertain wind and temperature corrections had to be applied, as the effect of wind and temperature on the records of enemy gun and the shells of the friendly artillery was the same and therefor could be disregarded.

An idea may be gained of the *amount* of artillery information supplied by the flash and sound ranging sections from the following extract taken from the report of the artillery information officer of one of the American corps. This officer had at the time as sources of information three American sound ranging sections, two American and three French flash ranging sections (later three American and two French flash ranging sections) aviation and observation balloons. During a period of three weeks of rapid advance, 425 separate locations of enemy batteries were made; of these the two American flash sections reported 63 per cent; the three French flash sections reported 16 per cent, and the three American sound sections reported 21 per cent. In a period of two weeks, when the advance had been temporarily checked by the enemy, the total number of locations was 392, and the percentages were: From the three American flash sections 38 per cent; from the two French flash sections 8 per cent and from the three American sound sections 54 per cent. In another and very active sector the figures were: During a period of three days' preparation for an advance, sound locations 22, flash 22; balloons, 0, aviation, 0. During a period of sixteen days of rapid advance; sound 4, flash 46, balloons 30, aviation 15. During a period of four days of stabilization; sound 6, flash 34, balloons 13, aviation 15. These figures are fairly characteristic. During preparations for an advance, both the sound and flash sections are very useful sources of information. During rapid advance the sound rangers do not get into action as often as the flash, because of the greater technical difficulties. During this period the major part of the information comes from the aerial observation.

American flash and sound ranging sections were operating on the front from March, 1918, until the armistice and always in sufficient numbers to cover the sectors held by American troops, except for a portion of the front of the Argonne offensive when the line was moving extremely rapidly. The work of the officers and men of the 74th Engineers engaged in this service was of a very high order, and their untiring watchfulness was often the indirect means of saving the lives of countless of their fellow soldiers by affording the information needed to silence the fire of the enemy guns.

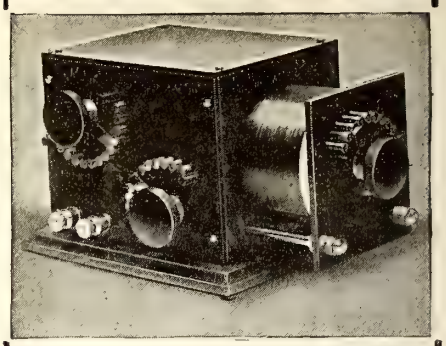
SOUND AND FLASH RANGING IN THE A. E. F.

[Editorial Notes.]

No microphones were used by the A. E. F. in sound ranging. Also no earth-borne vibrations used.

The Bureau of Standards made exhaustive tests for several years, not to mention hundreds of tests conducted by the U. S. Army Corps of Engineers, which have demonstrated that it is not practicable to endeavor to use sound wave transmission thru the earth. This is so for one basic reason, viz.: That the velocity of sound varies for each different kind of earth, such as damp earth, wet earth, dry earth, rock, sand, chalk, etc.

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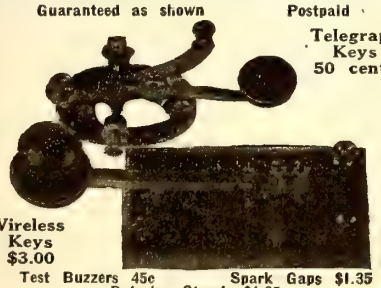
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What was used, then, in the A. E. F., when the U. S. Army Corps of Engineers who took charge of all this work during the war on the whole American front (every yard of which was fully protected by this apparatus for accurately locating the German guns from the time that the first American troops went into action) until the close of the war? No sound vibrations thru the earth, to begin with, and no microphones.

When Colonel Trowbridge arrived in France, he was given charge of this work for the A. E. F., and was appointed to the staff of Gen. Pershing at Headquarters. Very shortly, and in conjunction with some laboratory work which has been carried on in the Palmer Physical Laboratory at Princeton University, an entirely new method of "Sound Ranging" was developed. In the first place, sound vibrations as transmitted thru the *air* were used in contra-distinction to the sound waves originally used, which were transmitted thru the *earth*. A new sound translating device was constructed for the purpose, which yielded wonderful results. This instrument comprises nothing else than a series of fine, electrically heated wires, forming a *grid*. This grid of fine wires which were heated red hot by a strong current transmitted from the central station of a given sound-ranging sector, was suddenly cooled *by the blast of the onrushing sound wave* transmitted thru the air whenever a German gun was fired, even though it was four to five miles away.

To begin with, the velocity of sound wave propagation was constant to a very close degree, and this insured the success of the new system from the start. When the sound wave reached the location of the thermal sound detector, several of which were installed on well charted locations, there was caused a variation in the air at this point.

To intensify this effect, the next step was to place the grid device, which was a small affair, on to some acoustic resonating chamber which would be affected in a more or less pronounced manner so as to reinforce pneumatically the local effect of the air wave variation when it arrived.

At first, English "whiskey jugs" were used, and the grid thermal detector was clamped to the top of the jug. When the sound wave arrived in the vicinity of these jug detectors, a puff of air would rush into the jug, and out again, thus causing a variation in the heating of the wire and this partial cooling and change in the heating would change the resistance of the line, and cause the recording apparatus at the central station to register a "wiggle" on a rapidly moving photographic paper strip such as here shown, which corresponds to the enemy gun or guns. Later, several important and unique features in connection with this very interesting sound detector, were observed and put into effect. Due to the fact that the soldiers used to smash the jugs repeatedly in an effort to see whether there was any whiskey inside, researches were quickly made, and finally gasoline and kerosene cans came into use. The grid was now clamped on the opening of the can, and presently it was discovered that in order to render the device more quickly damped in its operation, and to give but one deflection on the record, that this quality could be effected by simply punching some small holes around the can, so that the opening where the air enters the can when the sound wave arrives, did not tend to keep vibrating; but due to the air escaping thru the small holes, it would damp out quickly.

The only really special apparatus required, was the recording instrument which comprised an Einthoven string galvanometer provided with six strings or wires



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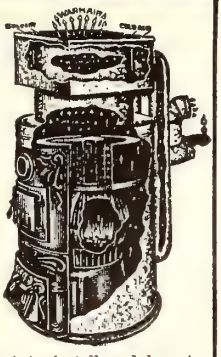
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The next point of interest leads us to the front line trenches and their vicinity, where sound ranging posts were stationed. The observers were sometimes stationed in dugouts *in advance* of the front line trenches. Each observer had a switch or key, and a telephone of course. Whenever he saw or heard the enemy's gun fired, he immediately prest his key, which operated a series of relays connected by means of wires running back to the recording station of that particular sound ranging section. One of the relays closed the grid current circuit thru the hot wire grid on the whiskey jugs or gasoline cans, which were sprinkled over the field in the vicinity of the front line trenches. Another relay started the recording apparatus in motion. The incandescent lamp burned all the time in front of the galvanometer telescope. Thus, it is shown that by the time the sound wave arrived from the gun fired, which may have been anywhere from two to eight miles away, the apparatus was in full operation and ready to record the "bursts." The method of arranging the various sound wave detectors along the arc of a circle is described in the article by Prof. Trowbridge.

The American type of air wave "sound detectors," were arranged of course to deflect the rain and other elements. The proper current was maintained thru each hot wire grid in the following manner. When the grid was installed, its resistance was noted as marked on a tag accompanying it. All circuits operated in the A. E. F. were full metallic (two wires), and no ground circuits were used under penalty of court martial and a possible sentence of death. This was done to prevent the enemy from intercepting any signal (telephonic or telegraphic) due to leakage from grounded circuits. The wires were No. 12 heavy rubber covered conductors.

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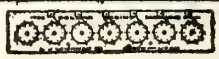


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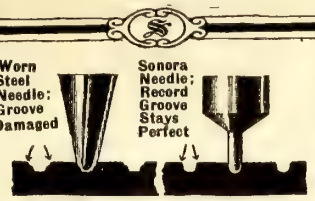
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By Frederick Von Lichtenow

(*Continued from page* 774)

maximum value. The charge thus gained is then applied to the pith ball hanging from its insulating support, which was made use of in the preceding experiment (pith ball to be first neutralized, of course), with the result that the light body will be strongly repelled by the El-cover. This shows, that the former is fully charged. (It will retain the charge for quite a while!)

A sheet of glass, about 1/16 thick, of a somewhat smaller size than the hard rubber plate, is then placed between the latter and the metal cover (Fig. 2) and the charging process gone thru as before. The spark discharges will in this case, naturally, be of a weaker nature, but the polarity of the sparks will in both cases be the same, that is +, which is manifest thru the repulsive action upon the charged pith ball.

Simple as the experiment itself is, its underlying principle is of a more complicated character. There seems to exist only one tangible explanation for the whole action, which, broadly speaking, touches upon the condenser principle in *a modified form.* It is well to observe, that the glass, not being a conductor, will not take a charge directly applied, but will hold such of opposite sign (+) to that of the charging body (—) on its face next to the same *as long as it is in contact with the latter,* while this induced charge, on the other hand, superinduces such of, again, opposite polarity (—) upon the upper surface of the glass sheet.

What finally becomes of both these induced Electro-static charges remains an open question, since the glass plate can not be tested for its respective former polarities after being removed from the charging body; and so this particular problem winds up in a case of *"Spurlos Versenkt"!* The fact remains, that, in the above connection, a negative charge is found upon the glass's upper side and is retained there (it is never repelled there as it would on a conductor!) gradually diminishing in value with that upon the hard rubber plate.

For the sake of the uninitiated or some "Doubting Thomas" and to emphasize the fallacy of another possible (on their part) version of the principle action, I may state here, that in the above case the original charge *does not penetrate,* unchanged in sign and simply lessened in power *thru the sheet of glass,* for this fact alone would be sufficient to eliminate the use of glass for a condenser—as well as insulating—purposes and, for that matter, would have done so long ago.

The diagram in Fig. 2A. shows the distribution of the electrostatic charges upon the various parts of the apparatus, while the latter are in electrical contact with one another.

EXPERIMENT NO. 3.

(Inductive Action Upon Neutral Body)

This experiment, although again simple in its conduction, "Teaches a lot", as it demonstrates the inductive action of an electro-static charge upon a *neutral* object, from start to finish, in a very clear manner.

In order to make such a clear demonstration possible, a neutral insulating body (sheet of glass or hard rubber) is needed in conjunction with the other necessary instruments; electrophorus, insulating stand, and suspended pith ball, with which alone the very fine inductive action can be worked out only to a certain, limited extent.

The addition of the *sheet of glass* is *essential, because it "slows down," as well*

(*Continued on page* 839)

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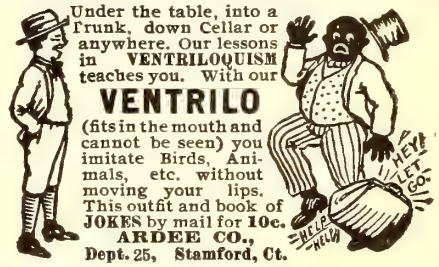
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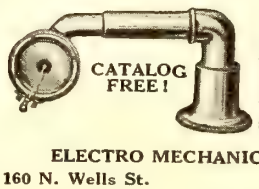


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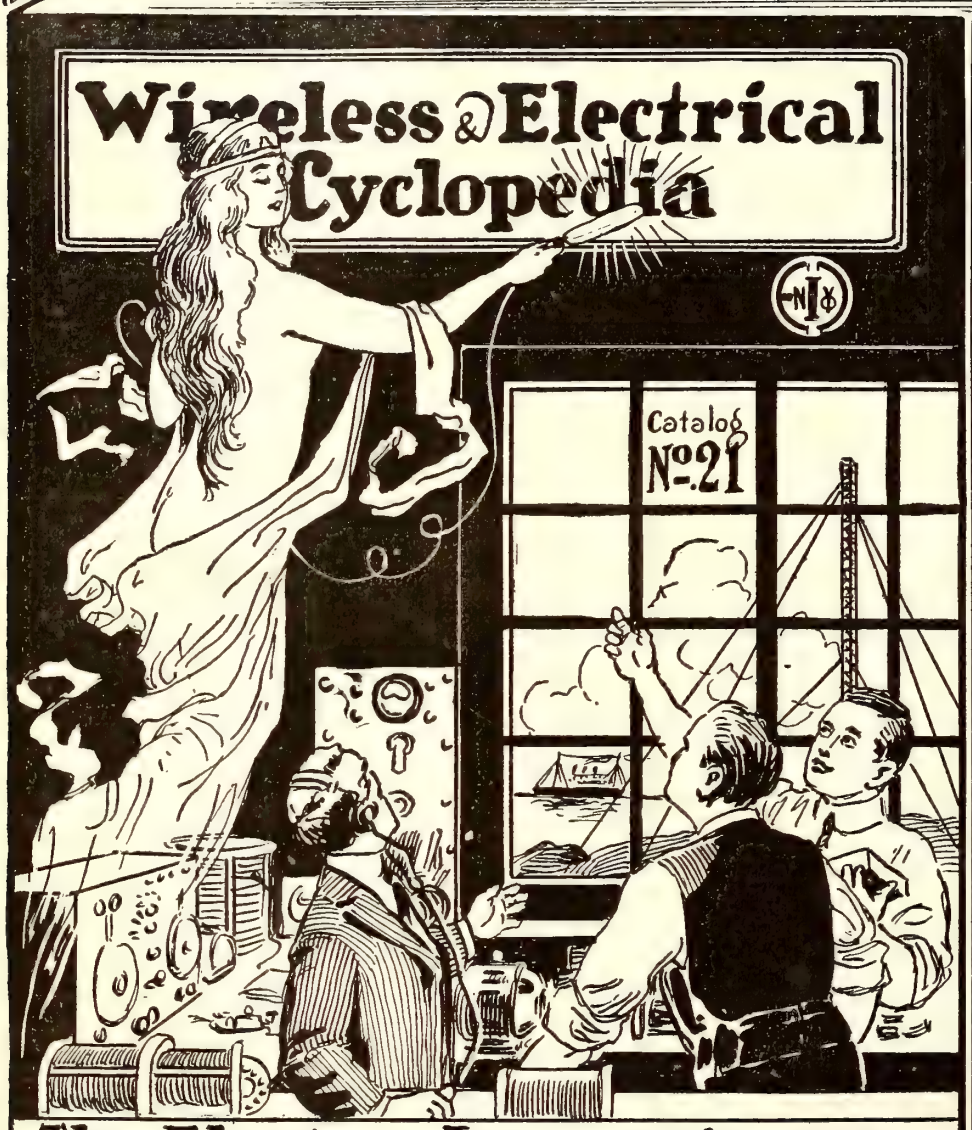
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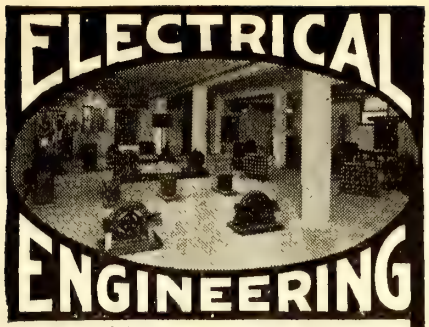
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By Frederick Von Lichtenor

(*Continued from page* 837)

as exposes (as far as this possibly can be done) *"those workings" of, the action, which ordinarily take place, but do not manifest themselves,* all of which will be more fully understood later on.

Fig. 3 indicates the respective positions of the instruments to one another, which are to be placed in line, with the insulating sheet *very close* to the neutral body. This is important as the success of the experiment depends upon this factor more than on anything else. Care must, consequently, be taken in finding the *proper* distance between the sheet of glass and the pith ball, which, generally speaking, is about equal to the thickness of the glass itself, but which has really to be found by experimentation, since this is subject to the volume of the induced charge, the size of the pith ball, the temperature of the surrounding air, etc., etc.

With the apparatus arranged as above suggested, the charged El-cover is moved slowly in the direction of the pith ball, whereupon the latter, altho separated from the cover by several inches, will be "pushed" onto the insulating sheet and cling there. At this very juncture, that is, without bringing the charged cover any closer, all action on the part of the operator should cease for a while. Thus keeping the cover in its last position, the pith ball will soon loose its hold upon the surface of the glass and swing over toward the charged cover. As the gap between both is shortened or widened by the operator, so will the light object, naturally, be more strongly attracted or allowed to swing back onto the sheet of glass, as the case may be, but *it will not cling to the latter any more.* (Under no circumstances and at no stage of this experiment should the pith ball be permitted to make contact with the Electrophorus cover, for this would destroy the principle of the inductive action with one stroke!) On getting the light object once more "under control" by shortening this gap, the opportunity offers itself for the removal of the insulating body, which is then done. After this the charged cover is also removed. An investigation will show the existence of a small charge upon the pith ball, which the latter acquired during the process and which is evidenced thru its attractive properties when in contact with any neutral object.

Although quite a few things happen in this little experiment, the explanation for the whole action is very clear and as follows: The (+) charged El-cover, on being approached to the pith ball, induces a negative charge upon the part of the latter facing it, while a charge of opposite sign is repelled to the other side of the ball. This repelled positive element does *under ordinary conditions,* that is, without the addition of the insulating sheet, *not manifest its existence.* In the above case, however, it will find a complement of negative electrons on the sheet of glass, to which, in accordance with the *law of attraction of opposite polarities,* it will attach itself. This negative element, again, is the result of the disturbance of the "electrical balance" upon the insulating body, while under the influence of the repelled positive charge (if not even under that of the original [Electrophorus cover] charge); and to enable both these weak charges to reach one another, the sheet of glass must find its place close to the pith ball, which was clearly pointed out in the foregoing. Since a second object is absolutely imperative in order to bring out this, otherwise, "lost



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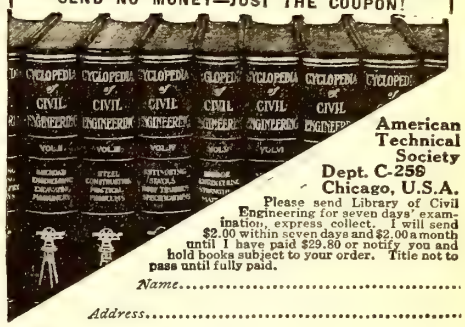
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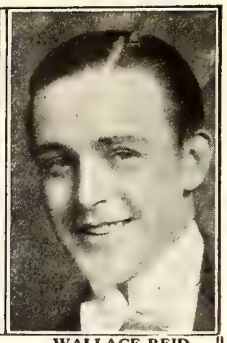
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action", which will now be fully understood, and since a conductor has, for obvious reasons, to be avoided, an insulating body, as the *"last* best thing", is consequently chosen.

The latter (sheet of glass in the above case) possesses qualities which tend to retard the process to a certain extent and which is clearly demonstrated, when the pith ball clings to the insulating sheet for a while. In doing so, the small amount of repelled positive charge becomes neutralized and *neutralization of a charged object in contact with an insulating body takes place very gradually,* which accounts for the "slowed down" action. The negative element induced upon the pith ball remains there, however, as at this stage of the experiment the electrophorus cover (+) is still held in its rigid position. Upon separating itself from the sheet of glass again, the ball will be evenly charged *negatively* and consequently strongly attracted by the (+) charged cover.

The minute charge found finally upon the pith ball, that is, after both sheet and cover have been removed, is acquired by the latter upon contact with the insulating body and is really not to be included in the inductive action of an electrostatic charge upon a neutral body, (altho similar conditions may prevail [for all we know] in space, where the "bigger workings" occur, and give reason for just such an action). It should, in the above case, rather be considered a "necessary evil", which finds its way into the experiment, with the operator not finding a way out of preventing it from getting in there. For with the elimination of the insulating body a successful "work-out" of the whole action is impossible, which is now quite clear; nor is it possible, while employing this very essential insulating factor, to prevent the pith ball from making contact with it, and yet observe the minute manifestation of the repelled element *by way of attraction only;* the close proximity of the two, necessitated by the very weak nature of the charge, stands against this.

If in this experiment the pith ball, after its separation from the sheet of glass, should again cling to the same, this shows that the repelled positive charge (on the ball) has *not* been completely *neutralized,* which, as pointed out in Experiment No. 1, finds its main reason in too low a potential of the Charge-source (El-cover) and, consequently, of the "counter-charges" induced upon the other instruments. The *proper* charge, neither excessively higher nor too low, for such purposes as the above, has to be found by actual experimentation.

The diagram in Fig. 3-A illustrates the experiment in its various, principal stages.

EXPERIMENT NO. 4.

(Imprisoning Charge Upon Neutral Body by Induction)

Many things, indeed, may be studied in this experiment, the main object of which is to prove the fact, that a neutral body may be put in a charged condition entirely thru the power of induction of an electrostatic element.

Depicted in Fig. No. 4 are the instruments, required for the experimental "work-out", which eliminates a further description of the same, beyond stating, that the two neutral bodies (pith balls) must hang side by side (touching one another) in the same plane and that they are suspended from *separate* silk-threads, so as to enable the operator to remove one of them, when the necessity arrives; the reason for this will be clear after a while.

The charged hard rubber plate is approached to the light objects in the manner that the plate faces only one of the balls, whereupon, at a certain distance, both of the latter (still keeping contact with one another) will be slightly attracted by the charged hard rubber sheet. Here the sheet should become "rigid," that is, not be moved any closer. After a short while the

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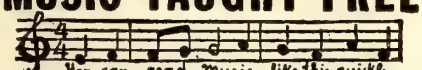
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two bodies will separate; one will swing over toward the charge-source and attach itself to it, while the other (the one further away from the plate) evidences a *repulsive* action. The sheet of hard rubber (ebonite) and ball No. 1, are then removed together, by simply lifting the latter with the plate from its support (which is easily accomplished as long as the ball has not lost its "hold" upon the electrified sheet!) Great care must, however, be taken in doing so, not to bring these two objects any closer to the remaining ball; not to speak of permitting any contact between them. After this has been carefully done, the solitary ball will, upon test with a neutral body, be found to be in a charged condition, although in the above arrangement it never came in *direct* "touch" with the charge-source.

The explanation for the above will be found in the following: on approaching the two neutral bodies with the electrified hard rubber plate, its negative charge induces a (+) charge upon *the side* of the first ball, *which it faces,* repelling at the same time such of its own sign (—) to the other side of that ball. This repelled negative element, again, attracts the positive electrons found in the second pith ball to the part of the latter, which is in contact with ball No. 1, while a charge of opposite polarity (—) will be repelled toward its part farthest away from the charged plate. With the latter approaching gradually closer, both balls will be moderately attracted to the same (to be exact: the nearest ball is attracted, while the other one is simply pulled along!); and that they still keep together during this motion, is due to *neutralization* of their "inner charges", *which invariably manifests a "clinging action" while taking place.*

After the act of neutralization has been completed, both separate, whereupon the first ball, now left (+) charged, will be strongly attracted to the (—) electrified sheet and consequently attach itself to it, while ball No. 2, will be distinctly repelled on account of its now evenly negative polarity. At this stage of the experiment both, charge-source and ball No. 1, are removed, as was outlined before; and I may mention here, that the (in the above connection) slow process of neutralization of the (+) element induced upon that pith ball makes this "holding together"—removal possible. (This ball will finally, that is, after being neutralized, be negatively charged [higher potential of plate!] and repelled, which, however, has *no bearing in this experiment*).

The negative charge, which in the end is found imprisoned upon the remaining pith ball, is the direct result of neutralization of the induced "inner" charges between the *bodies,* with *their* immediately following *separation* and simultaneously *that* of *their "spell-bound" charges,* all happening under the influence of the inductive energy emanating from the charge-source; and, consequently, this negative charge is of a truly induced character.

Fig. 4-A, gives a clear demonstration of the principal actions which take place in this experiment.

Concerning the apparata themselves I may say, that they should be kept clean and in a dry condition, in which they always are, when in their *proper* place in a comfortably heated room. In case of excessive dampness of the atmosphere they may be placed upon a radiator for a short while, but must never be heated nor employed while in such a condition, because some of the apparatus (hard rubber sheet, for instance!) will doubtless suffer under such treatment and because thermo-(heat-) waves upon the apparatus will introduce erroneous manifestations into the experiments, which do not belong in there, thus counteracting the desired actions, if not nullifying them entirely.

(To be continued)



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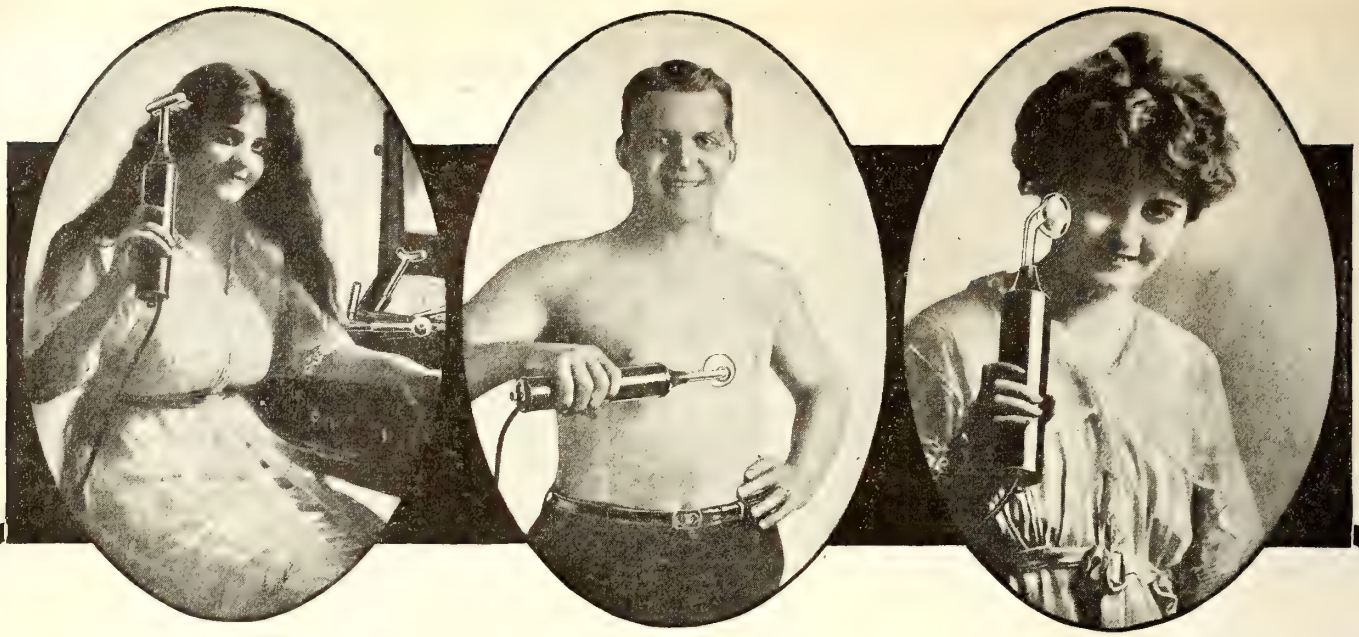
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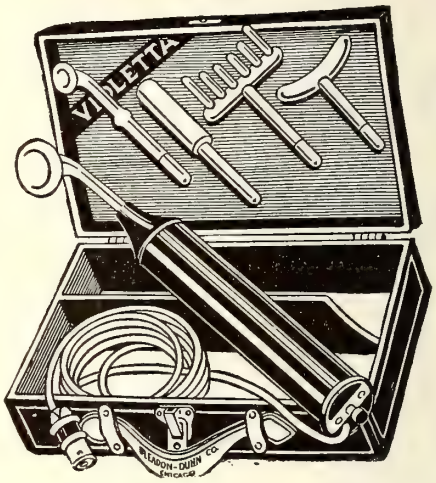
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(Continued on page 844)

(Continued from page 843)

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(*Continued on page* 846)

(Continued from page 845)

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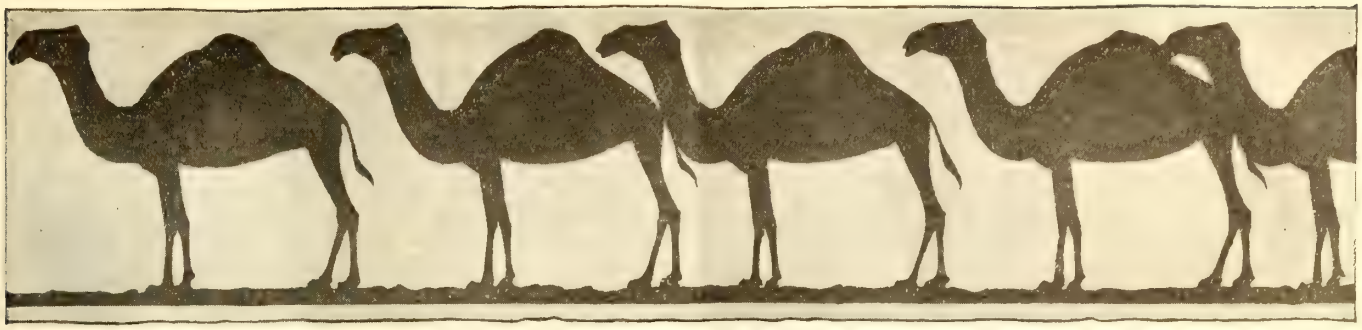
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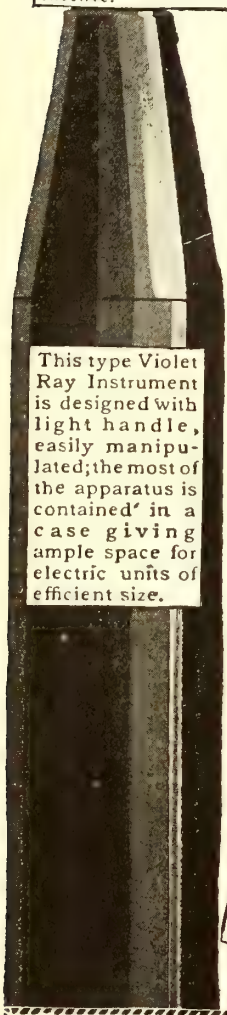
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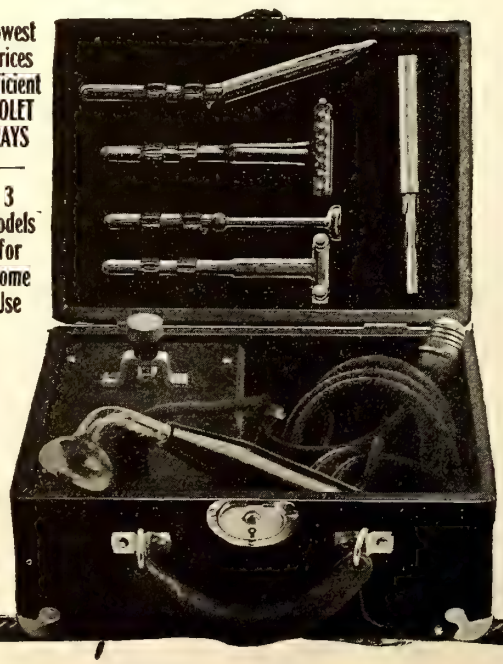


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EDITORIAL

A Celestial Short-Circuit



ON November 26th there fell into Lake Michigan a meteor of unprecedented size. Press reports which have since been verified thru a number of independent sources, reveal the following remarkable facts:

Witnesses aver they saw the great ball of fire, white and orange colored, which illuminated the whole country, pass over the lake south of Grand Haven. It fell into the waters, creating a fog of steam clouds.

Telegraph operators of the New York Central lines reported wire trouble as far north as Grand Rapids, Mich.

The power plant of the Calumet Electric Light Co., at Kalamazoo was put out of commission, and another plant near Berrien Springs was disabled.

The greater majority of the meteors which strike the earth are rather small, probably well below 100 lbs., for the individual fragment. Great meteors such as the Peary *Ahnighito,* weighing 37½ tons, are exceedingly rare. The composition of most of the known aërolites is iron with a small percentage of nickel. While the meteor moves thru interstellar space at the terrific speed of from 18 to 36 miles per *second,* its temperature is that of free space, namely—459° Fahrenheit. The instant the meteor strikes the upper regions of the atmosphere, the latter, acting like a cushion towards the meteor, retards its flight. That means that an immense amount of heat is immediately generated, because you cannot arrest a body traveling at such a prodigious speed without generating heat. But as the aërolite rushes earthward, the atmosphere becomes denser and denser, and the friction between the world wanderer and our planet's air becomes enormous. That means still more heat—sufficient as a matter of fact to melt all or part of the iron-nickel mass.

From the time the meteor enters into our atmosphere till it finally strikes the earth, only a few seconds elapse. The entire cooling and subsequent heating process ranging from—459° to over 2500° Fahrenheit, probably takes place in less than 3 seconds. When a really big meteor comes along weighing anywhere from 50 tons upward, it can be readily seen that the internal stresses must be enormous, because the core may be at a temperature of—400°, while the shell may be in a molten state. Such a titanic difference in temperatures in a single body sets up ponderous stresses, tending to rend the mass apart, which as a matter of fact happens almost invariably.

In its flight earthward several other things probably occur to a meteor, but as to these we are still ignorant. For one thing, due to the enormous friction set up, the writer advances the thought, that the meteor probably becomes highly electrified, taking on a charge that runs into the millions of volts. Indeed there is no good reason to deny a strong charge even *before* the meteor strikes our atmosphere. Remember a meteor is composed of iron-nickel, a very excellent magnetic alloy. Such a body without a shade of doubt must take on an electrical charge when traversing any field of force, particularly as it travels at such an enormous speed. The old experiment of an unmagnetic iron rod which becomes a magnet when twirled around rapidly by means of a string, is a case in point.

Thus when the big meteor, probably as large or larger than a big mansion, struck Lake Michigan an immense electrical force was liberated—a titanic *short-circuit* it was in fact! The bottom of the lake forming the "ground" or return circuit, it can be readily seen why the electrical disturbances were not only felt for miles around, but were of such a magnitude as to even burn out the big fuses of the electrical power plants.

The effect may be compared to the "return shock" of lightning which often knocks down men and kills cattle, altho they may be at a considerable distance from the spot where the lightning hit.

H. GERNSBACK.

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Take the ordinary longhand letter *d* Eliminate everything but the long downstroke and there will remain / This is the Paragon symbol for D. It is always written **downward.**

From the longhand letter *e* rub out everything except the upper part—the circle—and you will have the Paragon E. ∘

Write this circle at the **beginning** of / and you will have Ed. /

By letting the circle remain **open** it will be a **hook,** and this **hook** stands for **A.** Thus / will be **Ad.** Add another **A** at the end, thus / and you will have a girl's name, **Ada.**

From *o* eliminate the initial and final strokes and ∘ will remain, which is the Paragon symbol for **O.**

For the **longhand** *m* , which is made of **7** strokes, you use this **one** horizontal stroke —

Therefore, —∘ would be **Me.**

Now continue the **E** across the **M,** so as to add **D**—thus / and you will have **Med.** Now add the **large** circle for **O,** and you will have / (medo), which is **Meadow,** with the silent **A** and **W** omitted.

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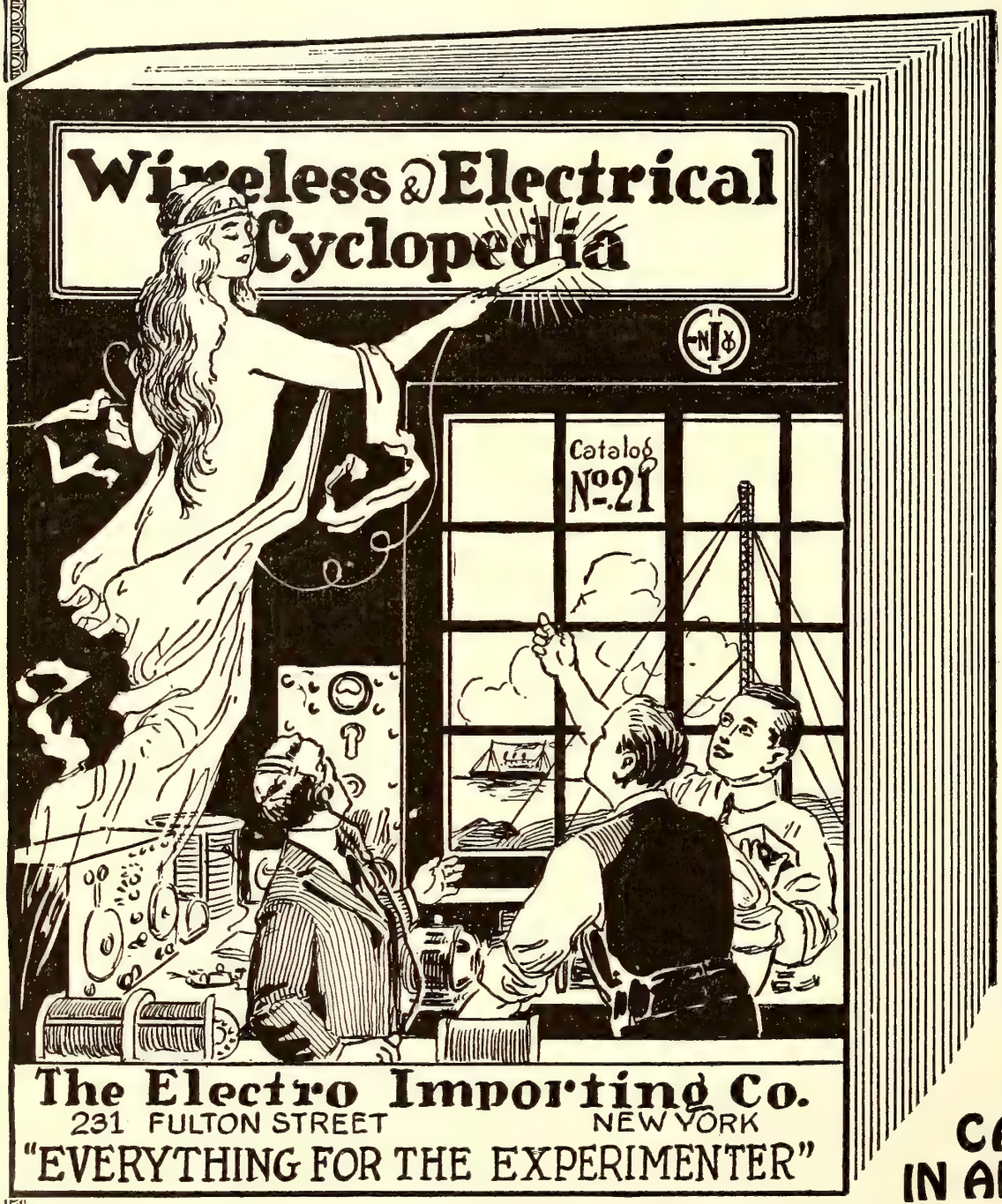
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"Everything for the Experimenter"

How One Evening's Study Led to a $30,000 Job

A Simple Method of Mind Training That Any One Can Follow With Results from the First Day

By a Man Who Made Formerly No More Than a Decent Living

I HOPE you don't think I'm conceited or egotistical in trying to tell others how I suddenly changed from a comparative failure to what my friends term a phenomenal success.

In reality I do not take the credit to myself at all. It was all so simple that I believe any man can accomplish practically the same thing if he learns the secret, which he can do in a single evening. In fact, I know others who have done much better than I by following the same method.

It all came about in a rather odd manner. I had been worrying along in about the same way as the average man, thinking that I was doing my bit for the family by providing them with three square meals a day, when an old chum of mine, Frank Powers, whom I had always thought was about the same kind of a chap as I, suddenly blossomed out with every evidence of great prosperity.

He moved into a fine new house, bought a good car and began living in the style of a man of ample means. Naturally the first thing I did when I noticed these things—for he had said nothing to me about his sudden good fortune—was to congratulate him and ask him what had brought the evident change in his finances.

"Bill," he said, "it's all come so quickly I can hardly account for it myself. But the thing that has made such difference in my life lately began with an article I read a short time ago about training the mind.

"It compared the average person's mind to a leaky pail, losing its contents as it went along, which if carried any distance would arrive at its destination practically empty.

"And it showed that instead of making the pail leak-proof most of us kept filling it up and then losing all we put into it before we ever reached the place where the contents would be of real use.

"The leak in the pail, the writer demonstrated, was forgetfulness. He showed that when memory fails, experience, the thing we all value most highly, is worthless. He proved to me that a man is only as good as his memory, and whatever progress a man accomplishes can be laid directly to his powers of retaining in his mind the right things — the things that are going to be useful to him as he goes along.

"Farther on in the article I read that the power of the mind is only the sum total of what we remember —that is, if we read a book and remember nothing that was in it, we have not added one particle to our experience; if we make a mistake and forget about it, we are apt to make the same mistake again, so our experience did not help us. And so on, in everything we do. Our judgment is absolutely dependent on our experience, and our experience is only as great as our power to remember.

"Well, I was convinced. My mind was a 'leaky pail'. I had never been able to remember a man's name thirty seconds after I'd been introduced to him, and as you know, I was always forgetting things that ought to be done. I had recognized it as a fault, but never thought of it as a definite barrier to business success. I started in at once to make my memory efficient, taking up a memory training course which claimed to improve a man's memory in one evening. What you call my good fortune to-day I attribute solely to my exchanging a 'leaky pail' for a mind that retains the things I want to remember."

* * * * *

Powers' story set me thinking. What kind of a memory did I have? It was much the same as that of other people I supposed. I had never worried about my memory one way or another, but it had always seemed to me that I remembered important things pretty well. Certainly it never occurred to me that it was possible or even desirable to improve it, as I assumed that a good memory was a sort of natural gift. Like most of us, when I wanted to remember something particularly I wrote it down on a memorandum pad or in a pocket notebook. Even then I would sometimes forget to look at my reminder. I had been embarrassed—as who has not been?—by being obliged to ask some man whom I had previously met what his name was, after vainly groping through my mind for it, so as to be able to introduce him to others. And I had had my name requested apologetically for the same purpose, so that I knew I was no different than most men in that way.

I began to observe myself more closely in my daily work. The frequency with which I had to refer to records or business papers concerning things that at some previous time had come under my particular notice amazed me. The men around me who were doing about the same work as myself were no different than I in this regard. And this thought gave new significance to the fact that I had been performing practically the same subordinate duties at exactly the same salary for some three years. I couldn't dodge the fact that my mind, as well as most other people's, literally limped along on crutches, because it could not retains names, faces, facts, and figures. Could I expect to progress if even a small proportion of the important things I learned from day to day slipped away from me? The only value of most of my hard-won experience was being canceled—obliterated—by my constantly forgetting things that my experience had taught me.

The whole thing hit me pretty hard. I began to think about the subject from all angles as it affected our business. I realized that probably hundreds of sales had been lost because the salesman forgot some selling point that would have closed the order. Many of our men whom I had heard try to present a new idea or plan had failed to put over their message or to make a good impression because they had been unable to remember just what they wanted to say. Many decisions involving thousands of dollars had been made unwisely because the man responsible didn't remember all the facts bearing on the situation and thus used poor judgment. I know now that there isn't a day but what the average business man forgets to do from one to a dozen things that would have increased his profits. There are no greater words in the English language descriptive of business inefficiency than the two little words "I forgot."

I had reached my decision. On the recommendation of Powers, I got in touch at once with the Independent Corporation, which shortly before had published the David M. Roth Method of Memory Training. And then came the surprise of my life. In the very first lesson of the course I found the key to a good memory. Within thirty minutes after I had opened the book the secret that I had been in need of all my life was mine. Mr. Roth has boiled down the principles perfecting the memory so that the method can almost be grasped at a glance. And the farther you follow the method the more accurate and reliable your memory becomes. Within an hour I found that I could easily memorize a list of 100 words and call them off backward and forward without a mistake. I was thunderstruck with the ease of it all. Instead of study the whole thing seemed like a fascinating game. I discovered that the art of remembering had been reduced by Mr. Roth to the simplest method imaginable—it required almost nothing but to read the lessons! Every one of those seven simple lessons gave me new powers of memory, and I enjoyed the course so much that I look back on it now as a distinct pleasure.

The rest of my story is not an unusual one among American business men who have realized the value of a reliable trained memory. My income today is close to $30,000. It will reach that figure at the beginning of our next fiscal year. And two years ago I scarcely made what I now think of as a decent living.

In my progress I have found my improved memory to be priceless. Every experience, every business decision, every important name and face is easily and definitely recorded in my mind, and each remembered experience was of immense value in my rapid strides from one post to another. Of course I can never be thankful enough that I mended that "leaky pail" and discovered the enormous possibilities of a really good memory.

David M. Roth

When Mr. Roth first determined to exchange his leaky mind for one that would retain anything he wanted it to, it was because he found his memory to be probably poorer than that of any man he knew. He could not remember a man's name 20 seconds. He forgot so many things that he was convinced he could never succeed until he learned to remember. Today there are over ten thousand people in the United States whom Mr. Roth has met at different times —most of them only once —whom he can instantly name on sight.

Mr. Roth can and has hundreds of times at dinners and lectures asked fifty or sixty men he has never met to tell him their names, businesses and telephone numbers and then after turning his back while they changed seats, has picked each one out by name, told him his telephone number and business connection. These are only a few of the scores of equally "impossible" things that Mr. Roth can do, and yet a few years ago he couldn't remember a man's name twenty seconds. Why go around with a mind like a leaky pail when, as Mr. Roth says, "what I have done any one can do."

SEND NO MONEY

Mr. Roth's fee for personal instruction to classes limited to fifty members is $1,000. But in order to secure nation-wide distribution for the Roth Memory Course in a single season the publishers have put the price at only five dollars, a lower figure than any course of its kind has ever been sold before, and it contains the very same material in permanent form as is given in the personal $1,000 course.

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One Rule That Makes Selling Easy

How I Learned It in A Few Hours and Became a Super-Salesman

YOUNG fellows who take to office work are not usually of the type who are interested in salesmanship. I was no different from the rest; my natural bent, my future, semed to be on the "inside."

As jobs go I had a fair one. I had the good fortune to be thrown in contact with two unusually high-grade business men. From them I had the chance to learn an interesting business and the opportunity to pile up to my credit a daily record of work well done.

As I look back now I can see that my viewpoint was that of the loyal subordinate who works faithfully, but without a fixed purpose. Like many other young men, I had plenty of hope, which I mistook for ambition.

Purchasing was a vital factor of our business and I had much to do with the routine end of this work. I naturally became interested in the kind of men who could or could not sell to our firm. The daily contests between buyer and seller were absorbingly interesting to me.

One question which perplexed me, and to which I could not find an answer, was, "What made a first-class salesman? Why were some

salesmen inefficient? Could *I* be a salesman of any kind—good, fair or poor?" I often wondered. But that was as far as I got. The possibility of actually becoming a super-salesman no more struck me than the possibility of my becoming a beautiful butterfly.

That is, until the night of what I call The Great Revelation, when—But I am getting ahead of my story.

My employers were not easy people to sell. Besides being accomplished buyers they were human beings with likes and dislikes, prejudices and whims. Mr. Pond was rather overbearing and could be very tyrannical. Mr. Booth was our scholar—quiet and cold, oversensitive and refined. Anything crude or noisy grated upon him.

I soon found that all the salesmen who called upon us could be classified into three types: First, and in the large majority, were the incompetents. They generally went away empty-handed. Occasionally, out of pity, Mr. Pond would give one of them a little order. But all men of this type ever got from Mr. Booth was a quick application of high-bred freezing process. He had nothing but contempt for inefficiency.

The second class consisted of the medium-grade salesmen. These men were turned down, however, oftener than they got orders. And I noticed this—that those who could sell to Mr. Pond were often unable to get anywhere with Mr. Booth. It was the other way around, too.

Out of all the salesmen who ever called upon us there were only about five who nearly always made a sale. They seldom went away empty-handed. Nor did they talk much nor work at all hard to make a sale. They made up the third class—the Master Salesmen.

How did they do it? I did not know then. But now I know that consciously or unconsciously they used The One Great Rule of Successful Selling. Even though these five men expressed themselves differently and were entirely different types of men, they all used The One Great Rule. And the men who *failed to sell to us did not use this rule.*

But let me tell you how I found this out. One day I ran across something in print on salesmanship. I had never taken printed matter on salesmanship at all seriously, but for some reason or other this gripped my attention.

Then came the interest that no novel can give. With the swiftness of lightning I was well nigh paralyzed with Revelation I possessed the one, the all-embracing, Rule that would make me, bashful clerk that I was, a super-salesman.

Though I may have a thousand future lives to live, I believe that I can never forget those wonderful moments when I first read of The One Great Rule of Successful Selling and Its Hundred Devices. It was mighty knowledge to have and use.

To make my story short, I "sold" my firm on the idea of sending me on the road. Right from the start I sold goods in substantial quantities. In nine short weeks my sales topped the list of our entire selling force. You can well imagine my joy. I had actually out-distanced "Old Timers" and had become the firm's Super-Salesman.

But for what I have done I claim no special ability. I had only a grade-school education, and never was considered anything out of the ordinary intellectually. I say this frankly, as I have no desire to pin roses on myself.

The point I want to make is this: If I, with these handicaps, could so quickly become a top-notch salesman, it is only reasonable to suppose that others can, too. The thing that so quickly made me a Master Salesman was a knowledge of The One Great Rule in Selling and Its Hundred Devices, told by Arthur Newcomb in his astounding 7-Lesson Course in Super-Salesmanship.

Every word of this great course is written out of practical achievement in selling. That is why it stands out from the legion of books and courses on selling.

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Who Is Arthur Newcomb?

After his graduation from college Mr. Arthur Newcomb took up newspaper work, and in the ten years from 1896 to 1906 was reporter, city editor, news editor, managing editor, special correspondent, advertising manager, manager, and advertising counsellor for various newspapers and periodicals.

In 1909, he edited the course in "The Science of Business Building" of which fifty thousand copies were sold in the eight years following.

In 1912-13, Mr. Newcomb edited "The Science of Personal Efficiency."

In 1914, in collaboration with Dr. K. M. H. Blackford, he wrote "The Job, The Man, The Boss," which not only had a phenomenal sale, but set in motion the great employment movement which has since been adopted by the United States Chamber of Commerce and the United States Government.

In 1913-14, he edited "Character Analysis by the Observational Method," by Dr. K. M. H. Blackford and, in 1915, collaborated in writing "Analyzing Character," both of which works have had a very wide sale.

In 1918, Mr. Newcomb edited, for Dr. Blackford, the short course, "Reading Character at Sight," now being studied by tens of thousands.

In his Course, "Super-Salesmanship," Mr. Newcomb has broken away from all the old traditional theories of salesmanship and persuasion—which made such a wide appeal and had so much good effect because they were partly true—and has based his work upon human nature as it is and upon the world's greatest commanders, leaders, and salesmen. Mr. Newcomb has been a salesman and salesmanager. He has employed and trained hundreds of salesmen and knows exactly the problem salesmen must solve and how to solve them. In all his experience Mr. Newcomb has found but one great rule for selling goods of any description.

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The Secret of Making People Like You

"Getting people to like you is the quick road to success—it's more important than ability," says this man. It surely did wonders for him. How he does it—a simple method which anyone can use instantly.

ALL the office was talking about it, and we were wondering which one of us would be the lucky man.

There was an important job to be filled—as Assistant-to-the-President. According to the general run of salaries in the office, this one would easily pay from $7,000 to $10,000 a year.

The main requisite, as we understood it, was striking personality and the ability to meet even the biggest men in their offices, their clubs, and their homes on a basis of absolute equality. This the firm considered of even more importance than knowledge of the business.

You know just what happens when news of this sort gets around an office. The boys got to picking the man among themselves. They had the choice all narrowed down to two men—Harrison and myself. That was the way I felt about it, too. Harrison was big enough for the job, and could undoubtedly make a success of it. But, personally, I felt that I had the edge on him in lots of ways. And I was sure that the firm knew it, too.

Never shall I forget my thrill of pleasure when the president's secretary came into my office with a cheery smile, looked at me meaningly, handed me a bulletin and said, "Mr. Frazer, here is the news about the new Assistant-to-the-President." There seemed to be a new note of added respect in her attitude toward me. I smiled my appreciation as she left my desk.

At last I had come into my own! Never did the sun shine so brightly as on that morning, and never did it seem so good to be alive! These were my thoughts as I gazed out of the window, seeing not the hurrying throngs, but vivid pictures of my new position flashing before me. And then for a further joyous thrill I read the bulletin. It said, "Effective January 1, Mr. Henry J. Peters, of our Cleveland office, will assume the duties of Assistant-to-the-President at the home office."

Peters! Peters—surely it could not be Peters! Why, this fellow Peters was only a branch-office salesman. . . . Personality! Why, he was only five feet four inches high, and had no more personality than a mouse. Stack him up against a big man and he'd look and act like an office boy. I knew Peters well and there was nothing to him, nothing at all.

January the first came and Peters assumed his new duties. All the boys were openly hostile to him. Naturally, I felt very keenly about it, and did not exactly go out of my way to make things pleasant for him—not exactly!

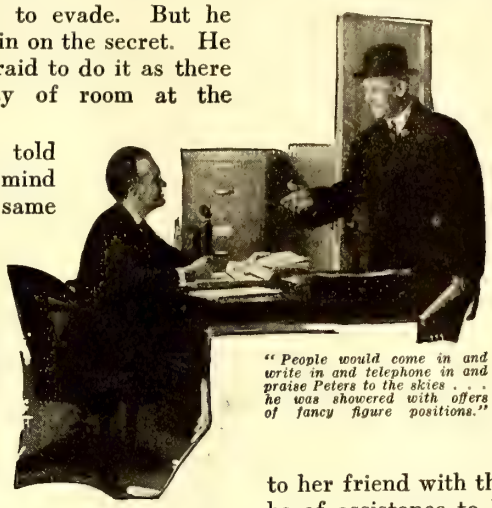
But our open opposition didn't seem to bother Peters. He went right on with his work and began to make good. Soon I noticed that, despite my feelings against him, I was secretly beginning to admire him. He was winning over the other boys, too. It was not long before we all buried our little hatchets and palled up with Peters.

The funny thing about it was the big hit he made with the people we did business with. I never saw anything like it. They would come in and write in and telephone in to the firm and praise Peters to the skies. They insisted on doing business with him, and gave him orders of a size that made up dizzy to look at. And offers of positions!—why, Peters had almost as many fancy-

figure positions offered to him as a dictionary has words.

What I could not get into my mind was how a little, unassuming, ordinary-to-look-at-chap like Peters could make such an impression with everyone—especially with influential men. He seemed to have an uncanny influence over people. The masterly Peters of today was an altogether different man from the commonplace Peters I had first met years ago. I could not figure it out, nor could the other boys.

One day at luncheon I came right out and asked Peters how he did it. I half expected him to evade. But he didn't. He let me in on the secret. He said he was not afraid to do it as there was always plenty of room at the top.



"People would come in and write in and telephone in and praise Peters to the skies . . . he was showered with offers of fancy figure positions."

What Peters told me acted on my mind in exactly the same way as when you stand on a hill and look through binocular glasses at objects in the far distance. Many things I could not see before suddenly leaped into my mind with startling clearness. A new sense of power surged through me. And I felt the urge to put it into action.

Within a month I was getting remarkable results. *I had suddenly become popular.* Business men of importance who had formerly given me only a passing nod of acquaintance, suddenly showed a desire for my friendship. I was invited into the most select social circles. People—even strangers—actually went out of their way to do things for me. At first I was astounded at my new power over men and women. Not only could I get them to do what I wanted them to do but they actually anticipated my wishes and seemed eager to please me. But let me tell you some of my experiences.

One of our biggest customers had a grievance against the firm. He held off payment of a big bill and switched to one of our competitors. I was sent to see him. He met me liked a cornered tiger. A few words and I calmed him. Inside of fifteen minutes he was showering me with apologies. He gave me a check in full payment, another big order, and promised to continue giving us all his business.

For certain reasons it became necessary for the firm to obtain a signed letter from a prominent public man. Three of our men had tried, and failed. Then I was given the job. I felt I had been made the "goat." But I got the signed letter, and with it an inside tip which enabled us to land a prize order about which our competitors are still guessing and wondering.

Then trouble sprang up at one of our factories. Then men talked strike. Things looked ugly. I was sent to straighten it out. On the eve of a general walkout, I pacified the men and headed off the strike. And not only this, but ever since then this factory has led all our other plants in production.

I could tell you dozens of similar instances, but they all tell the same story—the ability to make people like you, believe what you want them to believe, and to do what you want them to do. I take no personal credit for what I have done. All the credit I give to the method Peters told me about. We have told it to lots of our friends, and it has enabled them to do just as remarkable things as Peters and I have done.

Which reminds me: One of my wife's close friends moved to another town where she was a stranger. My wife of course knew of my method. She told it to her friend with the idea that it might be of assistance to her in meeting new people. It helped her so wonderfully that in a very short time she won the close friendship of many of the "best families" in the town. Every one wonders how she did it. But WE know.

But you want to know what method I used to do all these remarkable things. It is this: You know that every one doesn't think alike. What one likes another dislikes. What pleases one offends another. And what offends one pleases another. Well, there is your cue. You can make an instant hit with any one if you say the things they want you to say, and act the way they want you to act. Do this and they will surely like you, and believe in you, and will go miles out of their way to PLEASE YOU.

You can do this easily by knowing certain simple signs. Written on every man, woman and child are signs, as clearly and as distinctly as though they were in letters a foot high, which show you from one quick glance exactly what to say and to do to please them—to get them to believe what you want them to believe—to think as you think—to do exactly what you want them to do.

In knowing these simple signs is the whole secret of getting what you want out of life—of making friends, of business and social advancement. Every great leader uses this method. That is why he IS a leader. Use it yourself and you will quickly become a leader—nothing can stop you. And you will want to use it for no other reason than to protect yourself against others.

What Peters told me at luncheon that day was this: "Get Dr. Blackford's 'Reading Character at Sight.'" I did so. This is how I learned to do all the remarkable things I have told you about.

You have heard of Dr. Blackford, the Master Character Analyst. Many concerns will not employ a man without first getting Dr. Blackford to pass on him. Concerns such as Westinghouse Electric and Manufacturing Company, Baker-Vawter Company, Scott Paper Company and many others pay Dr. Blackford large annual fees for advice on dealing with human nature.

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The Knack of Talking Convincingly

IN nearly every group of men there is one good talker. He is always the leader. Convincing talkers are the dominating leaders of every business. Here's how you can learn the principle of convincing speech in one evening and rise quickly to leadership.

I WONDER if you would have felt as elated as I did. A man whose name you would know instantly—a power in the financial world—had granted me an interview. I wanted him to tell me the secret of his great success. Put yourself in my place if you can, and imagine yourself seated before this multi-millionaire, chatting with him about his boyhood, his start in business and his meteoric rise.

He was the biggest man I had yet interviewed in the hope of getting a real "half-Nelson" on the illusive "secret of success." I had half expected to hear the same old story about "honesty, hard work and stick-to-itiveness." So you can imagine my surprise when he said that his success was due primarily to one thing. To use his own words:

"If you should ask me what advice I would give every young man in business, I would say, 'Learn to talk convincingly.' All success in business is built upon getting others to think and do as you wish—in getting the willing co-operation and loyal support of other men. And the only way this can be had is through becoming a convincing talker."

"There is no ability which will bring success to a man so quickly as the ability to talk convincingly."

And the more men I see who have made their marks in the world, the more I realize that he was right. They are all convincing talkers. With their mastery of words, their ability to talk convincingly, and with the dominating influence of their speech, they have swept away all barriers and have attained success.

IT is no figure of speech, but fact, to say that **the great men have talked themselves to success.**

Many a man who deserves success is being held back because he can not express his thoughts and ideas in strong, convincing speech. Many of us deserve a greater salary than we are getting. You may have a wonderful ability—a genius for your work—which is not being rewarded because you can't put your ideas into speech that convinces. Do not let this handicap hold you back another day from the success that is rightfully yours. When the time comes—and opportunity is always at hand—you can be ready to get up and put your thoughts into speech, the sheer force and conviction of which will mark you as a leader.

This knack of talking convincingly will do wonders for any man or woman. Most people are afraid to express their thoughts; they know the humiliation of talking to people and obtaining in answer a casual nod, or a curt "yes" or "no". But when you can talk convincingly, it's different. When you talk, people listen to you.

Can You Do This?

Can you talk as well in public as at home?

Can you get financial backing when you want it?

Can you win confidence, friendship, love through your speech?

Can you make people listen when you talk?

Can you hold your hearers spell bound?

Can you give humorous, extemporaneous talks?

Can you address any size audience from one to thousands?

Can you get up and talk, any time, any place, without nervousness?

When you have acquired the knack of talking convincingly, it's easy to get people to do anything you want them to do. You can get special attention from anyone from a hotel clerk up to a millionaire. You can make others see your point of view, think as you do, and carry out your slightest wish.

And again it helps in social life. Interesting and convincing talk is the basis of social success. At social affairs you will always find that a convincing talker is the center of attraction and that people go out of their way to "make up" to him. Talk convincingly and no man—no matter who he is—will ever treat you with cold, unresponsive indifference. Instead, you will instantly "get under his skin." Talk convincingly and any man—even a stranger—will treat you like an old pal and will literally "take the shirt off his back" to please you.

YOU can get almost anything you want if you know how to talk convincingly enough. You've noticed that in business, ability alone does not always count. Many a man of real ability, who cannot express himself well, is outdistanced by a man of mediocre ability who knows how to talk convincingly. There's no getting away from it, to get ahead—to get what your ability entitles you to, you've got to know how to talk convincingly.

You have seen or read about scores of courses which claimed to teach convincing speaking. You have often thought you would like to take advantage of them and master this knack of powerful speech. Possibly you have investigated a few of them. But you have always found one of two things. Either the course in question dealt almost entirely with oratory—for which you have no use—or else you discovered that the price was entirely beyond what you wish to pay for such training.

BUT here at last is a wonderful new method of teaching the principles of convincing speech. It is not instruction in oratory or the use of high-sounding words. But it shows you in one evening the principles of talking your way to a better position, more salary and success. And the price—not twenty, thirty or forty dollars—but FIVE.

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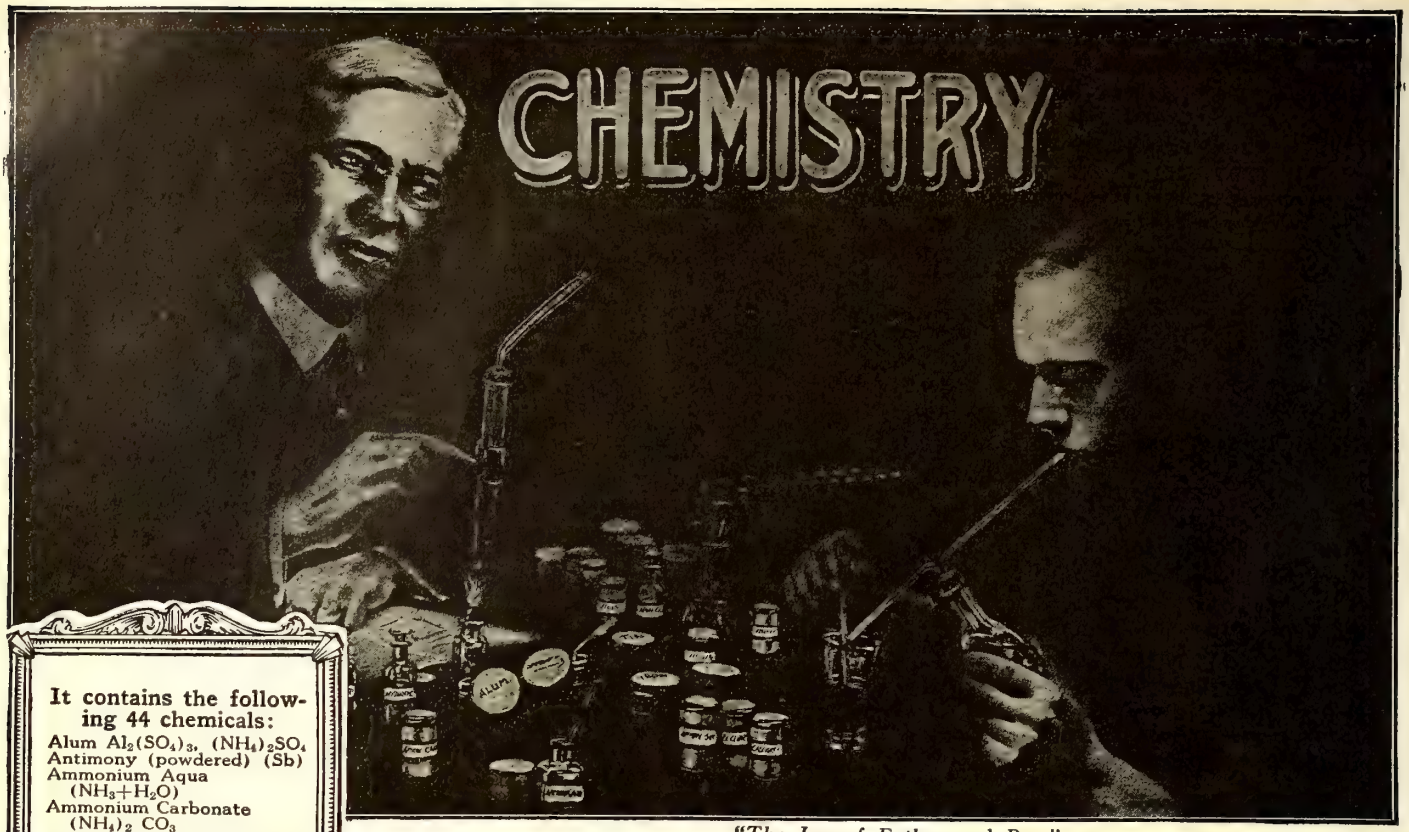
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Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate $(MgCO_3)$
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
Sulphate of Nickel $(NiSO_4)$
Sulphate of Zinc $(ZnSO_4)$
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
Zinc Carbonate $(ZnCO_3)$

The following apparata are furnished:

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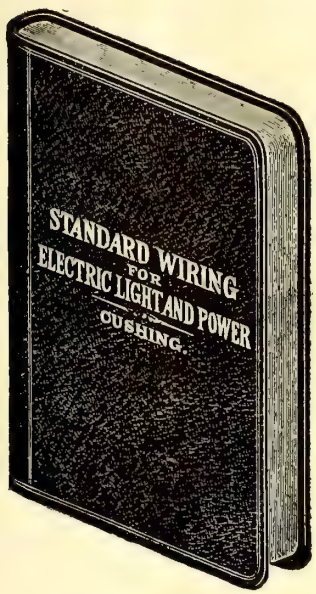
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ELECTRICAL EXPERIMENTER

H. GERNSBACK – EDITOR
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Vertical Lighthouse Beams

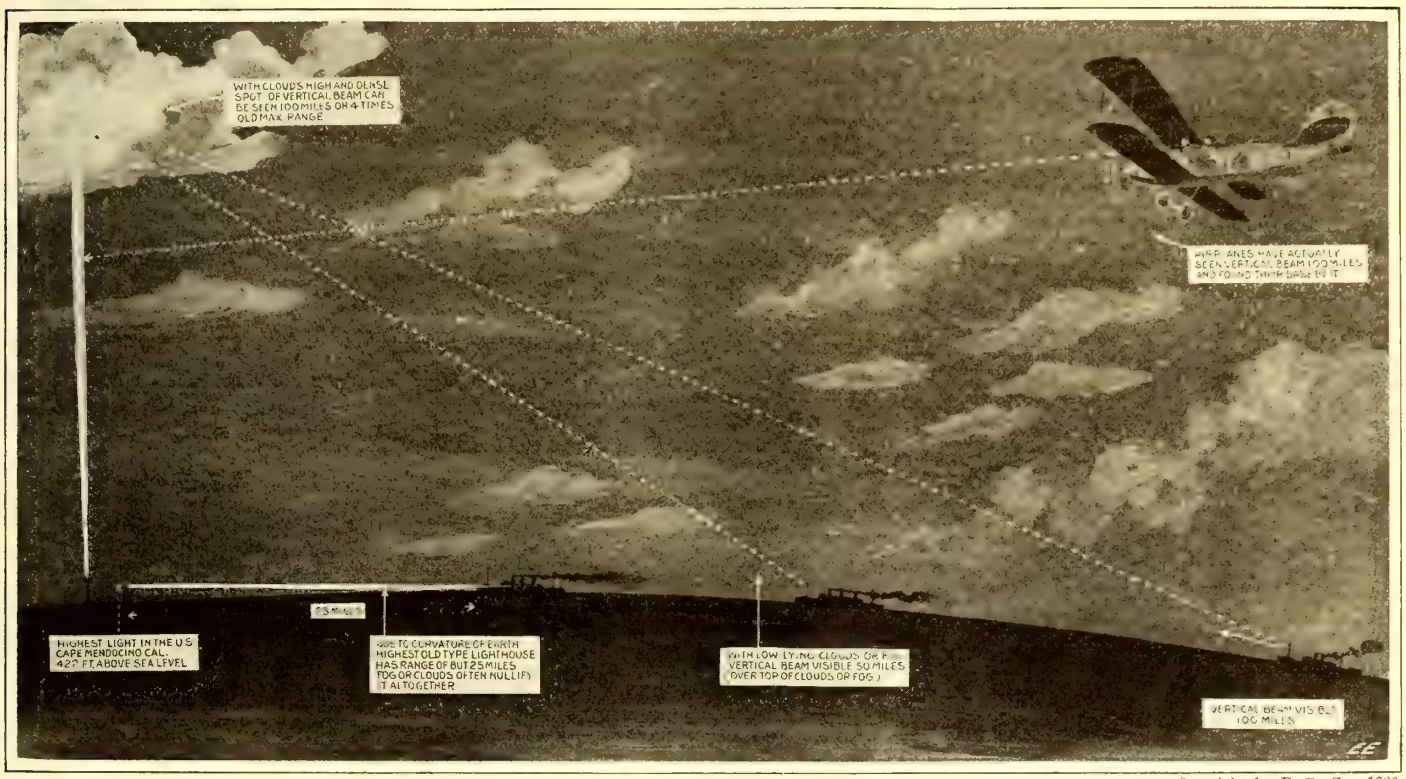
"THE history of lighthouses is as old as navigation itself. Ever since the ancients ventured out of sight of land in their triremes and their sailing craft, there have been mariners' beacons. From the beginning, navigation has been a twenty-four-hour-a-day industry and guiding beacons have been a necessity. Altho vague references to beacon lights are found in literature dating many centuries B. C., the first lighthouse of which we have authentic record is the great Pharos of Alexandria. This famous light of the ancients, which was built about 258 B. C., was a huge tower of solid masonry on which a large bonfire was maintained nightly. Even today one can see, not far from London, the remains of an old masonry beacon quite similar to the Egyptian Pharos." Thus spoke P. R. Bassett, research engineer of the Sperry Gyroscope Company, which concern has recently developed a remarkable vertical lighthouse projector or searchlight, which can be seen 100 miles at sea. The greatest range heretofore of any lighthouse has been 25 miles.

"It was in the 18th century that the first attempts were made to use an optical system with the light. In 1812, the United States adopted a scheme consisting of a crude copper reflector and a bull's-eye lens in several of the important lighthouses. But, in the terms of one of the old lighthouse reports of the time, it 'made a bad light worse,' and hence was short-lived. It was succeeded, however, by better and better apparatus until in about 1852 the Lighthouse Board adopted the Fresnel system of prisms and lenses, which has remained unimproved for this service up to the present time. This system is now so universally employed for lighthouses that one always thinks of a lighthouse as a tower with one of these beautiful cages of concentric glass rings and prisms mounted in the light-room at the top.

"Within twenty miles of Brooklyn, the most brilliant lighthouse in America shines every night. The Navesink Light at Sandy Hook holds this foremost position, swinging a beam of 11,000,000 candle-power out across the harbor entrance once every ten seconds. It is well worth a trip to this faithful mariners' guide to see the remarkable Fresnel prism head. Two tons of optical glass built in the form of a cylinder about six feet high are mounted so beautifully that one can rotate the system with the slight pressure of a finger. This heavy head floats in a container of mercury and thus rotates with practically no friction. The two-ton head is revolved slowly all night long by the gradual dropping of a small weight through the height of the tower.

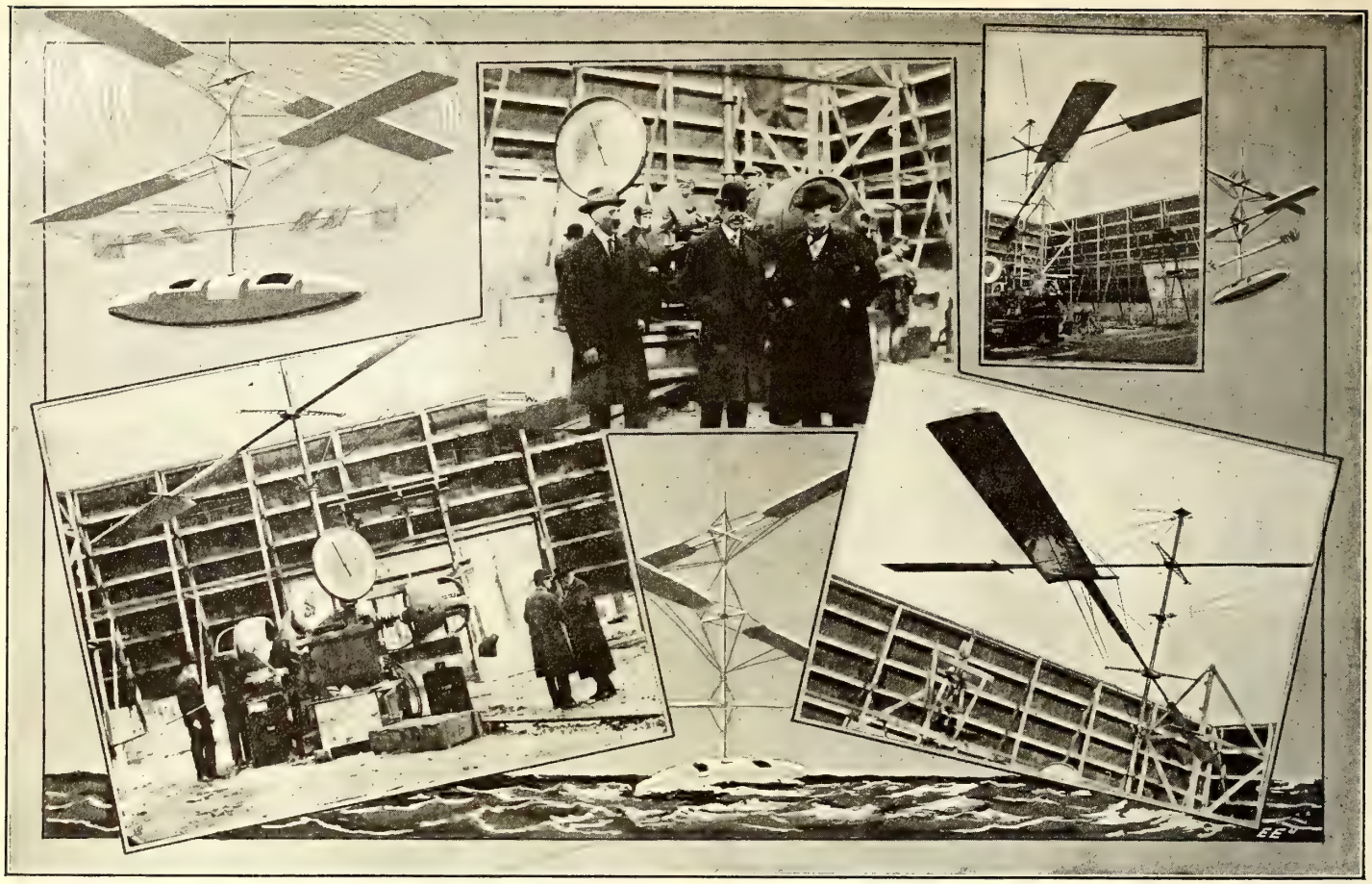
"Let us look at the broader aspects of the lighthouse problem and consider the requisites and the limitations. In general,

(*Continued on page* 928)



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The Latest Idea in Lighthouses—Vertical Shafts of Light Instead of the Old Horizontal Beams Which Were Often Not Visible at All in Foggy Weather. Vertical Lighthouse Beams Have Been Seen 100 Miles Away—the Maximum Range of the Old Style Beacon Is About 25 Miles.



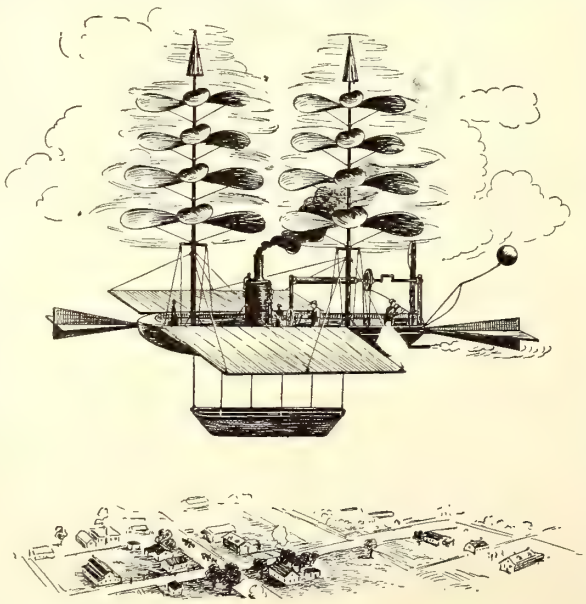
Top Right: Full Length View of Helicopter No. 1, Showing the Testing Installation of the Vital Features of the Machine. Lower Left: Showing the Temporary Installation of Two Electric Motors Each Capable of Developing a Maximum of 100 Horse-power. The Upper Gear Wheel of the Reducing Gear Is Seen Just Above the Box-Like Structure, Which Carries the Large Dial of the Platform Scales Used in Measuring the Lift or Thrust of the Propellers at Different Speeds and Power. The Motor Foundation Was Pivoted So That It Would Show Any Tendency of the Propellers to Turn the Whole Machine About Its Center. This Impulse Was Found to Be Practically Negligible, and the Entire Apparatus When Running at Maximum Trial Speed Could Be Rotated Freely to Right or Left by the Pressure of One's Hand. While Guys Were Attached to the Top of the Shafting to Steady the Machine, This Precaution Was Found Unnecessary, Because the Apparatus Stabilized Itself in a Pronounced Manner, the Faster the Screws Revolved. Lower Right: Details of the Propeller Blades, Guying and Shafting of Helicopter No. 1. Top Center Photo: Dr. Peter Cooper Hewitt in the Center. Thomas A. Edison, Who Is Interested in the "Helicopter," at Dr. Hewitt's Left and One of Dr. Hewitt's Technical Assistants to His Right.

The "Helicopter", A Vertical Airplane

By ROBERT G. SKERRETT

THE HELICOPTER has been an aeronautical puzzle ever since inventive genius tackled the problem of producing a heavier-than-air flying machine. Mechanical success of a sort has been realized from time to time by those variously engaged in this undertaking; but so far as the records show no full-sized craft of this type, with one exception, has been produced capable of lifting its designed full load. In short, they have been unable to rise as they stood. The one exception is the reason for being of the present article.

In an effort to strengthen our coast defense during the recent conflict, Doctor Peter Cooper Hewitt, who has given the world the most economical form of artificial light in his mercury vapor lamp, and Professor Francis Bacon Crocker, long the head of the Department of Electrical Engineering of Columbia University, combined their talents to bring to a practical head certain experiments with the helicopter initiated by Dr. Hewitt in 1906. They began their work in 1917, and a year ago brought their labors to a brilliant climax after they had put *Helicopter No.* 1 thru a series of exhaustive tests. The armistice was declared just as the ground trials were finished and *flight* was the next feature of the program. The cessation of hostilities caused a tremendous slump in aviation, and interest for the nonce in the helicopter lagged. Now, however work is about to be resumed, and both Dr. Hewitt and Prof. Crocker are positive in their assertions that the craft will do as well aloft, as it has done within its hangar at Ampere, New Jersey.



An Early Forerunner of the Helicopter—a Steam Driven Vertical Flier Proposed by Mr. de La Landelle in 1863.

The fundamental stumbling block heretofore has been a propeller capable of translating into effective thrust, or *lift*, a sufficient measure of the prime mover's developed power. None of them has in the past given, at useful working speeds, more than 10 pounds of thrust per unit of horse-power—most of the aviation propellers fall considerably below this in performance. The propellers evolved by Dr. Hewitt and Prof. Crocker have yielded more than 20 pounds of thrust per horse-power! These engineers have achieved this by breaking away from the generally accepted types of aeronautical screws both in the matters of size, design, and the materials employed. To be brief, they are adaptations of the aerofoil—the blades are relatively miniature airplane wings.

Without elaborating upon the physical circumstances under which the usual airplane propeller of relatively small diameter functions, it will suffice to mention that it revolves at a speed varying from 1,000 to 2,000 times a minute; it has a very large percentage

of slip; and its effectiveness is greatly reduced by the way in which it disturbs the air well ahead of it. This latter motion cuts down proportionally the screw's hold upon the atmosphere and its capacity to exert a propulsive effort. As the outer portions of a propeller's blade do most of the helpful work, it is evident that the hub and the massive inner sections of the blades are something of a handicap. Finally, owing to its moderate diameter, the ordinary airplane screw has only a modest volume of air to work upon.

In planning Helicopter No. 1, the first aim was to obtain propeller blades having high sustaining and propulsive factors, as the entire burden of lift and horizontal movement was to depend upon the screws. These were mounted upon concentric, tubular shafts, revolving oppositely. It was not enough to use aerofoil blades; it was quite as necessary *to have recourse to propellers of large diameter, driven at comparatively low angular velocities,* which would act upon a large mass of air without previously setting up discounting perturbations. To this end, each of the propellers of Helicopter No. 1 has a diameter of 51 feet, and the speed of revolution is about 100 turns a minute.

The blades are attached to tubular steel arms, and placed where the periferal speed will make most effective their length of 15 feet and their breadth of 2½ feet. The blades consist of a succession of transverse partitions or frames of aluminum over which is laid, top and bottom, a single sheathing of the same metal. To prevent "chattering" the blades are attached to the supporting arms forward of the center of pressure. Therefore, the blades are, in effect, drawn instead of being pushed thru the air. This arrangement gives the blades a certain measure of automatic adjustment of pitch when meeting with varying stresses and changing angles of travel on the part of the machine.

The vital features of Helicopter No. 1, as assembled for testing, weighed something less than 2,300 pounds. When the screws were turned at the rate of 70 revolutions a minute—their two electric motors then developing 126.5 horsepower—the total effective *lift* amounted to 2,550 pounds, i. e., *20.2 pounds of lift per horse-power!* Electric motors were used in place of aviation engines because they made it possible to carry on the tests progressively, from the lowest speeds upward, and to read off at the electric meters the actual power consumed at any moment. The driving apparatus between the motors and the shafts consists of an ingenious reducing gear by which it is feasible to step down the prime movers' speed from 1,400 to 100 revolutions a minute. This makes it practicable to employ the high-speed aviation engine and yet to obtain the desired low rotary movement of the propellers.

The reducing gear was developed by Dr. Hewitt, and, while possessing a measure of flexibility to meet the variable stresses of mechanical flight, is, nevertheless, positive in the contacts between the pinions of the engine shafts and the two geared wheels to which the upper and the lower tubular propeller shafts are, respectively, secured. Revolving oppositely, the propellers exert a very notable stabilizing moment; *and so marked is this effect that it was unnecessary to steady the machine by guys during the ground trials!* Furthermore, due to the fact that the screws neutralize one another, so far as they might tend to turn the engine platform about its center, it is at once evident that the helicopter will not spin about its own axis when aloft. Also, it will, for this reason, be easily steered by the rudders to be provided for that purpose. Dr. Hewitt has designed a double reducing gear which will operate at a ratio of 23 to 1. By means of the wide use of opposing forces, and the employment of antifrictional bearings, this engineer-scientist obtains a series of dynamic couples which neutralize one another and thus insure balanced action.

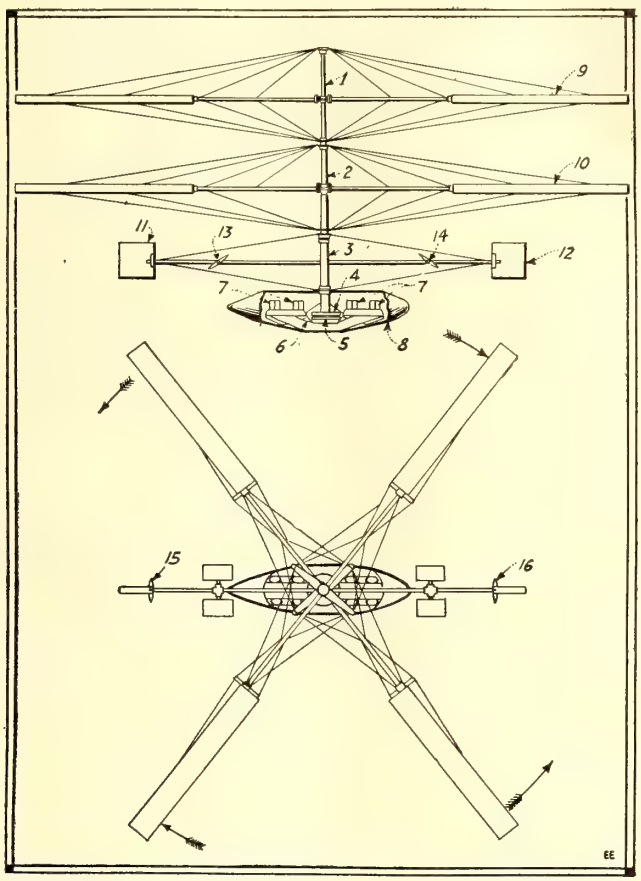
In all of its essentials, Helicopter No. 1 is a practical man-carrying machine, and can be made ready for flight by substituting two airplane engines in place of the testing electric motors. *It is only necessary to tip the machine a matter of about five degrees toward the bow or toward the stern, to propel it at high speed in either of these directions.* This tipping action is effected by suitable rudders; and when the helicopter has assumed the desired angle, a double set of vertical rudders, opposed to the line of advance, act against one another and hold the machine in that plane of motion. The helicopter will be able to hover aloft, and can be made to ascend or descend vertically with the utmost deliberateness. With half of the engine power "dead" the helicopter will return to earth at a safe speed. However, because of its high ratio of thrust per unit of power, it is feasible to equip an aircraft of this kind with a reserve motor which can be put in gear at the will of the pilot or automatically upon the failure of any of the working engines.

Professor Crocker has thus summarized the advantages of the present type of flying machine: "The helicopter will start from any moderate space such as a roof or ordinary street, and come back to land on the same spot. It is inherently stable and cannot dive, the support being all above and the weight below; so that special skill is not required to operate it at high or low speeds to prevent it from getting out of control. The helicopter is substantially *fireproof,* being constructed thruout of metal. To build it, no labor or materials that are difficult to obtain are needed. The craft can be constructed in an ordinary machine shop, and can be assembled, disassembled, or repaired with the skill and facilities commercially available. The helicopter is far less noisy than the airplane and, because of its general design and arrangement, less conspicuous when up in the sky."

As the editors see it this remarkable development in flying machines certainly looks like a long step in advance, if all of the many predicted qualities inherent in its design are fulfilled in actual flight. Especially in war-time will the marked advantages of this type of aircraft be apparent, for its visibility will be far less than that of the present airplane, which has wings of considerable area. Besides, the small wings or rerevolving screws of the Helicopter will prove a difficult target for the enemy gunners, whether aloft or on land. The cab of the Helicopter can be armored so as to readily withstand ordinary bullets and shell fragments. And just imagine the great superiority of an aerial observing station that can "hover" about, in one spot if need be, in order to gain an accurate sight on enemy artillery and other activities.

We have now considered some of the advantages of the Helicopter, but it would seem to the editors that there are also some disadvantages. For instance, owing to the small sustaining surface of the screws, which act virtually as wings also, what will happen if accidentally or in battle, the engines happen to fail? It would seem that the airship would obey the law of gravity and dart earthward at a rapid rate. Airplanes can volplane down safely if the engine stops, as their superior wing surface allows of their doing so; but perhaps the inventors of the Helicopter here shown have circumnavigated this problem in a manner which they have kept to themselves so far.

Those interested in trying out the merits of the Helicopter flying machine will find a most interesting article on a successful flying model of this type, by Mr. William J. Beach, in another part of this journal.



1. Inner Concentric Shaft Which Rotates Upper Propeller, 9.
2. Outer Concentric Shaft Which Rotates the Lower Propeller, 10.
3. Permanent Tubular Sleeve Which Takes the Weight of the Machine and Alternately Bears the Lift and Compression Loads When the Craft Is Flying or at Rest.
4. Upper Wheel of Reducing Gear.
5. Lower Wheel of Reducing Gear. The Geared Pinions on the Engine Shafts Are Introduced Between These Wheels and Drive Them Equally. The Shaft of the Lower Propeller Is Secured to the Upper Wheel and the Shaft of the Upper Propeller Is Attached to the Lower Gear.
6. Engine Foundation Structure.
7, 7. Aviation Motors.
8. Fuselage.
11 and 12. Rudders That Can Be Swung Both Horizontally and Tipped to the Right or Left from the Vertical. By Tipping Them Oppositely, the Down Draft from the Propellers Tends to Rotate the Fuselage So That the Craft Will Swing to Port or Starboard. By Tipping No. 11 So That the Rudder Face Is Vertical Instead of Horizontal the Machine Is Inclined by the Head and Will Then Advance Horizontally in that Direction. Similarly So Inclining No. 12 will Cause the Helicopter to Travel Rearward.
After the Craft Is Started Horizontally at Any Angle of Advance, the Rudders 13 and 14 Are Set Oppositely, Thus Forming a Dynamic Couple Which Tends to Hold the Machine Inclined and Upon the Desired Line of Travel.
15 and 16. Rudder Yokes.

Is the Electric Airplane Possible?

What An Eminent Airplane Engineer Says

HENRY WOODHOUSE, the well-known aviation expert, recently gave out a report that there had been plans disclosed in Chicago for a radically new type of flying craft, to be propelled by electricity entirely, and therefore to be of such great power and efficiency as to be able to make flight around the world.

This wonderful new flying machine, he said, was designed for propulsion thru the air by electric motors driving the propeller blades, with a total horsepower of 6,000. The airplane is also credited with being capable of carrying from 75 to 100 passengers, and the wings are to have a spread of 240 feet, while the airship itself is 180 feet in length. The appearance of this new flying craft is shown in the accompanying illustration.

WHAT DR. WILLIAM WHITNEY CHRISTMAS THINKS OF THE ELECTRIC AIRPLANE.

Before going further, it would be well to listen to what a leading aviation expert, Dr. William Whitney Christmas of New York, has to say with respect to electrically-driven airplanes. Dr. Christmas is the inventor of the famous "Christmas Bullet," whose cantilever supporting wings are flexible like a bird's, but not to the same extent. The "Christmas Bullet" is the fastest plane in the world and has made 200 miles an hour on official test, when fitted with a liberty motor. Recent unofficial reports from France, mention a new record for an airplane flight of 226 miles per hour. Dr. Christmas has been connected with aviation matters from the days of Professor Langley, and his views upon the subject of airplanes are therefore of interest to us.

Dr. Christmas said: "In suggesting that airplanes be driven by electricity, I realize that I am making myself open to severe condemnation by many well informed gentlemen who say that it cannot be done. Nevertheless, I am of the opinion that the ultimate craft of the air will be electrically driven.

"It is not my part to say how this is going to be accomplished, but to argue from the present failings of the aviation gas engine to the conveniences of electric motors.

"As is well known, an airplane depends upon its motor to stay in the air and the very delicate adjustments required on common aviation motors make them not entirely reliable. There are so many parts that can wear out or get out of adjustment, that it is a wonder they show up as well as they do.

"I do not mean that they are altogether unsatisfactory, but I do say that they can be improved upon by substituting a common electric motor.

"The electric motor is compact. While the present day motors are heavier and bulkier per horsepower than most aviation engines, this is because aviation engines have been refined for the particular service on airplanes and electric motors have not. Now if our electrical geniuses put their heads down to the job of developing a fine aviation motor, they will doubtless come within the same limits that the gas engine men have attained.

"The problem of supplying the electric energy to the motor on electrically-driven airplanes is, as we might surmise, some problem! However, it is not insolvable, and there are three obvious ways to be suggested. One—to carry storage batteries; two—to transfer electrical energy by *wire* or *wireless*, i.e., as by means of a depending trolley cable between the airplane and a contact or third rail, over the contact rails of which would run a contact shoe at the lower end of the cable; and the wireless transmission of energy, referring to the ideas of Dr. Nikola Tesla, of course not developed yet to the stage of practicability; and third—a gasoline-electric airplane in which great constancy of power and beautiful control of driving screws are obtainable. In this scheme the gasoline engines drive dynamos which generate electric current, and this current is then controlled as desired by the pilot, and fed to one or more electrically-driven motors to which the screws or propellers are attached."

THE GASOLINE-ELECTRIC AIRPLANE TO THE FORE.

As the accompanying illustration shows, the layout and arrangement of the electric propelling mechanism on the newly proposed airplane described by Mr. Woodhouse, is along well-known and thoroly tried engineering lines and corresponds to the electric drive on our newest battleships.

There is not a very great loss in converting the mechanical energy developed in the gasoline engines (of which there are two in this case) into electrical energy as developed by the dynamos; and these losses are more than compensated for in applying the electrical drive to the airship, by virtue of the much smoother operating control and driving qualities. One thing is certain—that with this arrangement of gasoline-electric propulsion we know it will work!—providing we build our electric machinery sufficiently light, as Dr. Christmas has pointed out, so as not to over-burden the flying craft with useless dead-weight.

The *power-plant* here shown, comprises 6,000 horsepower of electric motors driving the four screws, or each motor produces 1,500 horsepower. The motors may be operated in pairs in case one generating set should fail, and therefore the two inside or else the two outside screws can be used.

The two dynamos develop 3,000 H.P. each and are driven by two 3,200 H.P. gasoline engines. The pilot in his cabin, atop the main body of the aircraft, has full control of the speed of the propelling screws at all times. Where the propellers can be so accurately and easily controlled, as in the case with the electric drive, the ease of handling of the airship is greatly enhanced, as for instance by speeding up the screws on one side, and reducing their speed on the other side, etc., especially in bad weather. With electrified airships there comes many other niceties for long distance journeys, such as electric cooking, electric heating, electricity for operating a powerful radio set, electric lights, and an electrical gyroscopic compass.

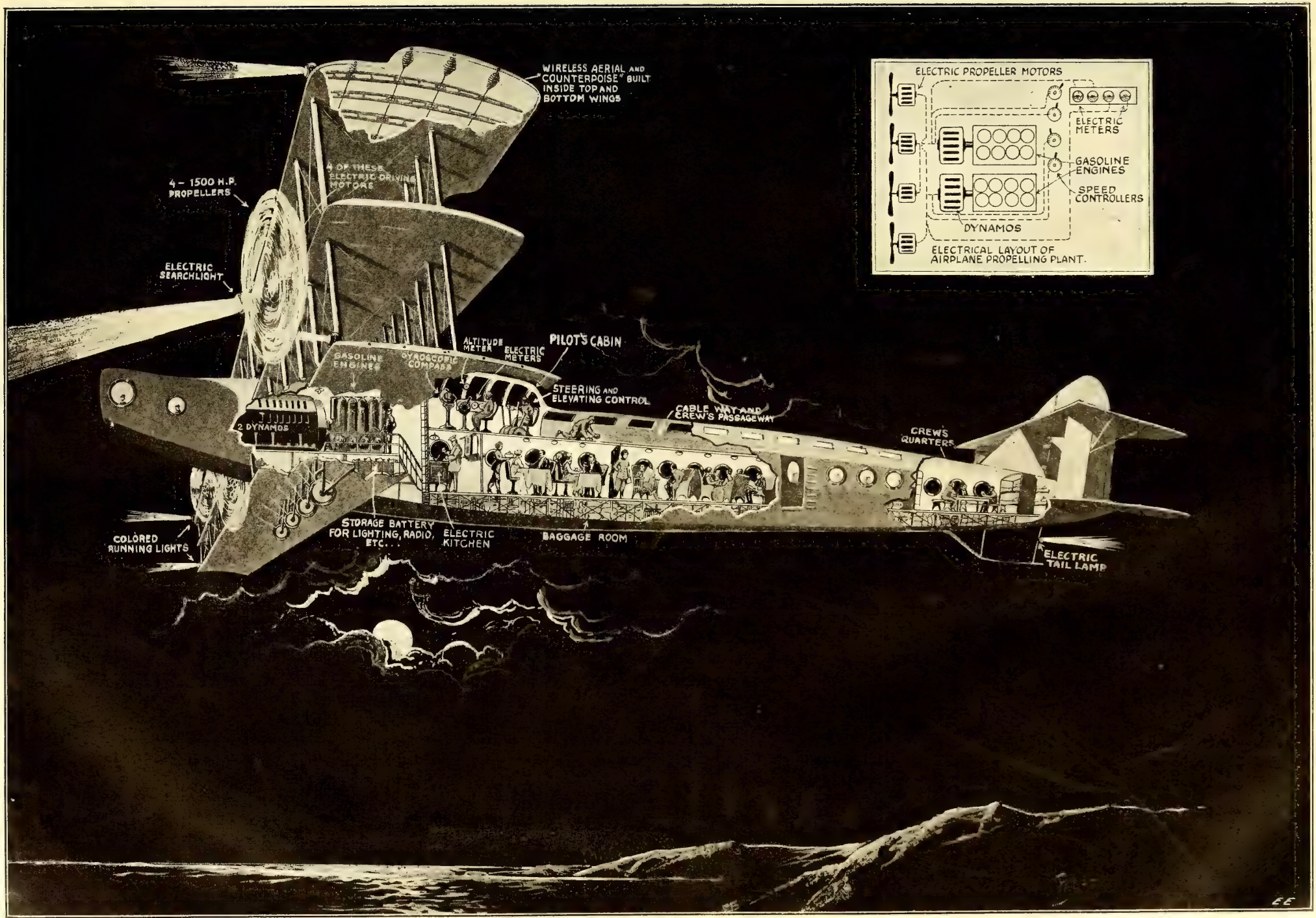
As will be noted from the illustration, the radio antenna in this machine follows the latest departure in this direction, and the wires constituting the antenna are placed inside the wings.

Objection might be raised on this point that there is considerable danger of fires owing to electric discharges from the antenna wires, but it might be said that the latest idea in building such machines is to cover the wings with sheet aluminum or aluminum alloy sheeting, in the same manner as some of the German and other foreign planes have been successfully built.

As will be seen, there is room for a limited amount of baggage on such an airplane, and for night trips, sleeping quarters may be provided on the order of the well-known Pullman car accommodations—that is, by converting the seats into berths. Powerful electric searchlights are available for flying at night, and especially for landing purposes, while port and starboard lights or *markers* are fitted on all such planes at the present time.

Heard German Conversation One Mile Away

It is a common knowledge, especially among men of the U. S. Signal Corps who served with the A. E. F., that by means of the wonderful 6, 8 and 10 stage audion amplifiers, available in the present war, and by placing a parallel loop of wire over a few hundred feet near the front lines, that enemy conversations could be easily and accurately intercepted and amplified. As we have just said, this phenomena is more or less well known, but it is not generally known, we believe, that, as recently pointed out by a U. S. radio expert who invented the amplifying radio buzzer system used in trench and field warfare carried on by the Allied troops, it was possible by the use of the high power ten-step amplifiers, both French and American type, to overhear telephone conversation and also telegraphic signals whenever the Germans happened to communicate over wires, at a distance of one mile behind the front line trenches. Interrogated at this point, the expert explained that not such a long wire loop was necessary as might be supposed, but that a wire about 250 feet long, placed parallel to the German trenches, was all that was necessary, and just to show that the "Yanks" had the "Boche" on the run long before he entered his trenches, underground dugouts and wine cellars, it is a matter of record that the Allied troops, in many instances, and particularly toward the close of the war, found whole sections of German telephone instruments over a considerable area near the front lines entirely sealed with red labels marked "Verboten," and, furthermore, some of the captives stated that their troops had been ordered not to use the telephone at all under any consideration, even where the wires were laid in iron pipes. Many other valuable uses were made of these eight and ten-step vacuum amplifiers, some of which will be described in future articles.



Electric Drive for Battleships Has Proven Eminently Satisfactory; Why Not Try It for Aircraft? Here We Have a Newly Proposed Electric Drive Airplane Rated at 6000 Horsepower, Capable of Flying Across the Continent with a Load of 100 Passengers and Baggage. Inset Cut Shows Electric Control Features.

What Atomic Forces Could Do

SIR OLIVER LODGE, the eminent English scientist, declared recently that the first utilization of basic atomic properties of matter, had first been utilized by man in wireless telephony. This refers to the remarkable electronic action occurring in Audion bulbs. He added, that if the atomic energy of one ounce of matter could be utilized in a practical everyday sense by man, it would be sufficient to raise all the German ships sunk in Scapa Flow and pile them on top of the Scottish mountains. In conclusion he stated that it was his hope that the human race would not discover how to use this vast store of energy until it had brains enough to apply it properly, because if the discovery were made before its time and by the wrong people, this planet would be unsafe to live on.

RADIUM WATCH DIAL A VEST-POCKET POWER-PLANT.

What is this atomic force and have we any means of seeing it at work today? Thanks to Radium and Radio-activity, we have a means of demonstrating some of the wonderful effects of sub-atomic activity on a small scale. If you own a radium dialed watch with luminous figures and hands, then you are the possessor of a vast power plant of no mean proportions. There is sufficient radium on your watch dial to haul you train homeward, if it could be properly applied. As the matter stands, the innocent-looking radium dial does not seem to possess any extraordinary amount of concentrated energy, but this is only apparently the case, and not actually so; for the reason that while the amount of activity manifested by the radium paint on the dial is small, this effect will keep up for 2,500 years, provided the zinc sulfid, with which the radium is mixed so as to produce a glow, held out that long. The zinc sulfid in most cases gives out in about eight to ten years. See Fig. 1.

One of the accompanying illustrations, Fig. 2, shows a sectional view of a very interesting radio-active instrument known as the "Crookes Spinthariscope." This instrument which is a simple and inexpensive device, demonstrates in a most beautiful manner the marvelous activity of radium or any radio-active salts.

It comprises an eye lens-piece, as shown, which can be adjusted to different focuses, and in the bottom of the tube there is placed a zinc sulfid screen. Just in front of this screen there is placed a tiny speck of some radio-active substance. The needle holding this substance is usually mounted on an adjustment nut. This spinthariscope, when viewed thru the lens opening in the dark, presents a most wonderful spectacle, as hundreds of the atomic particles, thrown off continuously from the radio-active substance, bombard the zinc sulfid screen; each spot at which a particle strikes the screen lighting up, until the whole interior of the spinthariscope resembles a veritable fireworks display.

THE STRUCTURE OF THE ATOM.

The modern idea of the structure of an atom as well as the *family tree* of the atom and molecule are shown in Figs. 3 and 4. Referring to Fig. 3 we see that the atom, which was the smallest known sub-division of matter a few years ago, is composed of a *positive* electric charge or *nucleus,* around which there are constantly rotating at tremendous velocity, a certain number of *electrons* or *negative* electric charges. This idea of the atomic structure is believed in by practically all of the leading scientists of today, including such men as Millikan. There are some scientists who raise the question as to whether or not the electron is really the ultimate sub-division of matter. Some scientists think the electron may in turn be composed of a series of small electric charges, and that these charges may represent the ultimate particles of matter. Fig. 4 shows the whole electron family. First we have the molecule, which is composed of atoms,—then the atom, which is composed of electrons—and finally the electron, which may be easily composed of ultimate ether particles—which latter are thought by some physical investigators to be *without weight.* In other words, these *ulti-particles* would merely be *ether whorls.*

Now we are coming to the point that Sir Oliver Lodge had in mind when he made the statement cited in the forepart of this article. What he meant when he intimated what tremendous amount of energy would accrue to mankind if we could only unlock the secret of the atomic structure, was this: That instead of having to wait thousands, or hundreds of thousands of years, for atomic structures to form of their own accord, that we should be able to *re-arrange the formation of the electrons in the atom.* For it is upon the number of electrons and their arrangement in the atom, that we depend for the different substances or elements which we have today, such as iron, tin, copper, gold, silver, etc. Every ounce of matter that we know of today, including our very bodies, is composed of millions of billions of these ever-whirling electrons, so our scientists tell us.

DIFFERENCE BETWEEN BREAD AND IRON ONE OF ATOMIC STRUCTURE.

Thus, we see that the difference between a piece of bread and a piece of iron—is that one has a different electronic structure than the other. Aluminum, for example, has a different number of electrons whirling around its atomic nuclei than does gold or iron. It has been intimated by some of our ablest scientists that the dream of the Alchemists of old would surely come to pass, once we master the key to the atomic structure. For if we can apply, let us say, a powerful electric charge to a certain substance so as to alter its electronic and atomic formation, then we can turn lead or iron into gold, but we have no such control as yet over the electron family circle. Thus we cannot cause them to combine in any desired pattern, altho we are beginning to learn what some of these patterns are, at any rate.

As Professor Millikan has shown, as well as other investigators, there is apparently a vast amount of space between the electrons in an atom and experiments have been made which have demonstrated this phenomenon to a very remarkable degree. Free electrons have been shot thru an atom without touching any of the other electrons in that atom, or without dislodging any of them, and past on over a considerable distance before coming to rest.

Fig. 5 illustrates Sir Oliver Lodge's prediction of what might occur if we understood how to produce atomic disintegration and realize the tremendous, almost inconceivable power locked up in the atom—that is, we could raise all the German ships that were sunk in the Scapa Flow atop the Scottish mountains.

It is *interesting* to learn of some other remarkable results that could be accomplished by atomic disintegration. As Soddy shows, radium gives off heat at the rate of 133 gram calories per hour, or in the 2,500 years of its life (half-period of decay) it will yield the stupendous total of 2,900,000,000 gram calories per gram of pure radium. The calculation data on the steam locomotive were kindly supplied by Mr. H. S. Vincent, of the Engineering Department of the American Locomotive Co. An interesting computation shows that five ounces of this precious stuff, which you can hold in your hand, would propel a standard passenger train of 10 Pullman cars from New York to Chicago, a distance of 908 miles by railroad. How many tons of coal do you think it takes to drive such a train over a 900-mile, 22-hour journey? It requires 60 tons of the best anthracite coal to make one trip from New York to Chicago or vice versa. Such a train averages 41 miles per hour and the steam passenger engine used for the trip develops an average of 1,600 horse-power. The engine is rated at 2,200 horse-power.

FIVE OUNCES RADIUM WOULD DRIVE TRAIN 900 MILES.

The manner of computing the amount of radium required to duplicate the work of a 60-ton coal pile, measuring 67 feet high, with a base 10 by 10 feet, as shown at Fig. 6, is based on the assumption that each

(*Continued on page* 934)

For "February"

How I Discovered Radioactivity—Feature illustrated article specially written by Prof. Becquerel.

The Giant Canadian Reflector—Second Paper on Large Telescopes and How They Work, by Prof. Floyd L. Darrow.

When Weight is Zero. By H. Gernsback.

The Audion as a Scientific Magician—What it has done and is doing. Prepared in collaboration with Dr. Lee de Forest.

The Dark Searchlight—Taking "Movies" by invisible light rays, by Lewis Yeager, its inventor.

New Experimental Chemistry Series. No. 1, Alcohol—To be conducted by Prof. Floyd L. Darrow.

Radium—the Wonder-Substance—Some unusual and simple experiments illustrated and interestingly told, by Harold F. Richards, A.M.

The New Theory of Electrical Mass, by Rogers D. Rusk, M.A.

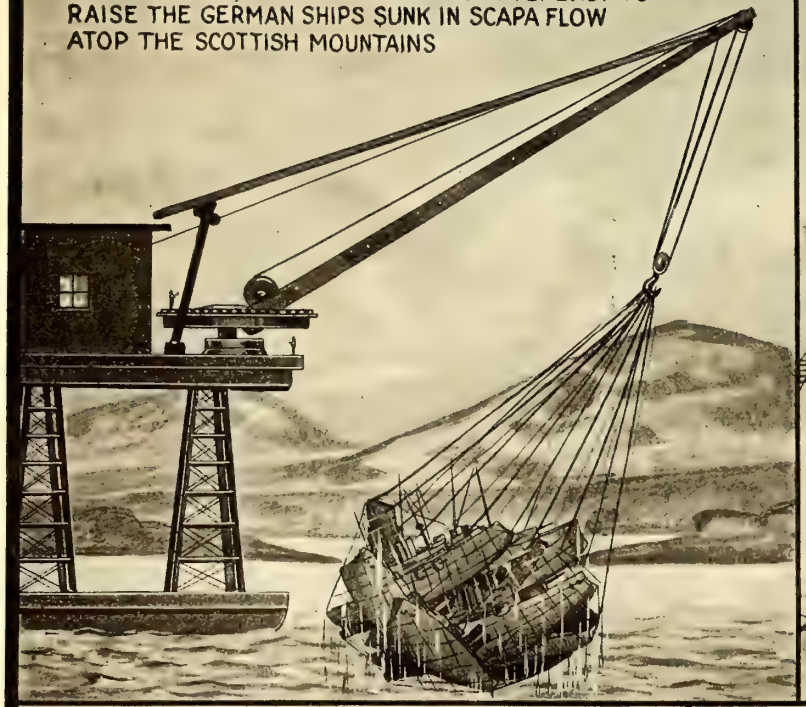
Building Model Airplane Motor of the Rotary Comprest Air Type, by W. J. Beach, M.E.

A New Commutator-less A. C. and D. C. Machine, by Richard A. Engler.

Radiotelephony and the Airplane, with diagrams, by William C. Mundt.

Audion Hook-ups—a page of them—Centralized battery connections for grid and filament, and hosts of others.

SIR OLIVER LODGE-"ONE OUNCE" OF MATTER IF ATOMICALLY DISINTEGRATED, WOULD DEVELOP ENOUGH ENERGY TO RAISE THE GERMAN SHIPS SUNK IN SCAPA FLOW ATOP THE SCOTTISH MOUNTAINS



60 TONS ANTHRACITE COAL REQUIRED FOR 1 TRIP NEW YORK TO CHICAGO

93% OF THE COAL ENERGY IS LOST IN HEAT RADIATION AND LOSSES. 7% ONLY SAVED TO RUN LOCOMOTIVE

COAL PILE 67 FT. HIGH

THIS MAN HOLDS IN HIS HAND 5 OZ. OF PURE RADIUM, WHICH IF DISINTEGRATED DURING THE RUN, WOULD DRIVE THE CHICAGO FLIER OVER ITS 900 MILE JOURNEY. DEVELOPING 1600 H.P. FOR 22 HRS. TOTAL HEAT IN GRAM CALORIES DEVELOPED BY THE RADIUM = 408,240,000,000. A GRAM OF RADIUM IN ITS LIFETIME DEVELOPS 2,900,000,000 GRAM CALORIES

1 GRAM RADIUM WEIGHS 1/28 OZ. AVD.

CHICAGO

NEW YORK

THE NEW YORK TO CHICAGO TRAIN, IN ITS 22 HOUR JOURNEY, CONSUMES 60 TONS OF COAL, TRAVELING 908 MILES AT AN AVERAGE SPEED OF 41 MI. PER HOUR. THE ENGINE DEVELOPS AN AVERAGE OF 1600 H.P. FOR 22 HRS.

THE COAL BURNED WOULD KEEP 20 SMALL FAMILIES ALL WINTER. IT DEVELOPS 13,500 B.T.U. PER LB. OR A TOTAL 3,402,000 GRAM CALORIES PER LB. A TOTAL OF 408,240,000,000 GRAM CALORIES FOR 60 TONS

← BASE 10 → FEET SQUARE

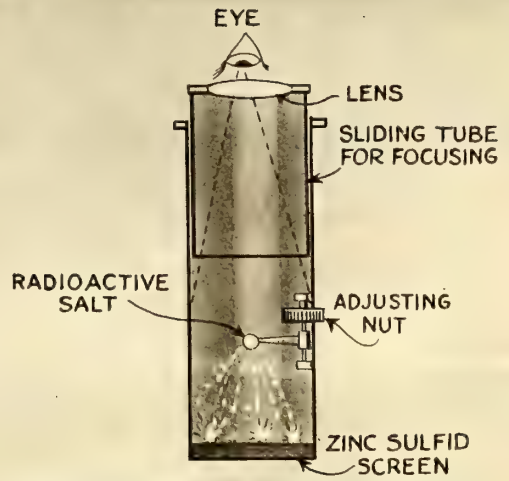
908 MILES
RAILROAD ROUTE TO CHICAGO

CAP

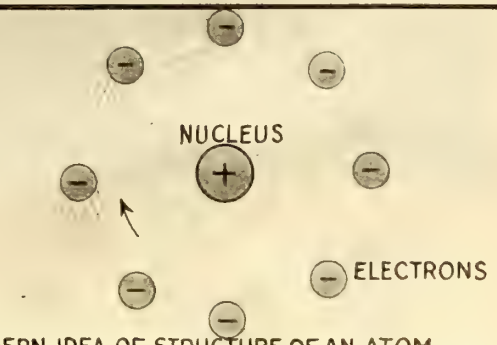


THE "RADIUM DIALED" WATCH CONTAINS ENOUGH ATOMIC ENERGY, IF DISINTEGRATED TO DRIVE YOUR RAILROAD TRAIN HOME, COMMUTERS

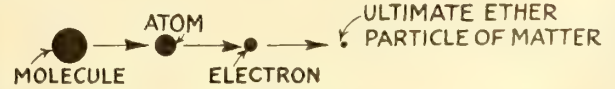
(1)



(2) THE CROOKES SPINTHARISCOPE WHICH SHOWS US THE SLOW DISINTEGRATION OF RADIUM



(3) MODERN IDEA OF STRUCTURE OF AN ATOM
A RING OF NEGATIVE CHARGES (ELECTRONS) ROTATING AROUND A POSITIVE "NUCLEUS"



(4) THE ELECTRON FAMILY

Some of the Marvels of Modern Science that are Happening Every Day, in Their Own Way, and Which Could be Made to Perform the Gigantic Feats of Strength Shown in the Short Time Noted. If Our Scientists Could Only Master the Secret of the Electron and Atomic Structure. Your Radium Watch is a Young Power House—But You don't Realize it, Because Nature Causes the Energy to be Given Off at a Very Slow Rate.

Electric Locos Cross Mountains

AMERICA has blazed the trail in many of the world's greatest engineering projects and accomplishments, and it has remained for one of the great western railways of the United States to electrify the longest stretch of trunk line in the world, and which within a short time will extend over a distance of about 850 miles. This route extends over some of the steepest ranges of our western mountains. The enterprising railroad which has had the foresight and courage to attempt such a gigantic electrification scheme as this, is the Chicago, Milwaukee and St. Paul Railway, whose tracks pass thru the thriving cities of St. Paul, Minneapolis, Butte, and Spokane. The section of this railroad running between Harlowton, Montana, and Avery, Idaho, 440 miles trunk line distance, and passing over the great Continental Divide, has been in electrical operation for some time. Work has been under way for several years on the electrification of the main trunk lines passing over the Cascade Mountains in Washington, between Othello and Puget Sound to Seattle, a distance of 211 miles. Electric current has recently been turned on the 110 mile stretch of this system, extending from Othello to Cle Elum, as shown in the accompanying illustration.

By the first part of the year 1920, it is expected to "open up" the *electrified* section of the road from Cle Elum to Seattle, or about 130 miles. This will then give a completely *electrified* trunk line for a distance of about 680 miles. As becomes evident, this leaves a gap of non-electrified or steam operated trunk line, extending from Avery to Othello, approximately 220 miles, which for the present will be operated with steam driven locomotives. However, a grand scheme of electrification has been mapt out by the engineers of the C. M. & St. P. system, for the complete electrification of the entire trunk line between Harlowton, Montana, and the Pacific coast, that is, Seattle and Tacoma, which will give a total electrified route of about 900 miles; this means one way direct trunk line mileage and does not include auxiliary trackage such as spurs, switches, yard tracks, etc., which would make a total of about 1000 miles of electrified track. When the complete electrification is effected within a year or two, when railroad matters have become more stabilized than they are at present, due to the government operation of railroads which has markedly curtailed the gigantic improvements which would have taken place otherwise, this system will have succeeded in electrifying within 200 miles, one-half of the entire mileage of the St. Paul-Seattle line.

It would be considered a wonderful feat of electric railway engineering, even if this great length of trackage had been electrified or was about to be electrified, over a stretch of *level country,* but one glance at the profile view on the opposite page showing the severe grades met with in climbing the stiff mountain ranges, will give some slight idea of the titanic task encountered in the "engineering" of this vast 20th century development.

Previously steam locomotives, the largest ever built, puffed and snorted painfully over these mountain trails. In the winter time, when snow and ice descended in the passes to depths of 15 to 20 feet, and the mercury in the thermometer slipt out of sight, the only thing the steam engines could do was to stand fast on the track and freeze up, so severe were the winter-time operarting conditions; this was often the actual experience of the C. M. & St. Paul Railway. It has happened many times since this system has been operating with electric locomotives, that one of these "electric steeds of the rail" has been sent out to haul in a disabled and frozen up steam engine.

In the accompanying illustration several interesting comparisons, of steam and electrified railroad systems, are vividly depicted. The two locomotives, one electric, and the other steam-driven, here illustrated, tell the story of the wonderful advance in railroading over the vast stretches of our western plains and mountains from the year 1848, when the first steam engine, "Bob Ellis", here shown, proudly hauled the first train of cars over Wisconsin rails, up to the present day, when the gigantic electric locomotive here shown, swings up and over the precipitous mountain paths and on to the coast, 850 miles thru America's most gorgeous scenery.

The electric power for operating this electrified railroad system, is derived from vast water-power developments, which have been brought to their present stage of efficiency by the Montana Power Company. The electrical power supply utilized in operating the 440 miles of electrified trunk line, between Harlowton and Avery, and the 160 miles of electrified spur and yard trackage in Montana, is obtained from the hydro-electric power plants of the Montana Power Co., whose main plant is located at Great Falls, Montana. The electric power for operating trains over the Cascade district will be obtained from hydro-electric developments at Long Lake, Snoqualmie Falls and possibly Priest Rapids on the Columbia River. The electric current from the water-power generating stations is delivered in the form of 100,000 volt alternating current. With this high potential the tremendous losses are brought to a very low minimum, and electric power may be transmitted for a great distance, even 200 miles or more, when necessary. The electric power for operating the mountain district for example, is delivered at 100,000 volts potential over transmission wires strung along the route on steel towers and is distributed along the way to 14 *sub-stations.* The purpose of these sub-stations is to pass the 100,000 volt ultra-high potential alternating current into transformers and thence into rotary transformers, which convert it to a much lower tension direct current, or one having a potential of but 3,000 volts; as but 1,800 to 2,000 volts is required to kill a man in the electric chair, it may readily be judged what a tremendous potential 100,000 volts really is! The substations thus perform two important functions—they transform the 100,000 volt current down to one of 3,000 volts, which can be more safely used in operating the motors on the locomotive, and besides—they change the alternating current to a direct or a continuous one.

The alternating current pulsates or rather alternates from positive to negative about 120 times per second, while the direct or continuous current passes in the same direction continuously, i.e., one wire is *positive* and the other *negative* all the time, while with alternating current, such as used in the main 100,000 volt transmission lines, the wires become charged positive and negative, alternately, 120 times per second. Motor-generators are used in each substation, the stept-down alternating current from the transformers operating an A. C. motor, which motor is connected directly on the same shaft with two direct current, 3,000 volt generators. The two D. C. generators are connected in series and deliver 3,000 volts D. C. to the over-head trolley wires from which the electric giants of the rail derive their power; not thru the ordinary trolley pole, but by means of a very elaborate trolley contactor known as the *pantagraph trolley.* The advantage of this trolley contactor is that on curves and also on high speeds for straight runs, there is only a slight probability of the trolley losing contact with the wire. The ordinary city or suburban trolleys use but 550 volts D. C.

ELECTRIC EQUIPMENT.

Under normal conditions, forty-two powerful electrical locomotives are required to haul freight and passenger trains over the electrified mountain districts of the Chicago, Milwaukee & St. Paul Railway. These locomotives each cost approximately $112,000; they weigh 284 tons each and will haul 3,200-ton loads, trailing up a 1 per cent. grade at an average speed of sixteen miles an hour. Similar electric locomotives, geared for greater speed, will haul 800-ton passenger trains over the same stretch at a speed of sixty miles per hour. To appreciate the immense tractive power of these electrical "Goliaths" one should know that the wood-burning locomotive of fifty years ago weighed twenty tons and had a tractive power of only 5,000 pounds! The present-day big Mallet steam locomotive has a tractive power of 76,200 pounds and the electrical locomotive, weighing 284 tons, has a tractive power of 85,000 pounds. These electrical locomotives are 112 feet, 8 inches long, and are driven by separate motors, twin geared to each of eight pairs of driving wheels. The cab extends nearly the whole length of the locomotive.

REGENERATIVE BRAKING.

Regenerative braking applies to a method used on down grades, by which the train, instead of consuming electricity, actually *produces* it while traveling onward, and by which, at the same time, the speed of the train is kept under perfect control.

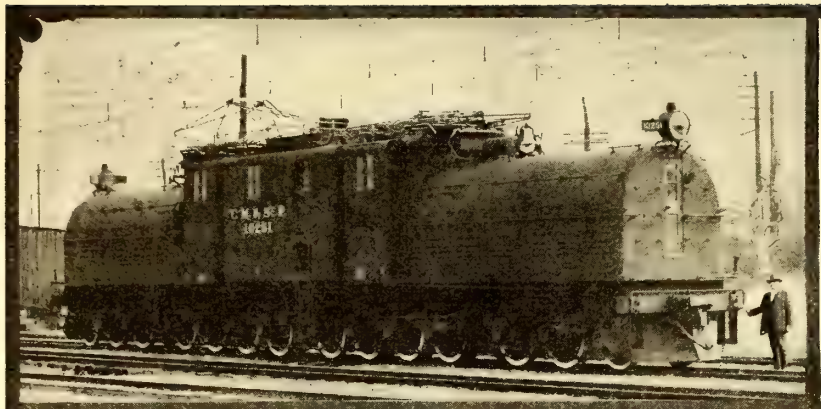
This is the first use ever made of direct current regenerative braking, and the following from an authority on the subject explains its functions:

"Electric motors are reversible in their function, namely; while they absorb electrical energy and give out mechanical energy going up grades, they can reverse this operation and absorb the mechanical energy given the train down grade by gravity, and transfer it into electrical energy. Thus the electric locomotive provides a perfect braking system, which is independent and separate from the air brakes, which are used only in emergency and for stopping trains. Electric energy so generated can be turned into the trolley wire to assist other trains and reduce the amount of purchased electric current."

In actual operation, at the crest of the grade, the helper locomotive is brought to the front of the train and coupled with the forward locomotive, both being operated as one. The train is then controlled on the down grade by regenerative braking.

This system of braking provides maximum safety, eliminates wheel, brake-shoe and track wear and overheating; insures uniform speed on down grades, and re-

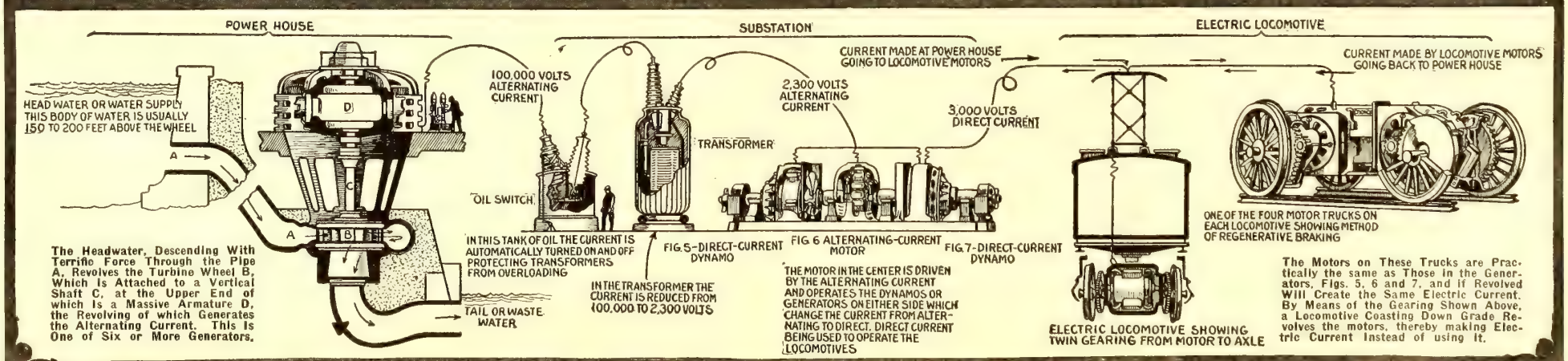
(*Continued on page* 931)



The Greatest Railroad Electrification in the World—The Chicago, Milwaukee and St. Paul System. When Completed, this Electrified Route Will Total Nearly 900 Miles. The World's Mightiest Locomotive, Propelled by Electricity, Appears at the Left—Compare It With "Bob Ellis," at Right, the First Steam Engine to turn a wheel in Wisconsin. Note the Size of the Man in Each Photo. "Bob Ellis" Weighed 46,000 Lbs., While the Electric Goliath of the Rails Tips the Beam at 568,000 Lbs. As the Tractive or Pulling Power Is Proportional to the Weight on the Driving Wheels, the Power of the Latter Is at Once Apparent.







The Headwater, Descending With Terrific Force Through the Pipe A, Revolves the Turbine Wheel B, Which Is Attached to a Vertical Shaft C, at the Upper End of which Is a Massive Armature D, the Revolving of which Generates the Alternating Current. This Is One of Six or More Generators.

The Motors on These Trucks are Practically the same as Those in the Generators, Figs. 5, 6 and 7, and if Revolved Will Create the Same Electric Current. By Means of the Gearing Shown Above, a Locomotive Coasting Down Grade Revolves the motors, thereby making Electric Current Instead of using It.

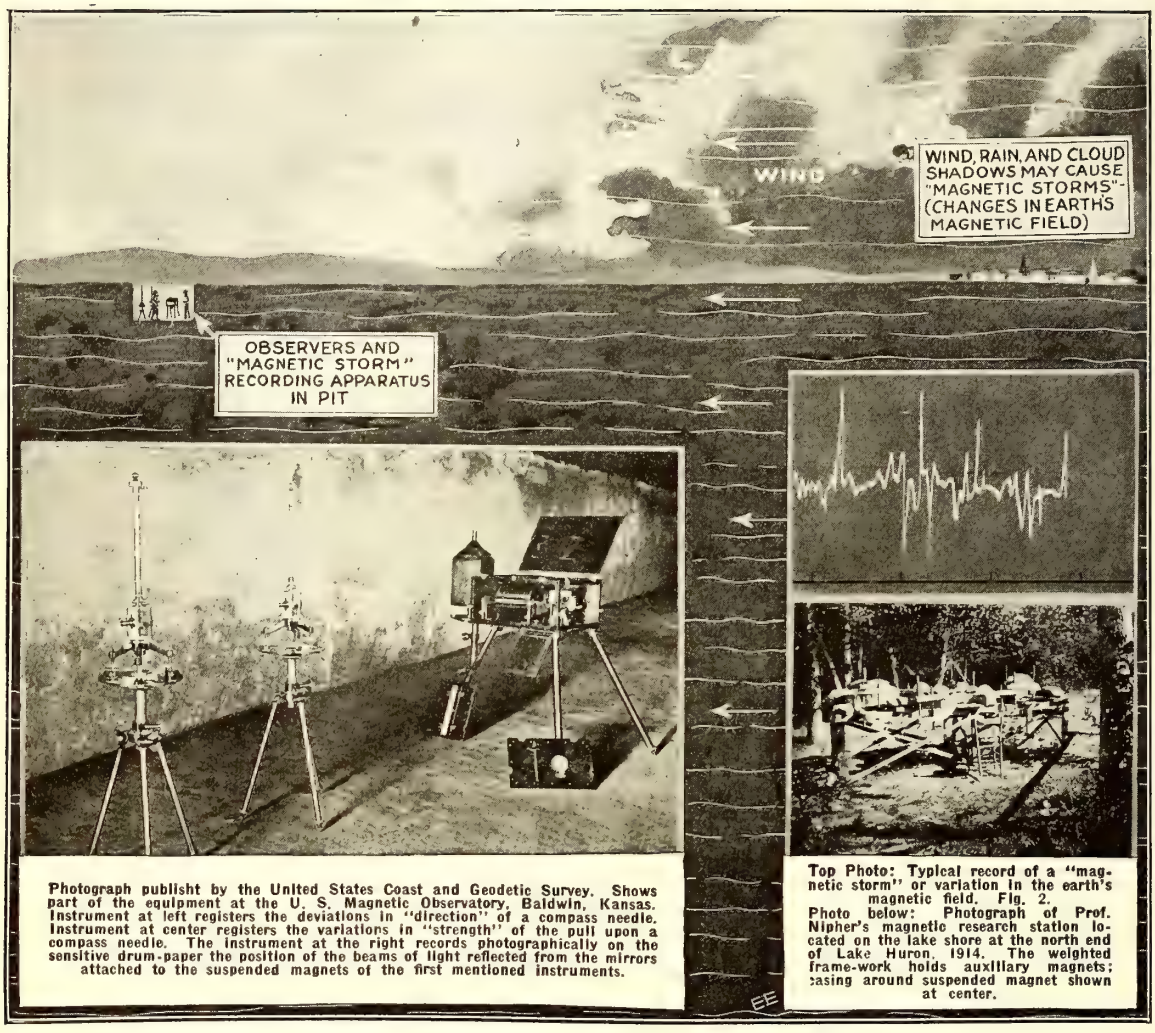
SERIES OF VIEWS SHOWING THE MANNER IN WHICH WATER POWER TRANSFORMED INTO ELECTRIC POWER OPERATES "THE KING OF THE RAILS"

Magnetic Storms

By LINDLEY PYLE

Professor of Physics, Washington University, St. Louis, Mo.

How Sun Spots, Rain, Wind and Cloud Shadows Affect Earth's Magnetic Force



Photograph publisht by the United States Coast and Geodetic Survey. Shows part of the equipment at the U. S. Magnetic Observatory, Baldwin, Kansas. Instrument at left registers the deviations in "direction" of a compass needle. Instrument at center registers the variations in "strength" of the pull upon a compass needle. The instrument at the right records photographically on the sensitive drum-paper the position of the beams of light reflected from the mirrors attached to the suspended magnets of the first mentioned instruments.

Top Photo: Typical record of a "magnetic storm" or variation in the earth's magnetic field. Fig. 2. Photo below: Photograph of Prof. Nipher's magnetic research station located on the lake shore at the north end of Lake Huron, 1914. The weighted frame-work holds auxiliary magnets; casing around suspended magnet shown at center.

MAN is so constituted that his organism is sensitive to certain types of energy transmission and insensitive to others. Our bodies are able to detect changes in temperature, changes in wind velocity, changes in humidity, changes in intensity of a light source, and our thermometers, anemometers, hygrometers and photometers are devised to measure these things. Our bodies are insensitive to the slow and continuous changes in atmospheric pressure as indicated by our barometers and barographs, tho we do respond to quick changes in pressure such as we experience in the rapid ascent or descent of elevators in skyscrapers. But there are cases where only our inanimate instruments are able to detect the presence of some physical agents and variations therein.

One of the most notable cases is that of the magnetic field,—a man can thrust his hand into the airgap of a powerful electromagnet and experience no sensation whatever. Of course when the body, which is an electrical conductor, is placed in a varying magnetic field there must be induced electrical currents set up in the tissues. Some experimenters have claimed to have detected the effects of these currents as set up by very powerful alternating magnetic fields, but the question may still be considered an open one. However, we are on sure ground when we state that the human organism is not directly aware of the magnetic field of the earth, and without the aid of special apparatus would be as unaware of it as if it were absolutely non-existent. But the *compass needle* furnishes irrefutable evidence of the presence of this mysterious ether phenomenon.

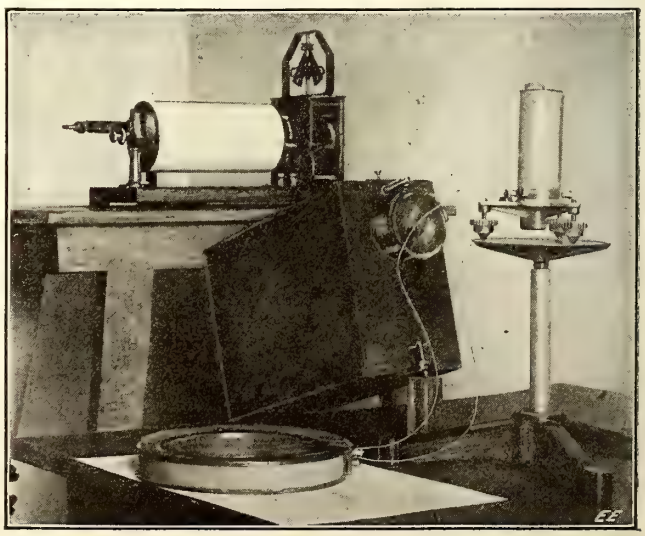
At any chosen geographical location close observation shows that the compass needle undergoes continuous fluctuations corresponding to changes in direction and strength of the earth's magnetic field. These changes may be clast as (I) Regular Fluctuations, and (II) Irregular Fluctuations. The first-named may be grouped under three principal subheads: (a) Secular, (b) Diurnal, and (c) Annual. The secular change has been known since 1634 and is a slow progressive change with lapse of time. The diurnal change is one that has a daily cycle or period and is repeated day after day. It was discovered in 1722 and is no doubt related to the ionizing action of sunlight upon the atmosphere. The annual change is likewise a recurring change, but is repeated every year. It is a small variation and is without doubt due to forces situated outside the earth.

The present paper deals primarily with the Irregular Fluctuations, commonly termed "Magnetic Storms." These are small, irregular fluctuations which may be especially marked for a duration of a few seconds, a few hours, or even for several days.

MAGNETIC STORMS CAUSED BY WIND, RAIN, CLOUD SHADOWS AND SUN SPOTS.

Just as a rain storm may be a purely local affair or may cover half a continent, so may a magnetic storm be purely local in origin or world wide in scope. In November, 1882, near the period of maximum *sun spots*, a magnetic storm occurred at the same moment over the entire earth. Such disturbances are usually accompanied by *auroral*

(*Continued on page* 920)



Electrical Apparatus Devised by the Writer of the Present Article for Recording the Effect of "Magnetic Storms" or Fluctuations in the Earth's Magnetic Field. See Also Fig. 1-A for Connections.



The Above Views Show the Large Men's Swimming Pool at the Hotel Pennsylvania, New York City. At the Left, and Also in the Center at the Right-Hand View, May be Seen the Tile-Covered Water Purifying Apparatus, the Ultra-Violet Ray Tubes of Which Sterilize All the Water in the Swimming Tank Continuously. Electrically Operated Ultra-Violet Ray Tubes Accomplish This Result.

Swimming Pool Purified by Electric Rays

By JOSEPH H. KRAUS

OF the thousands of people who frequent swimming pools every year, how many realize the fact that such bodies of water, both indoors and outdoors, are polluted with germs and bacteria of all kinds? A bacteriologist can at any time secure water from such a pool and upon making a germ culture, will find it filled with the bacteria of various diseases such as influenza, typhoid, enteritis, diptheria, Asiatic cholera, peritonitis, tetanus, etc., and seldom do people believe that they have obtained the disease from polluted waters, preferring to accuse any other source than to think of the possibility of "catching something" from an innocent-looking swimming pool.

One hotel management in New York has shown foresight enough to know that such is actually the case, and that disease germs do breed and lurk in the water of pools; even drinking water being full of the germs mentioned, and various other lesser cultures, too numerous to mention. Therefore, instead of using the water directly from the main pipes, they installed an *ultra-violet ray* sterilizing apparatus which completely sterilizes the water, so that the most exacting cultures of the water taken from the pool show a complete absence of all germs, fungi, and other poisons.

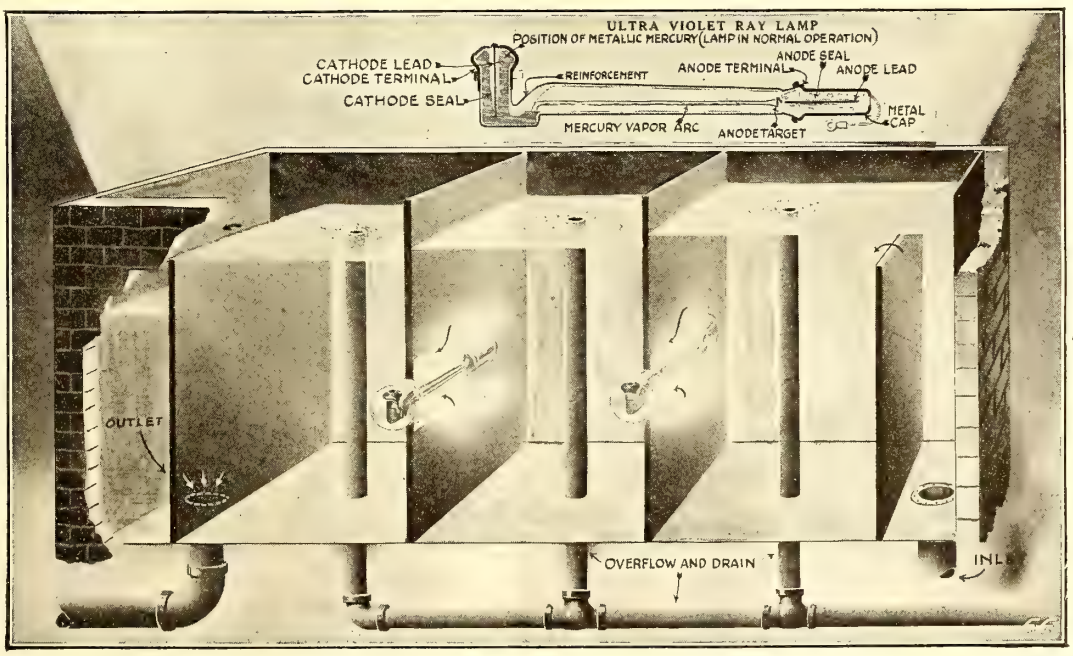
How Ultra-Violet Rays Sterilize Swimming Pool Water

This sterilizer consists essentially of a container thru which water is past, this apparatus being connected with the intake and exhaust water pipes, and a special type of electric lamp using 220 volts, which generates powerful ultra violet rays. These rays are generated and radiated thru a quartz tube surrounding a mercury vapor arc, as shown in the accompanying illustration.

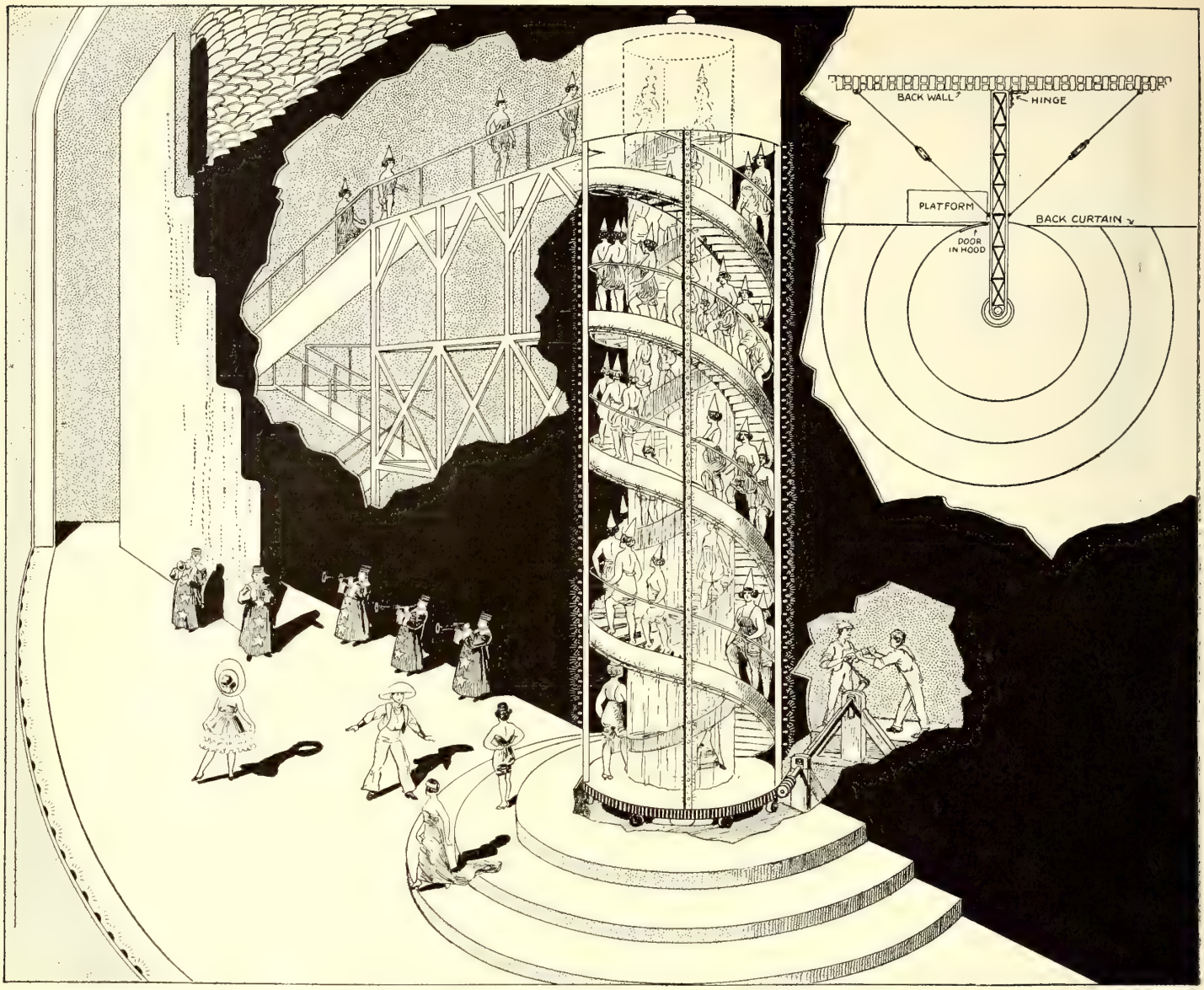
Strange as it may seem, ultra violet rays have the peculiar property of a complete bactericidal agent, and pathogenic germs, in fact all germs and fungi are completely destroyed by their action. These lamps were developed by Peter Cooper Hewitt in part; that is, he developed the mercury vapor arc and De Mare has first used it for water sterilization. This hotel uses 220 volts direct current for the operation of these lamps.

Ultra violet rays, altho invisible and intangible, are easily produced in very large quantities by quartz glass mercury vapor lamps. When started, the lamp is tilted, which breaks the mercury bridge and the arc is struck, whereupon the mercury is vaporized and the current passes thru the hot vapor, thus maintaining the arc. Not only is this method economy in itself, but it opens up a new branch of swimming pool water sterilization, inasmuch as by using proper filtering and circulating apparatus very good and sanitary water can be supplied indefinitely, as at the Hotel Pennsylvania in New York City. We do not mean to say that this hotel uses the same water indefinitely, but just cite this as an example showing that the same water could be used over and over again. The saying "that we swim in purer water than you drink at home" is quite correct. This apparatus also renders a pleasing atmosphere to the swimmers in the cool, inviting waters.

(*Continued on page* 939)



Sectional View Thru Ultra-Violet Ray Lamp Chamber With Partitions, Showing How the Water From the Swimming Pool Passes From the Inlet Pipe Thru the Successive Compartments, Where the Water Is Acted Upon and All Germs Killed by the Powerful Ultra-Violet Rays.



General View of the Capitol Theater Stage, New York City, Showing the Revolving Tower Effect Used. This Is Filled with Chorus Girls, Both Inside and Out, When It Is in "Full Bloom." Electric Lights Are Used to Outline the Tower Structure. While One Line of Girls Ascend the Second Line is Descending, Producing a Beautiful and Entrancing Spectacle. The Capitol Theater Is the Largest in the World.

The World's Largest Theater

A BEAUTIFUL, new theater was recently opened in New York, which not only dwarfed picture palaces that now flank Broadway, but also out-ranks the theaters of the world. This particular assertion not only embraces the so-called legitimate theaters, but also the celebrated opera houses of the globe, including the far-famed and gorgeous *La Scala* at Milan, Italy.

This new theater, the "Capitol," is remarkable not only for its size, but in its location on one of the most valuable sites in creation, a $3,000,000 plot, and in its unique combination of pictures and other forms of entertainment. It extends 109 feet on Broadway, 269 feet on 51st St., and thence 200 feet south to 50th St., where the stage is located. This feature in itself requires a frontage of 157 ft.

The theater presents an unbroken front of conventional, monumental design, ornamented by a solid row of pilasters, seventeen in number, the longest line adornment in similar New York buildings. The auditorium is 175 feet wide and extends south towards the stage, a stretch of 159 feet. Its orchestra floor seats 2,750, and its balcony seats approximately the same number; or a total seating capacity of 5,300. The balcony is guiltless of the presence of a single supporting column, due thru the application of the most modern *Cantilever* building construction.

THE CAPITOL THEATER SHOW

The entertainment at this theater is unique and marvelous in that the manager has attempted to combine both "folly" novelties and high-class "motion pictures." The scene depicted in the photographs is from the closing scene of the "Ned Wayburn Review." The feature scenic effect is a remarkable revolving tower filled with girls.

This tower is shifted into position on a set of tracks from its resting place back stage, being mounted on a carriage which is mounted on wheels, so that its movement forward may be accomplished in the least possible time and with the minimum of labor.

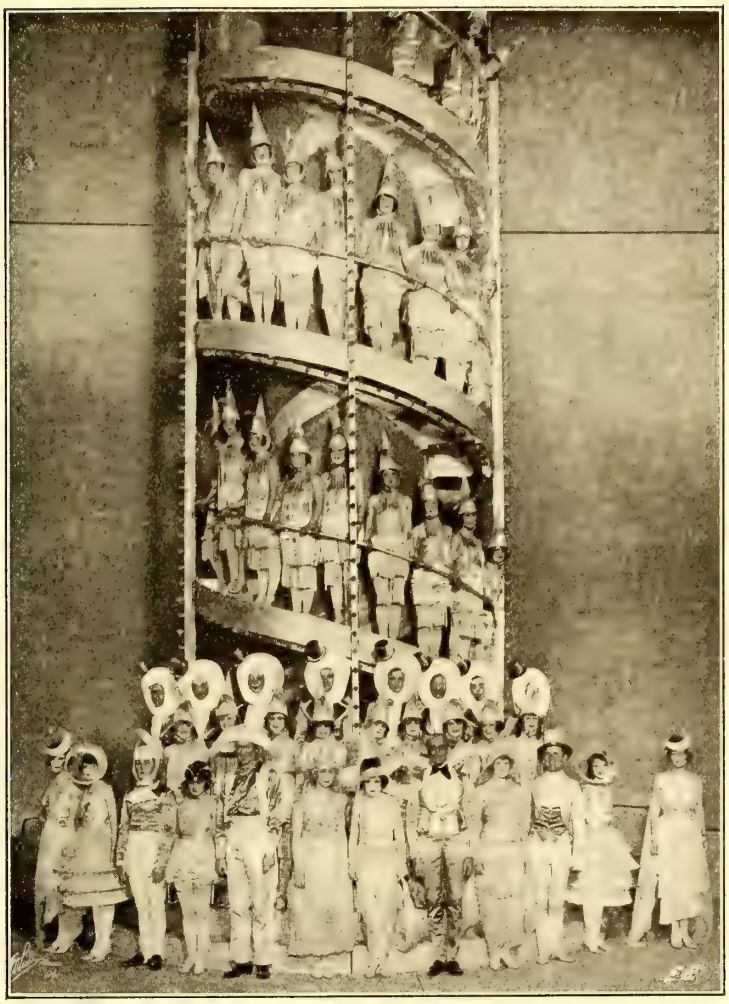
When thus shifted forward, a semi-circular stairway is placed around the base of the tower, hiding its mechanism and covering the electric cables leading to it for the lighting purposes. A large iron beam swings forward and locks the tower so that it cannot topple over or sway.

The tower itself is mounted on a large wheel supported by roller bearings. Two stairways lead upward in such a manner that one spirals to the left and the outer to the right. The inner stairway is covered by very fine gauze, which makes it invisible ordinarily. The rotating mechanism of the tower consists of a worm-gear drive which is rotated by two men in back of the drop or back scene.

Now, for the effect! A stairway--likewise collapsible, so that it may be moved out of the way when not in use—connects to the top of the tower, but the means of

approach to the tower is hidden; a sliding trap door communicating directly with a door in the tower. The chorus girls, hidden from view, suddenly are seen to descend on the outer spiral and arrange themselves in artistic, graceful groups upon the platform of the tower itself and the stage. After a short period of entertaining they are seen to ascend the spiral stairway to the top and seemingly to disappear, while in reality they descend again on the inner stairway. Suddenly, the lights illuminating the inner spiral are flashed on the tower, being made to revolve at the same time. This causes the girls behind the gauze-veiled inner stairway to be seen as tho in a mist. They descend constantly, while those on the outer are ascending, thanks to communicating platforms between the stairways at both top and bottom, so that an endless stream of actors and actresses form a spectacular and bewildering maze.

The illustration shows clearly the arrangement of the tower and its methods of communicating at the top and bottom chambers, likewise the carriage and the rotative means. The insert view shows the top dome with its sliding trap door and the communication means between the two stairways; likewise the beam holding the tower rigidly in place. Two steel cables clamped to this beam are tightened by means of turnbuckles acting, in this way, as braces and minimize any lateral swinging tendency which the tower and its beauties may experience.



The Revolving Tower Filled with Chorus Girls from the Ned Wayburn Review at the Capitol Theater.

Immediately below the base are three commutators which supply current for the illumination of the tower. Large brushes make contact with the cummutators, each of which is directly connected to a very heavy rubber covered cable, running to its supply base, the switchboard back stage.

The switchboard itself is a beauteous marvel of simplicity. It is capable of producing not only ordinary actual work, but intense serviceability under unusual conditions. Its panels of the unit type are constructed so that they may be removed separately for any necessary repairs. From this switchboard, a variety of current may be obtained and methods for inserting plugs to draw any voltage of any form from it are found to conform with both the fire underwriters' laws, and laws, if such there are, for preventing any serious accident to those directly responsible for the electrical side of the show as there is no way of coming in contact with a live circuit, all the switches being entirely concealed. From the switchboard, 110 volts alternating or direct current may be obtained. Likewise, 220 volts in both forms. Elaborate rheostats and regulators allow a gradation of current value which alone is capable of producing most wonderful stupendous effects which any stage setting or any play may necessitate.

Fourteen or more projectors with variable color filters enable a diffusion of light in all its color values to be directed in streams upon the stage and actors.

The Locomotive Periscope: Next!

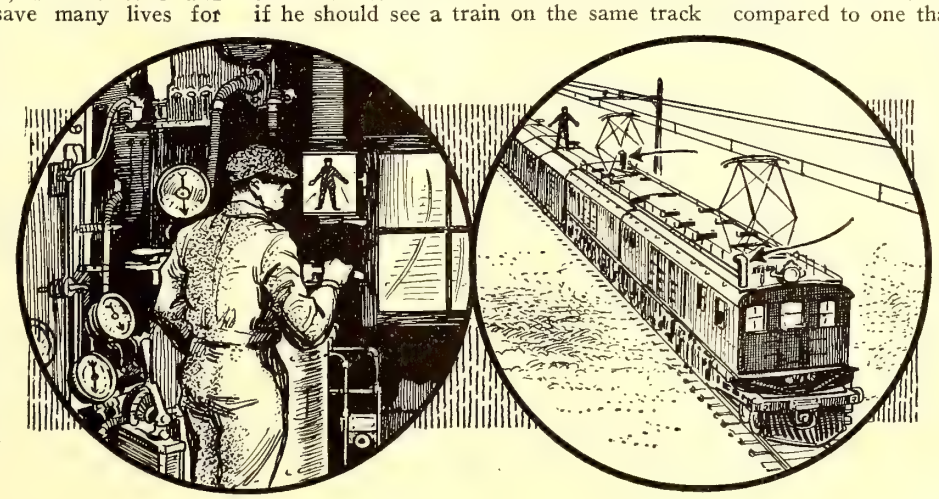
By GEORGE WALL

NOW that the war has shown us what an invaluable instrument the modern periscope really is, even to the extent that thousands of our brave soldiers in the trenches in many instances owed their very lives to the efficiency of the trench periscope for looking over the parapet without exposing their heads or bodies, we are not surprised perhaps to see the periscope adapted to the requirements of modern railroading. Why not use the periscope on locomotives, both electric and steam? It should save many lives for more reasons than one. Its use should certainly prevent many heretofore unavoidable occurrences such as rear-end collisions, etc.

The periscope for locomotives employs a large mirror, so that the engineer need not focus his gaze accurately on a small eyepiece, as in the submarine periscope, for this would hardly do owing to the many duties constantly thrust upon him. The accompanying illustrations show the periscope in use on an electric locomotive and two of them are here employed, as the electric locomotive, unlike its steam-driven prototype, is liable to run in either directions, for it is reversible.

For one thing, the locomotive periscope will enable the engineer to see at all times any signals from the rear of a long freight train, such as the swinging arm signals, or swinging lantern signals, given by brakemen atop the cars, and he also can see the track far to the rear. This means that if he should see a train on the same track approaching at a dangerous speed, that he can speed up his own train, so as to minimize the effect of a rear-end collision, if such really is to occur at all.

We have often heard of railroad engineers racing their trains so that the runaway train on the same track behind, either cannot catch up with him, or else if it did, and in view of the fact that his own train was traveling at a speed approximating that of the pursuing train, that any collision between them would be very slight, compared to one that might occur between the stationary or slow-moving train and the rapidly-moving train at the rear. No one can look in two directions at the same time ordinarily, but thanks to the locomotive periscope, the engineer of tomorrow will be better off so to speak, for after a little practice, he can keep a sight ahead as well as behind, by simply glancing periodically and regularly at the periscope beside him.



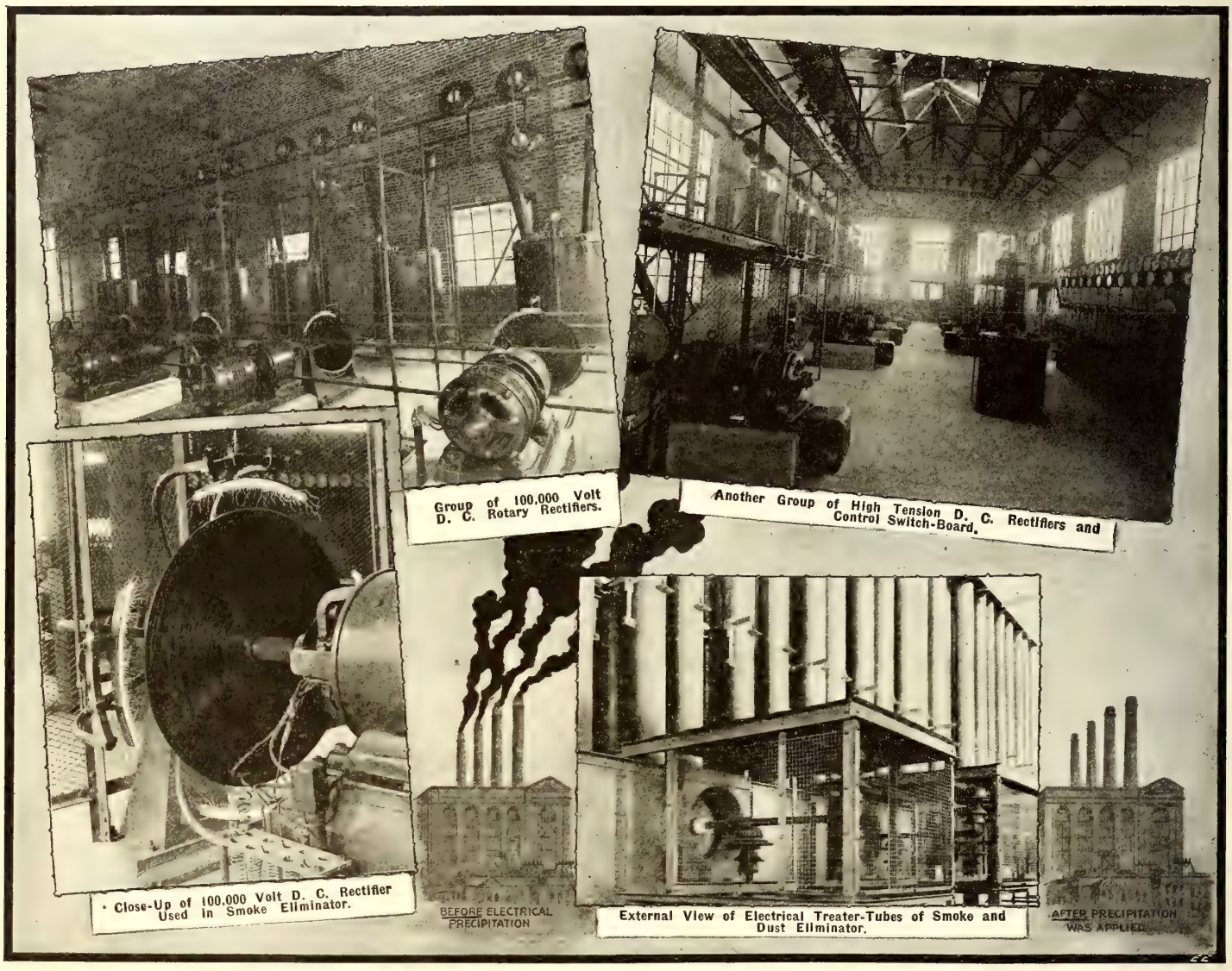
Abolishing Smoke Electrically

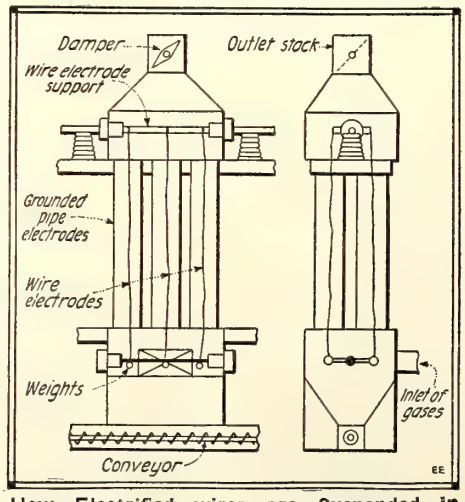
How Thousands of Dollars Are Reclaimed by Smelting Companies

THE dust and fumes which are discharged from the stacks of iron furnaces, cement mills, and many other industrial enterprises, not only represent a waste of valuable material but also frequently constitute a nuisance. In the interests of economic conservation it is desirable to eliminate the loss of material represented by this dust, and for civic or legal reasons it is often necessary to suppress the nuisance caused by its discharge into the atmosphere. Such cities as Pittsburgh for instance have long been known for their smoky and objectionable atmosphere.

While there are several mechanical and chemical methods for collecting or suppressing dust in furnace and kiln operation, they are in general limited in application by conditions of temperature, acidity, and similar qualities of the product to be handled. Electrical precipitation has few limitations of this sort and is generally applicable for collecting suspended solid and liquid particles of every description, whether acid or alkaline, from gases of widely varying temperature. The electrical method is simple, economical and effective, and has been successfully operated in a great number of plants of various kinds.

A visitor to one of these plants is easily convinced of the practicability of the process. He need only stand where he can watch the stacks leading from the *treater*, while some one opens and closes the treating circuit. *When the current is "off," the familiar clouds of smoke pour out; but when the current is "on," the smoke vanishes, and nothing but a fine vapor can be seen.* Final proof of the effectiveness of the operation is provided by the carloads of precipitated dust taken out of the collecting bins.





How Electrified wires are Suspended in Pipes Thru Which Dust Laden Gases Are Past

USES OF ELECTRICAL PRECIPITATION

Electrical precipitation processes are now being used successfully in lead and copper smelters to reduce metal losses from the stacks and to eliminate smoke nuisances; in cement plants to collect potash and cement dust; in acid plants to recover acid fumes; and in rock crushers to suppress the dust nuisance. The process is also being applied to iron blast furnaces to eliminate the ore dust and to recover potash values; to gas plants for removing the dust, tar, and lamp black from the gases; to locomotive roundhouses and power plants, located in centers of population, to remove the soot and cinders from the smoke; and to industrial processes produc-

(*Continued on page* 931)

The Electrical Engineer at Work

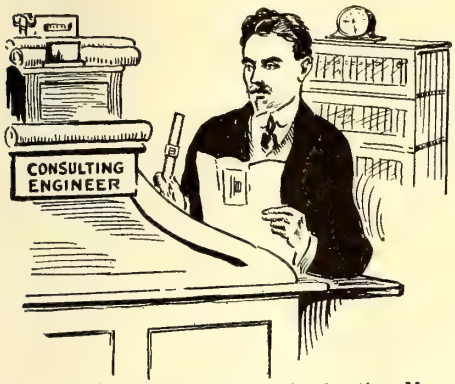
By H. Winfield Secor

THE DAILY WORK OF THE ELECTRICAL ENGINEER

HOW does the electrical engineer work, and of what does his work consist?—is probably a question uppermost in the minds of not only embryo students of electrical engineering, but one which exists in the minds of parents of young men about to choose a career as well. Of course, it is impossible to describe the daily routine or the general work carried on by an engineer to fit any one type of engineer or class of work, as there are so many ramifications of the engineering profession today that it is hard to find two engineers engaged on identically the same work, or who accomplish their work in the same manner, in one engineering office.



A Busy Scene in the Drafting Room of the General Electric Company's Works. Here the First Tangible Outlines of the Engineer's Ideas Are Brought to Life in the Form of Drawings and Blue-Prints.

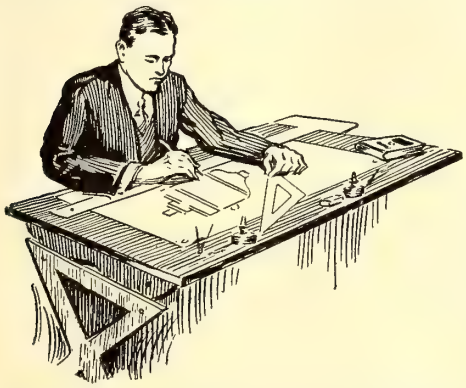


The Consulting Engineer—He Is the Man Who Must Understand the Technical Details of an Electrical and Mechanical Design. He Must Be a Good Mathematician.

Let us consider how the electrical engineer does his work in a typical case and under an organization such as exists in a large manufacturing plant.

THE CONSULTING ENGINEER

The consulting engineer is the man who either conceives the original idea from which a machine or device is to be built, or if he does not originally conceive the idea, he makes the first design from the idea as supplied by someone else in the organization or by a department of the organization, or again, possibly by a patron, who desires to have a certain machine built. Many times the outside patron simply has a hazy idea as to what he wishes to accomplish, but he is firm in his belief that it can be done—and it is, let us say, up to the consulting engineer who stands at the head of the engineering organization of his concern, to work out in his mind and develop the nucleus around which the future device or apparatus is to be built. The consulting engineer is invariably but not always, a college-trained man, and one who is a thoro mathematician. He is an expert with the slide rule and knows his text-books the same as a musician knows his notes and keys. In his early training he has wisely read all the books on the various subjects appertaining to his profession that he could possibly procure, and he has also providentially, in practically all cases, provided himself with a good working library of handbooks and text-books, which will be of real service to him. The carpenter, plumber or machinist works with his tools, and these tools he must have to accomplish any creditable performance of his work. The consulting or electrical engineer works from his hand-books and text-books, in general, coupled with his experience on various designs with which he has come in contact during his career. Right here we may advantageously study the mode of living, for that is really what it amounts to in the final analysis, of the thoroly trained engineer, no matter what line he happens to be engaged in. The carpenter for example, may build a house, or he may even design a building, but the writer has noted from personal experience, that very few carpenters or builders, who may erect such a complex structure, keep any data on the building as to its cost or the different dimensions for future reference, but the engineer, particularly the consulting engineer, will bend every effort conceivable to acquire all empirical data on any machine which he is interested in, and particularly, any machine or device that he has designed, and which has been built from his specifications. This should be so in every case, not only for the engineer; and as aforementioned, the engineer really lives his life in this fashion, and it does not hurt him either, for he grows to be methodical and exact without being taciturn or worrisome. Thus it is that the consulting expert refers to his books and also to catalogs, of which every engineering office has a complete file, in order to determine the dimensions of any stock parts such as wheels, pulleys, bearings, etc., which he may use in laying out the fundamental design of the first machine.

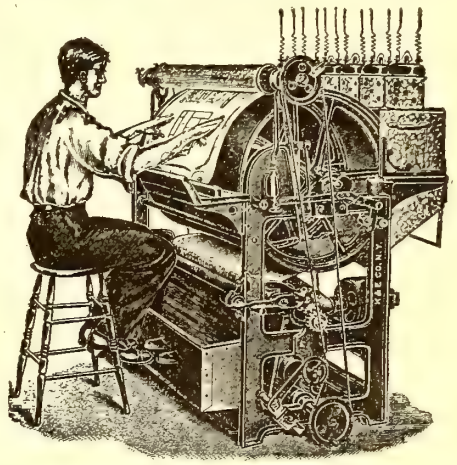


The Draftsman, Whose Work Generally Laps Over Into the Engineering Line More or Less, So That When He Has Had Considerable Experience He Frequently Holds a Position as an Engineer-Draftsman.

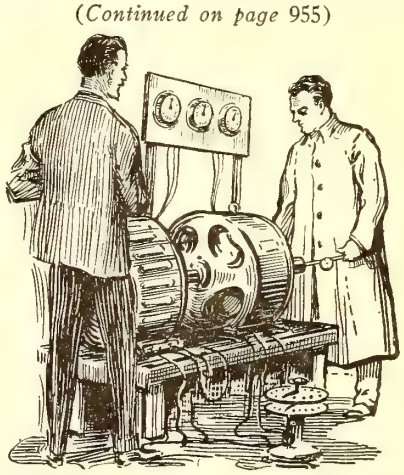
THE ENGINEER-DRAFTSMAN

The rough pencil or pen-and-ink sketches with a few notes on them covering the over-all design and "high lights" which come from the consulting engineer, reach the drafting room, and the chief draftsman, who is invariably a designing engineer of high responsibility and thoroly experienced. Under the head of this Department comes a staff composed of what the layman generally knows as the "draftsmen" and "tracers." But once the erstwhile layman has been initiated into the intricacies of the draftsman's everyday life, he will be surprised indeed, to learn what a mass of detail the draftsman,

(*Continued on page* 955)



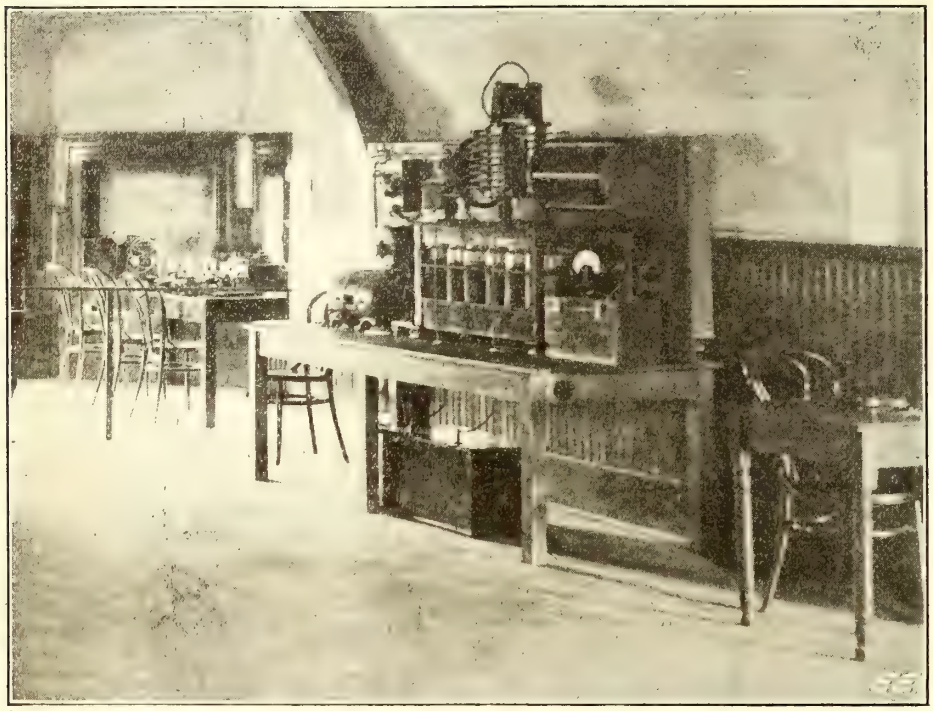
Blue-Printing by a Machine Fitted with Powerful Electric Lights Which Take the Place of Sunlight, Used in the Older Process. The Drawings Are Made on Tracing Cloth.



The Engineer Finds His Happiest Moments When the "Child of His Brain" Has Been Built and Made Ready for Test.

Learning Telegraphy and Radio at School

THIS Radio and Telegraph School, two departments of which are here illustrated, offers both day and evening classes in radio operating in which the instruction has been arranged to qualify the student to pass the U. S. examination and procure a First Grade Commercial Operator's License in the shortest possible time.



A View of the Transmitting Apparatus in the Radio and Telegraph School. Note the Very Simple Construction and Arrangement So That Each Piece of the Station May Be Freely Examined and Explained by the Instructor. The Set Shown Is a Standard Ship Outfit.

By means of a specially built high frequency alternator for code work any number of circuits can be operated at various speeds without any interference with one another. On the high speed circuit each student is assigned to a station with assigned call letters; traffic is then carried on between stations in a manner exactly duplicating actual working conditions "aboard ship". Wireless traffic is given special attention—the student is taught the correct form to use for all classes of messages—a point often overlooked by schools hitherto.

The school is equipt with both transmitting and receiving apparatus; all types of Vacuum Tube detectors, Regenerative and Cascade Amplifiers, etc., which are in daily use, receiving from damped and undamped wave stations at all times for the students' instruction.

To men recently discharged from the army and navy service the school offers a special course of instruction to brush them up for the examination. This can be completed in a very short time and should the student reside outside Chicago the school management offers to assist in procuring employment to enable him to earn living expenses while attending the classes.

As a radio inspector is assigned to this district the student after finishing the course can take the government examination without traveling to some other city.

The evening classes are particularly attractive to the out-of-town student as he can procure employment, pay his tuition on the installment plan and complete the course in a short time with little or no money to start with. This sounds fair.

The school is in close touch with the Marconi Company, the U. S. Naval Communication Service and other commercial wireless interests at all times. Advanced students may arrange for trips to the local U. S. Naval Station or to ship stations.

Morse "Land Wire" Department.

In teaching Morse telegraphy, the work is divided into four courses, each covering the different phases of commercial use.

Morse telegraphy can never be replaced by wireless for the one reason that two ships in the harbor cannot transmit wireless messages at the same time and must wait 'till the others finish while in Morse telegraphy there are probably a hundred thousand messages being transmitted and received simultaneously.

The various courses taught are as follows: Railroad course, which includes Morse Telegraph Code, Train Despatching, Railroad Signals, Railroad Abbreviations, Railway Messages, Accident Reports, Classification of Trains, Time by Telegraph, Train Sheets, Train Schedules, Car Reports, etc.

The Commercial Telegraph Course.

Commercial course is comprised of the following: Morse Telegraph Code, Press Reports, Service Messages, Night Messages, Commercial Messages, Cablegrams, Franked Messages, Weather Reports, Cipher Messages, Abbreviations, Government Messages, Typewriting, and includes everything contained in the Railroad Course.

The Brokerage Course.

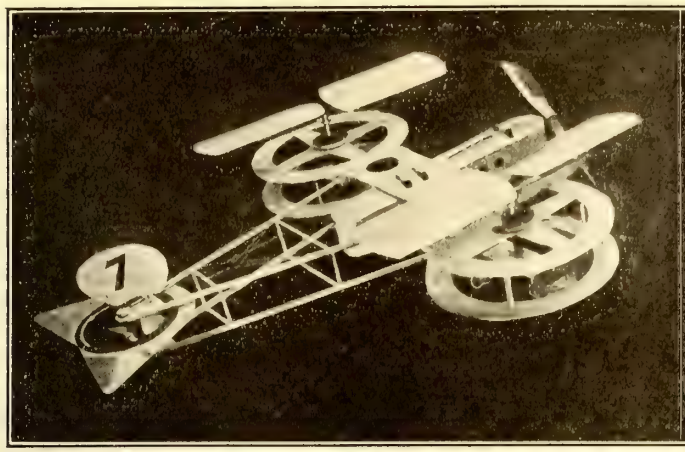
The Brokerage course includes all of the Railroad and Commercial Courses, high speed telegraphy, use of Vibroplex, Phillips Code, marking of quotation board, stock report quotations, C. N. D.'s market reports, grains, provisions, live stock, stock abbreviations and form and methods of handling, buying and selling stock, bonds, grains and provisions. This course is particularly interesting to those who are now high speed commercial operators and should appeal to every man and woman who speculates, regardless to what extent. Having this training, one can trade in a brokers office to greater advantage than one who must depend solely on the quotation board.

Associated Press Course.

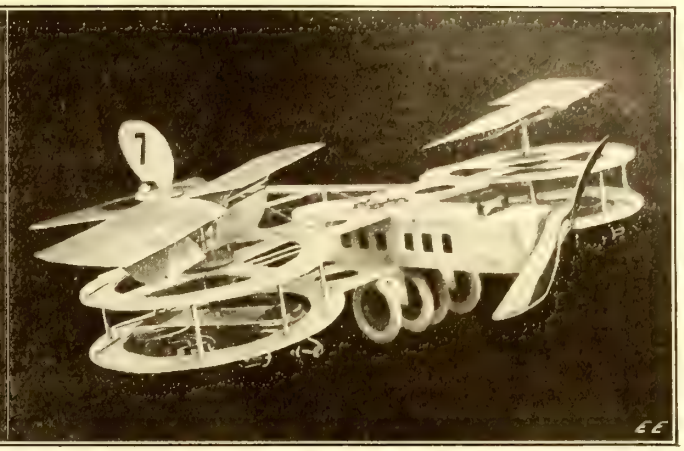
Associated Press course includes all of the three foregoing courses and in addition the necessary geography, history, literary facts, names of public characters, dates of events, which the newspaper man or woman telegrapher must be thoroly conversant with.



A Group of Interested Radio "Bugs" Who Intend Going Into This Game Not Alone as a Mere Hobby, but as a Real Means of Obtaining a Livelihood in an Interesting Profession.



Rear-ward View of the Beach "Helicopter"—Or Vertically Rising Airplane. The Model Flies Successfully.



Perspective View of the Beach "Helicopter"—the Comprest Air Motors Can Be Seen Just Below the Motor Tracks.

A Model Helicopter

By WILLIAM JOHN BEACH, M. E.

THE progress and development of mechanical flight has been so rapid that today we find ourselves almost at the end of our tether with the present type of machine, both from a size and speed point of view, especially in the latter respect. I do not mean to say that we cannot propel a plane faster than at present, but if we do, our difficulty comes in the landing, hence the aeronautical engineers of the world in general agree that there must be a radical departure from the present art, and to me the solution appears to present itself in a *helicopter* or *vertical rising flying machine.*

It may be well at this stage to suggest some of the advantages of such a machine in a perfected and practical stage. Firstly, it would provide for slow landing; secondly, it may rise or land in or on a space scarcely larger than its own dimensions; thirdly, it would be capable of proceeding in a forward direction at variable speeds, which desirable feature cannot be accomplished with the present plane much below 40 miles per hour. Last, but not the least of its advantages, it may *lower* or *poise* (*stand still*) *at any given altitude over any given spot.*

There is hardly a country in the world that has not had its share of inventors and experimenters in this direction, and in the majority of cases the attempts have involved a revolving pitched medium of some kind or other, as suggested as far back and by that very eminent novelist—Jules Verne. The writer, like the very many other experimenters, accept Jules Verne's theory as being correct from an aerodynamical point of view, but attempt to carry it into successful effect in a somewhat different mechanical manner.

The Vertical Rising Airplane

Let us present to ourselves the problem with which we are confronted, which is, *the attempt to lift direct into the air a maximum of weight with a minimum of horsepower.* Patents and data show that in most all cases experimenters have attempted to rotate sufficient uplifting surface from the axis of a motor, to lift direct the weight of the said motor, the necessary structure, pilot and useful load which has been proven repeatedly a mechanical impossibility with any known power plant. The introduction of gears does not in any way overcome the difficulty, but simply adds parasite weight and unnecessary consumption of power. The question which arises is: "Is there not more than one way and the means of employing a minimum of power to lift direct the said maximum of weight?" I consider there is, as will be hereinafter explained.

Assuming that we can successfully lift the said weight direct into the air, we are confronted with many other difficulties in a machine of this character and difficulties that do not perhaps occur except to those who are actual flyers. The balance of a machine designed to rise vertically has to be catered for, both while in vertical ascent and also while in horizontal flight, and special attention must be given in the former instance.

Drift, while attempting to hover, must be taken care of and, above all, experiments have shown me that this type of machine must possess a maximum of inherent stability.

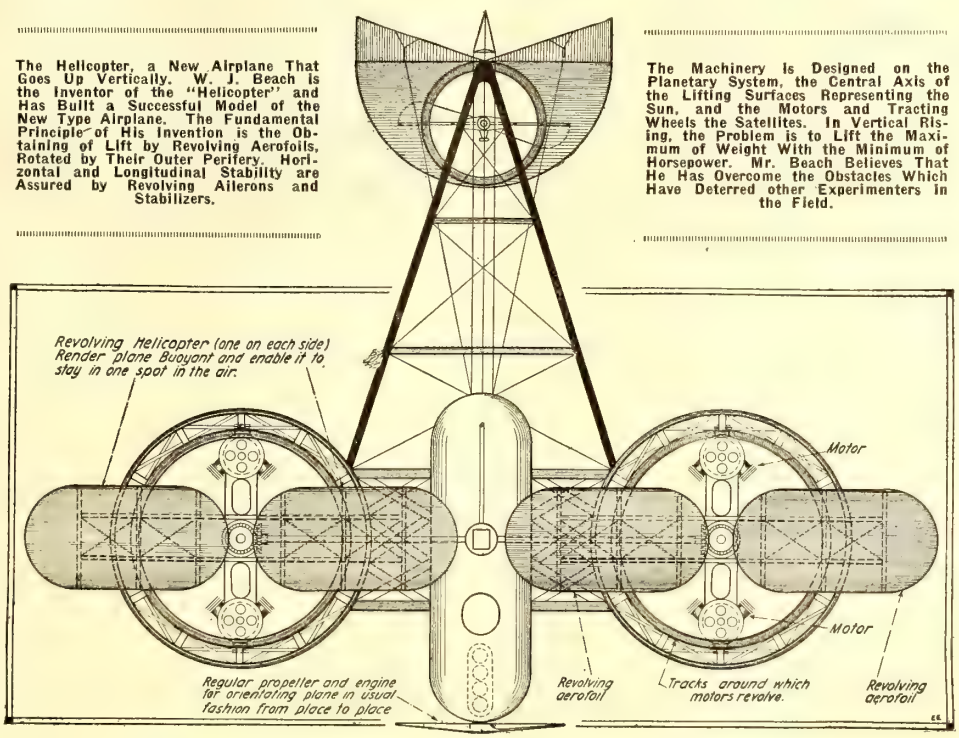
Wing curve and *chamfer* are a study in themselves, for when all is said and done, we are making a huge propeller and propellers are a subject that we know very little about.

Proceeding to explain my theory I do not accept a Helicopter as being a machine confined to one motor or power plant, but believe much to the contrary, as a plurality of motors in all cases means safety, since the motor is the heart of an aerial craft of any description. I further do not accept the theory that to rise *vertically,* an uplifting surface must naturally revolve at high speed; when I say *high speed* I mean airplane propeller speed, for should we attempt to revolve uplifting surfaces at propeller speed we

(*Cont. on p.* 935)

The Helicopter, a New Airplane That Goes Up Vertically. W. J. Beach is the Inventor of the "Helicopter" and Has Built a Successful Model of the New Type Airplane. The Fundamental Principle of His Invention is the Obtaining of Lift by Revolving Aerofoils, Rotated by Their Outer Perifery. Horizontal and Longitudinal Stability are Assured by Revolving Ailerons and Stabilizers.

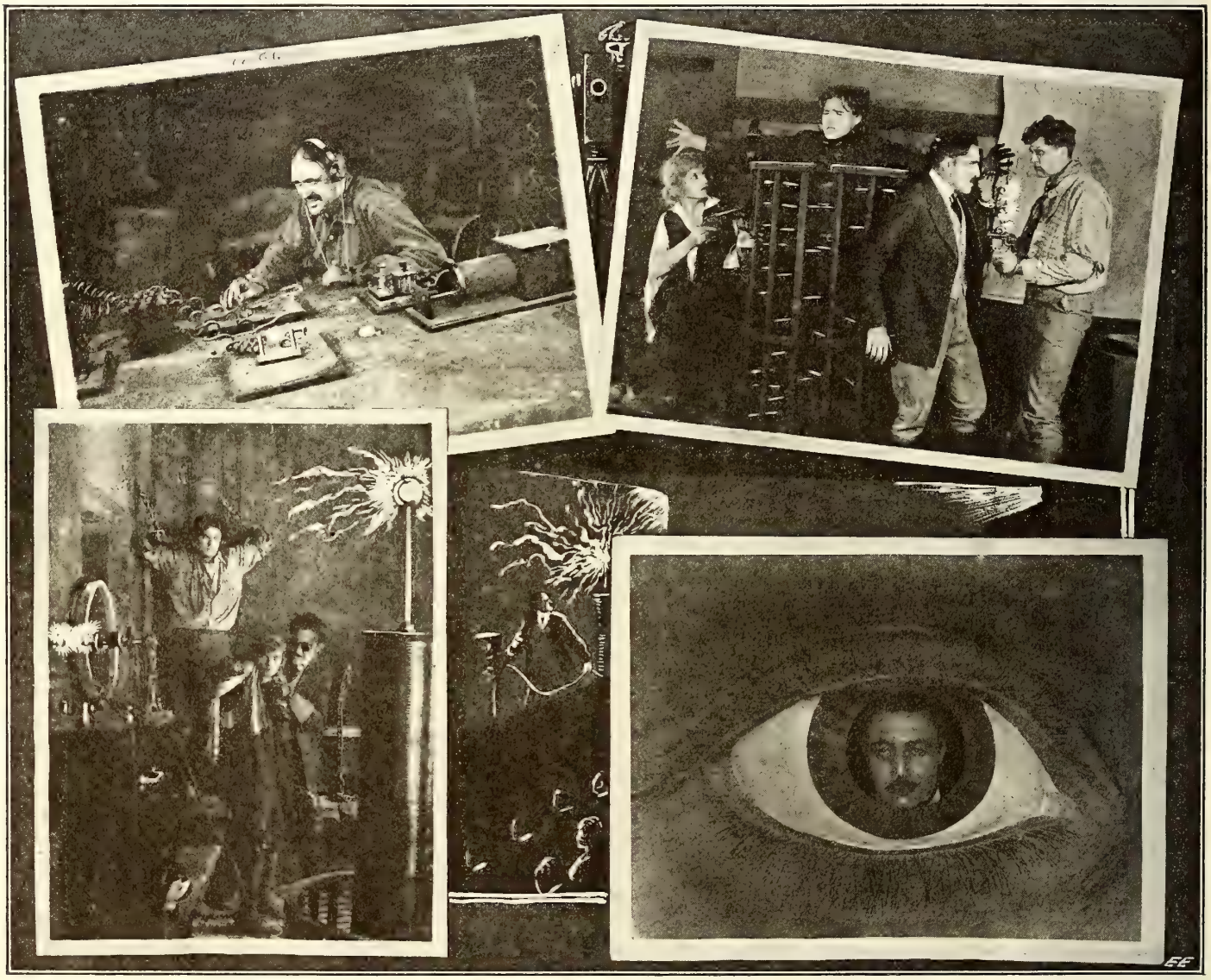
The Machinery is Designed on the Planetary System, the Central Axis of the Lifting Surfaces Representing the Sun, and the Motors and Tracting Wheels the Satellites. In Vertical Rising, the Problem is to Lift the Maximum of Weight With the Minimum of Horsepower. Mr. Beach Believes That He Has Overcome the Obstacles Which Have Deterred other Experimenters in the Field.



Science in Latest Movies

THE upper left and lower right photographs here reproduced are from the Pathé Serial—"The Third Eye." The villain in the photograph to the left is shown with a complete set of wireless instruments in the act of "sending," and the spark is shown leaping across the spark gap. This scene is in the cellar retreat of a gang of crooks whose radio apparatus is supposed to be used for communicating with the master criminal living in his palatial summer home on an island off the coast. He has just been ordered to start across the gap the same as tho he were transmitting. Funny—no, we must allow the movies some freedom, and cannot keep them down to absolutely conventional means of connecting and operating such apparatus.

This play is a mystery story in about eighteen episodes, in which a man is murdered in a moving picture studio. The camera which has been focust to the point mysteriously starts to turn without any visible means and take some movies of the murderer. When the film is developed, staff of a large New York newspaper. A girl had been murdered in New Jersey and he was sent out to get the dope and incidentally happened to be the first to make an examination. A short time prior to this he had read quite a little of the retina retaining an image of the scene or object it last saw, so he promptly photographed it on the murdered person. When the plate was developed, it actually showed an image, but the image was very imperfect and no definite indictment could be obtained on the image alone.



Villains In Order to Be Real (or Reel) Villainish Must Have Nifty Radio Sets. So in the Upper Left Photo They Have Given Him All Sorts of Diabolical Things to Play With, Blow Up Houses, Etc. In the Photograph at Its Right, Is the "Iron Maiden"—Electrified! "Now, Eileen (Lower Left) Don't Get Too Ticklish with the Oudin High Frequency." At the Lower Right, Is Nature's Photograph of a Movie Murderer, Permanently Inscribed on the Retina of His Victim!??

sending a message, which latter will be received at another station and a spark will fly across the gap, as a result, igniting a can of dynamite and completely dismembering the anatomies of the hero and heroine. Of course in the "movies" the apparatus must be arranged so as to get the most pronounced effect, hence the massive coiled wire; which, if used in a modern wireless station, would be laughed at and ridiculed, as the impedance produced by the coils leading to the high tension condenser would cause unnecessary losses. To watch a movie man receiving a message, one sees the spark crashing

it is found that the hero is indicted for the murder, according to the "circumstantial evidence" produced by the developed film; but was he the murderer? Of course no hero could be.

In the lower right picture the author has made use of the theory that the retina of a dead man's eye retains for some time after death, an image of the last thing it saw in life.

In corroboration of this, Mr. Lewis, the publicity manager of Pathé films, cited a case of his own experience which occurred before he entered the "movie" game, at which time he was acting on the editorial

The lower left and upper right photographs are taken from the Universal feature—"The Great Radium Mystery"—in which a one-gram tube of radium valued at $120,000 is actually being used. The entire play is based on the fact that a radium mine in Montana is discovered by two brothers and they had either mined or manufactured radium in such quantities that the whole manner of living and the history of the entire world would be changed at one single stroke, and new living conditions be thrust upon humanity over-night. Hence,

(*Continued on page* 961)

AMBRINE FOR ELECTRIC AND X-RAY BURNS.

Ambrine is the discovery of Dr. Barthe de Sandfort, a surgeon in the French navy. He believed, as most other surgeons believed, that open surface wounds should be treated with a dressing which would exclude all air and which could be removed without disturbing the newly formed epithelium. Ambrine is the wonderful preparation used with such success during the war to heal the burns from "liquid fire" attacks.

Ambrine is a neutral paraffin and resin compound, which is prepared according to a secret formula. On account of its organic composition, it is impossible to analyze.

The equipment comprises one fine varnish brush, or preferably a paraffin base atomizer; one double boiler; one electric drier; absorbent cotton divided into very thin layers.

When the patient enters the hospital, the clothing is removed; blebs are punctured, but not excised; and the entire area is thoroly dried with an electric hot air drier, or a fan, so that there is no moisture on the surface (an electric fan or common fan may be used). The wax is applied to the burn at the earliest possible opportunity, either with a fine varnish brush or atomizer —preferably with an atomizer. It is difficult to regulate the temperature where the brush is used; it is more or less painful and



Electric Burns Are Among the Worst. Ambrine—the Wonderful New Wax Treatment For Burns Developed During the War, Has Been Very Useful and Healing in All Such Treatment. X-Ray Burns Can Be Treated By Ambrine Also.

there is a tendency to brush away and traumatize the new epithelium and granulations.

Chemical Burns. If the burn is acid, an alkali is used to neutralize the acid present; and if alkali, an acid is used; the burned area thoroly dried and wax applied. In one case several acid burns, first and second degree, were treated in which 5 per cent. of the surface of the lower extremities was involved, which were cured and the patient in each case was discharged from the hospital in 11 to 12 days, with absolute freedom from pain during treatment.

X-ray Burns. Experience is too limited to express any opinion other than the relief from pain which the dressing assures. Dr. Mayo reports one case in which an excision had been done for a sluggish burn of more than one year's standing in which the granulating wound covered over satisfactorily with the wax treatment. It will probably have some value in the treatment of X-ray burns.

Electrical Burns. Holtze reports excellent results in the treatment of electrical burns (30 cases). Pain was relieved and patients recovered more rapidly than with other methods, with no contracting cicatricial tissue. He considers the method far superior to other methods and has standardized it in his service.

Astern! With Engine Running Ahead!

By CHARLES M. RIPLEY



The Newest Thing in Boat Steering Devices—a Split Rudder, Which Permits of Running In Any Direction, Even Backward, with Propeller Turning for Ahead! Photo at Right—3 Exposures on 1 Plate, Showing Boat Turning in Its Own Length after Being Suddenly Stopt Short in Its Forward Course.

ONE of the large American electrical concerns has recently equipt a 25-ft. motor boat owned by Mr. W. B. Landreth, Deputy State Engineer of New York, with a simple yet remarkable *reversing and control rudder,* with a view to showing the possibility of eliminating reversing turbines from the large turbine propelled ships.

This boat is capable of backing up with the engine running in a forward direction, but the most valuable feature is its ability to turn around in its own length. With this rudder the boat can be maneuvered without steerageway; that is, with the rudder placed at right angles to the axis of the keel and with engine running at full speed, the boat will stand perfectly still and then by making a slight adjustment of the rudders, the boat will turn around in its own length and continue to do so until the adjustment is changed; and during the process of this circular motion it can leave for any point of the compass at full speed.

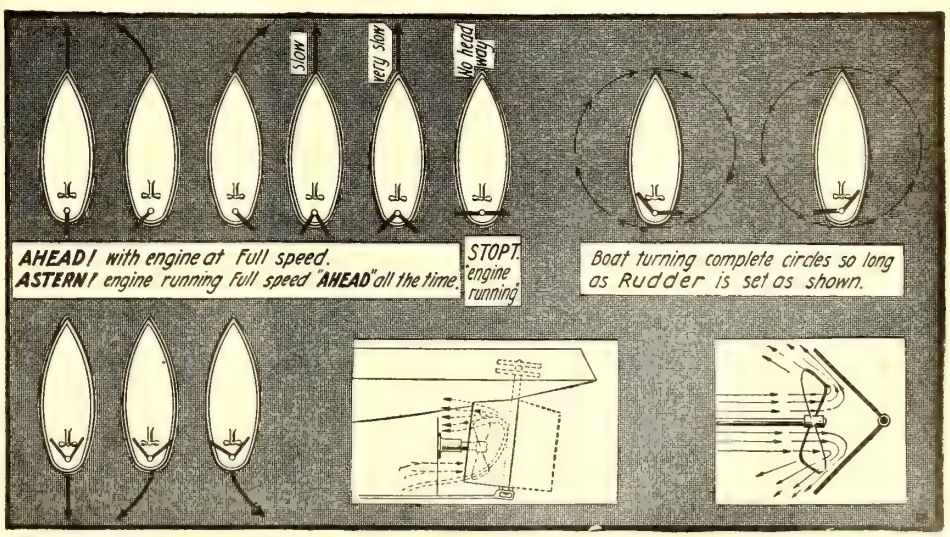
As an illustration of the maneuvering qualities of the rudder, this boat was run into a 40-foot slip full speed ahead, turned around and came out bow first without touching either side of slip.

The rudder on the Landreth boat, the invention of H. O. Westendarp, of Boston, consists of two steel plates 3/16 of an inch thick, each plate the same size as the normal rudder used on this type of boat. The rudder post consists of a steel rod inside a steel tube, one plate of the rudder is attached to the tube and the other to the rod. The boat is equipt with two steering wheels, arranged side by side, one wheel to operate the rudder affixt to the tube, and the other the rudder fastened to the rod. The manner in which the rudders are affixt to the stern of the boat is best shown in the side view herewith. This shows the two rudders close together in the position for normal cruising, when they are used the same as an ordinary rudder.

The two steering wheels, placed up forward in the launch, are on the same axis and when locked together operate as one wheel for ordinary cruising. But when the boat is to be turned sharply or reversed, the wheels are instantly unlocked and released, so that they may be revolved in *opposite directions* to manipulate the rudder plates.

It is truly remarkable how easily the boat can be made to turn within its own length. By placing the rudders in the position indicated in the diagram chart herewith *the boat will turn around in a few seconds and travel back up its own wake.*

(*Continued on page* 939)



The New Compound or Double Pitch Steering Rudder by Means of Which a Boat Can Be Run Ahead, Astern, or in a Circle of Radius Equal to the Boat's Length, with the Engine and Propeller Running Full Speed Ahead at All Times.

Popular Astronomy

By ISABEL M. LEWIS, M.A.

Of the U. S. Naval Observatory

The Einstein Theory of Relativity

EARLY in the spring of 1919 two eclipse expeditions which had been most carefully equipt at the Royal Observatory at Greenwich, England, set forth for two widely separated stations lying in the path of the total solar eclipse of May 29, 1919, one on the island of Principe in the Gulf of Guinea, the other at Sobral, Brazil.

The sole object of both expeditions was to test current theories as to the nature and properties of light and in particular the *Einstein theory* of the relativity of motion which predicted a certain definite and measureable displacement in the positions of stars lying within the immediate vicinity of the sun.

As the eclipse was to be of extraordinarily long duration and as the sun was to be at the time in a field particularly rich in stars it was felt that conditions were to be unusually favorable for a test of the theory.

The expeditions were placed in charge of four of the most distinguished and capable astronomers in England, men who were not only theoretical astronomers and mathematicians of the foremost rank but practical observers of the highest ability as well.

The expedition to Sobral was in charge of astronomers Crommelin and Davidson, the one to Principe in charge of Eddington and Cottingham. The eclipse was observed successfully at both stations. The two expeditions remained at their stations for two months to photograph the same field of stars after the sun had left it and the photographic plates were then taken to England and carefully measured and reduced.

The displacements of the stars in direction and amount were in accord with the prediction of Einstein. It was a great triumph for the *Einstein Theory of Relativity* and the entire scientific world was suddenly called to a consideration of the most remarkable and revolutionary physical theory that has ever been expounded, a theory that will require, if accepted, radical changes in our conceptions of the nature of space and time and of the properties of matter.

Tho there is scarcely a single branch of science that remains unaffected by the Einstein theory, it is in the fields of mechanics and electrodynamics that the most fundamental changes are to be made. Many of the Newtonian laws of motion are but *first approximations* to the Einstein laws of motion.

In a limited space it is extremely difficult to give even a most elementary idea of the nature of the Einstein theory, how and why it originated, and why it should produce such radical changes in our conceptions of such everyday matters as time and space.

The writer being aware of Einstein's statement that no more than twelve men in the world would comprehend the full significance of the theory will not venture to do more than first, outline the basis of the theory, the celebrated Michelson-Morley experiment; secondly, state the two fundamental postulates of the principle of the relativity of motion, upon the validity of which rests the entire structure of the theory and, thirdly, give without attempting to enter into any proofs (tho many of these are readily comprehensible to anyone possessing a fair knowledge of mathematics and physics), some elementary deductions from the theory that are of a most startling and revolutionary nature, showing finally why it is so difficult to devise tests of the theory and why to the man in the street the effects of the principles of relativity are imperceptible and produce no noticeable changes in the affairs of everyday life.

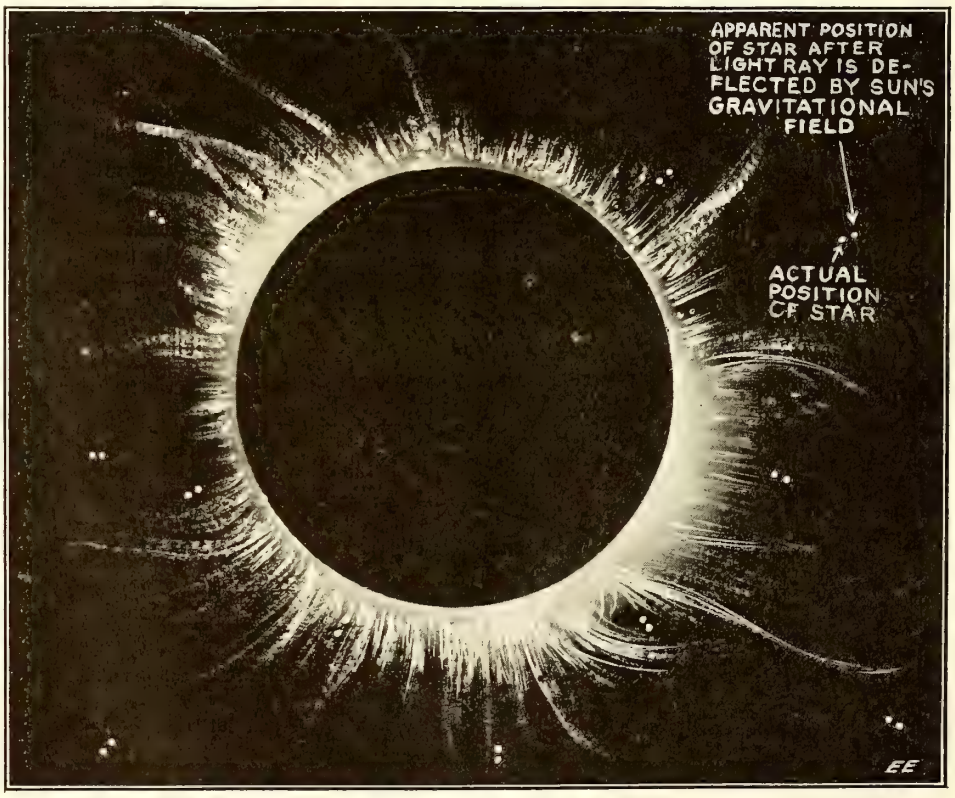
The Theory of the Relativity of Motion was first advanced in a brief mathematical treatise by the Swiss mathematician, Albert Einstein, in 1905. The original idea was enlarged upon and extended in a more general form in a later publication by the same author. For five years after the first paper was published the theory received little attention, but gradually it came to be regarded favorably by some of the most eminent astronomers and physicists of the present day, and now since one more of its predictions has been strikingly confirmed by the results of the eclipse expeditions, it is attracting the attention of the entire scientific world.

The foundation for the Einstein theory is the negative result obtained in the Michelson-Morley experiment which was an attempt to determine, experimentally, the motion of the earth thru the *ether*, a hypothetical medium which physicists have been led to believe pervades all space and matter and is itself stationary and unaffected by the motion of bodies thru it.

To determine the motion of the earth relative to this immobile ether the following experiment, known as the *Michelson-Morley experiment*, was performed.

Let a ray of light from a source S fall upon a semi-reflecting mirror A which is arranged so as to reflect half of the ray to B and to allow the other half to pass on to a third mirror C.

AB and AC are constructed perpendicular to each other and equal in length. Half of the ray reflected from B will pass thru A to the telescope T and also half of the ray reflected from C will be reflected from



How the Einstein effect was observed during the total eclipse of the sun of May 29, 1919.

The eclipsed sun is here shown with its corona. The two sets of star positions represent the stars, as they would appear if two photographic plates (one taken during eclipse and one two months later) were placed one on top of the other.

If a ray of light were unaffected by the sun's attractions a star would occupy the same position in the heavens when seen in the sky at night and when closely in line with the sun but if the sun's gravitational field has an effect upon the path of a ray of light a star lying close to the sun and therefore visible during a total solar eclipse, would be displaced from the position it would otherwise occupy in a direction away from the sun by an amount that varies directly with the angular distance of the star from the sun. The displacement of a star from its true position due to the effect of the sun's field under the Einstein theory should be 1.75 for a star lying at the sun's limb, and the value decreasing with the distance of the star from the sun.

In reducing the photographs the distances between star images on a plate taken during the eclipse were compared with the distances between star images on a plate taken two months later at the same place. There could thus be little doubt as to whether or not the Einstein effect existed. No other cause such as refraction or the presence of the solar corona could explain these displacements; as they must follow a certain definite law.

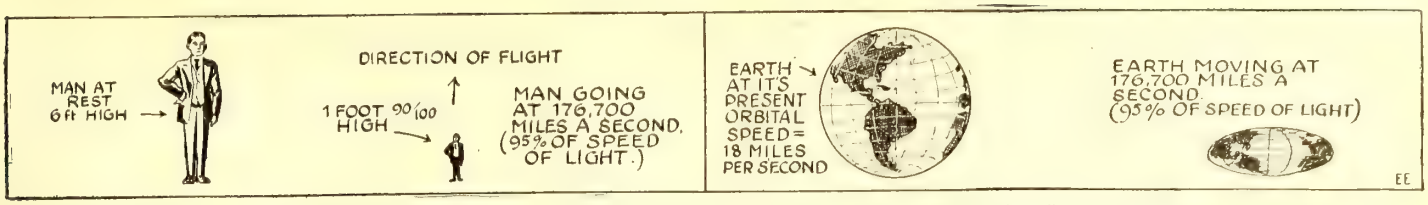


Fig. 3—Queer and Extraordinary Things Happen If We Speed Up a Body to Tremendous Speeds. The Illustration Above Shows This Grafically. Of course Such Speeds Such As Those Shown Here Have Never Been Performed on Earth. Even a Projectile Fired from the Fastest Gun Travels Only a Trifling Feet Per Second. Compare This with the Earth's Orbital Speed of 18 Miles Per Second. Einstein Proved Among Other Things That the Michelson-Morley Experiment Must Be a Failure Because the Earth, Due to Its Speed Shrinks a Few Inches—Just Sufficient to Nullify Any Variation That Might Otherwise Be Detected By the Experimenters.

A to T. Now the path of the ray ABAT should equal the path of the ray ACAT and the two rays should reach T at the same time if the apparatus is at rest in the ether.

Assume, however, that the ether is stationary and that the earth is moving thru it with no disturbance, then conditions will be as shown in the right-hand figure, the earth's orbital motion being in the direction of the arrow.

While the light is going from A to B and C, the apparatus is carried forward in the direction of the arrow to the position $B^1A^1C^1$.

Let the velocity of light be designated by C and the velocity of the observer which is the velocity of the earth in its orbit, by V.

It can be shown by a simple mathematical discussion, into which we will not enter here, that the two paths are unequal by the amount $\frac{dV^2}{C^2}$ where d is the distance AB or AC.

By turning the apparatus thru an angle of 90°, the difference should be in the opposite direction, and the displacement of the interference fringes along A^1T should be $\frac{2dV^2}{C^2}$. This quantity, altho small, lies well within the range of measurement, but many repetitions of the experiment at different times of the year and different times of day failed to show the displacement expected on the hypothesis of a stationary ether.

As a result of the failure of this experiment to show any motion of the earth relative to the ether, as well as the failure of a long series of physical experiments of one sort or another, performed prior to this by such eminent physicists as Arago, Klinkerfues, Roentgen and Trovton and Noble, all designed to detect the motion of the earth thru the ether, the first postulate of the theory of relativity was formulated by Einstein and states that:

It is impossible to detect the uniform motion of a body thru space by means of experiments made upon that body alone.

The principle is herein clearly formulated that the only motion of which we can have any knowledge is *the motion of one body relative to another.*

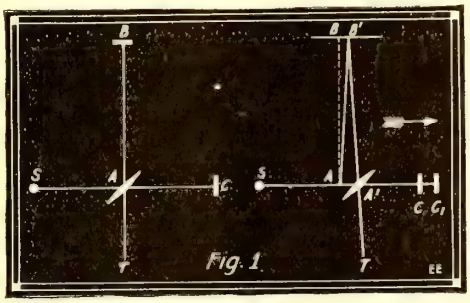
We may state right here that the theory of relativity is independent of the question of the existence or non-existence of the ether. It serves no purpose, however, in the theory of relativity and the founder of the theory appears to consider it as *non-existent.*

The second postulate of relativity, strange to say, is admitted to be true by all who believe in the ether theory of light, tho it also is independent of any consideration as to the existence or non-existence of the ether. It states a well-known principle, absolutely in accord with experimental evidence, namely that:

The velocity of light in free space is independent both of the velocity of the observer and the velocity of its source.

By *free space* is meant space free from gravitation and matter, for instance, interstellar or interplanetary space.

There are certain theories of relativity



The Famous Michelson-Morley Experiment Undertaken to Detect the Motion of the Earth As It Rushes Thru the Supposed Ether. Einstein Proved Why Such an Experiment Must Be a Failure.

that have been built up on the hypothesis that the velocity of light is *not* independent of the velocity of the source; these are spoken of as *emission* theories of relativity, but there is certain astronomical evidence that is plainly not in accord with these emission theories, and the weight of the evidence appears now to be all in favor of the Einstein theory.

It is this second postulate to which can be traced all the weird deductions and startling results of the Einstein theory to which we are now coming, and to overturn the Einstein theory of relativity one needs prove that this postulate (so universally accepted even by the opponents of the theory) is invalid.

We will now state briefly, without attempting to enter into the proofs, a number of the most revolutionary deductions to be made from the theory.

There is, in the first place, no such thing as a body *absolutely fixt* in space. (We would conclude, therefore, that there is no fixt center of the universe, and no ultimate system of reference.)

The idea of time and space as independent and self contained concepts must be abandoned. They are but different aspects of a greater whole.

In defining the position of a point-in space there must be added to the usual x, y and z co-ordinates of three dimensional space *a fourth co-ordinate, or dimension,* t, THE TIME.

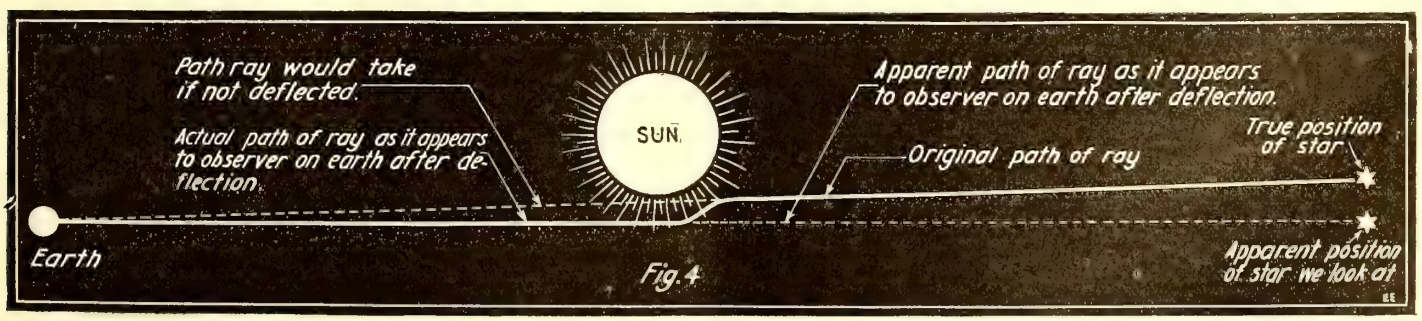
The principles of relativity can best be grasped in terms of the four dimensional space of *Minkowski,* in which a material body is regarding as tracing thru "the world" (or universe) a "world line" which never returns upon itself or crosses itself. The position of a point upon a "world line" is defined by the four co-ordinates x, y, z, t. Events are marked by the intersection of "world lines." The laws of motion are simply expressions for the relation between "world lines."

According to the conceptions of this four dimensional treatise, time and space are a blend, no more possessing individual existence than the two components of a force, and there can be no such thing as events happening simultaneously at different places.

To illustrate the process of reasoning followed in arriving at some of the most startling and revolutionary deductions of the principle of relativity, let us see how we can derive the theorem *that two observers on two systems in relative motion cannot agree in their estimate of the length of a given interval of time.*

Consider two systems of reference (two positions in space) S and S^1 (Fig. 2) in relative motion. Let A be an observer on S and let B be an observer on S^1. Then let S^1 be moving past S with velocity V, in the direction of the arrow. Assume both observers provided with clocks keeping the time of their respective systems and with plane mirrors M and M^1 for the purpose of finding how long it takes for light to travel a given distance. Both observers agree according to the second postulate of relativity that the velocity of light is independent of the velocity of its source and the velocity of the observer.

(*Continued on page* 916)

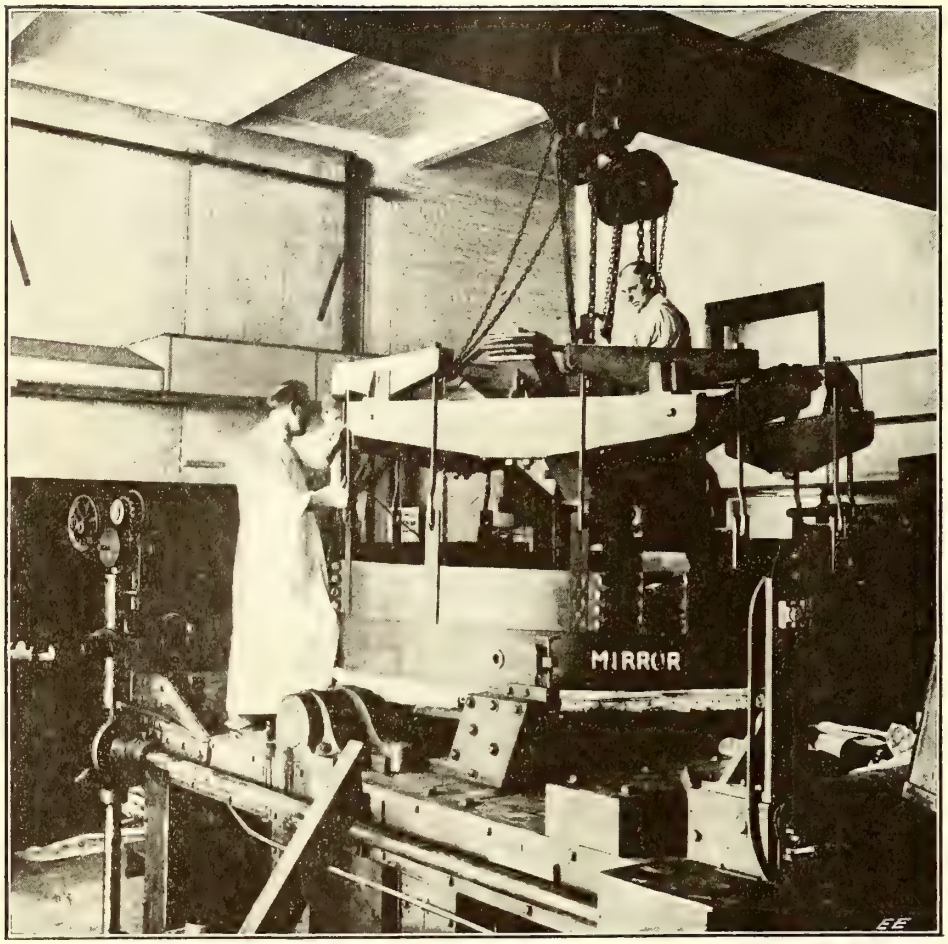


According to the Einstein Theory a Ray of Light Is a Sort of Periodical Electro-Magnetic Disturbance Which Is Transmitted Thru Space with a Constant Velocity of 186,000 Miles per Second and Which Possesses Mass and Weight. It Is Therefore Subject to the Laws of Gravitation and For This Reason It Is Bent from Its Course and Its Velocity Is Changed Whenever It Passes Thru a Strong Gravitational Field Such as Surrounds the Stars and the Sun. Under Such Conditions Its Path Becomes a Hyperbola, in Form, Concave Toward the Attracting Body, That Is, Light Acts Just As a Particle of Matter or a Comet, say, Would Act Upon Passing Close to the Sun.

The Mt. Wilson 100-Inch Reflecting Telescope

By FLOYD L. DARROW
Head of Science Department, Polytechnic Preparatory School, Brooklyn, N. Y.

HOW BIG TELESCOPES WORK



Lowering Clamp onto Huge 100-Inch Mt. Wilson Glass Reflector in Order to Lift It from Grinding Table.

NO other instrument upon which Man has applied his genius for invention has so broken down the barriers of space and loosed the fetters of intellectual bondage as has the telescope. From the days of Galileo and the crude "Optic Tube" with which he made those first epoch-making discoveries down to the giant 100-inch reflector just erected on Mount Wilson, California, stretches a continuous pathway of steady progress and brilliant achievement. As the novelist, H. G. Wells, says this planet receives no imports save meteors and has no exports whatever, yet these marvelous adaptations of optical glass bring to view other worlds without end, push heavenward the bounds of the known universe by billions of miles and enable us to weigh the planets and analyze the stars with mathematical precision and exactitude.

THE FIRST TELESCOPE

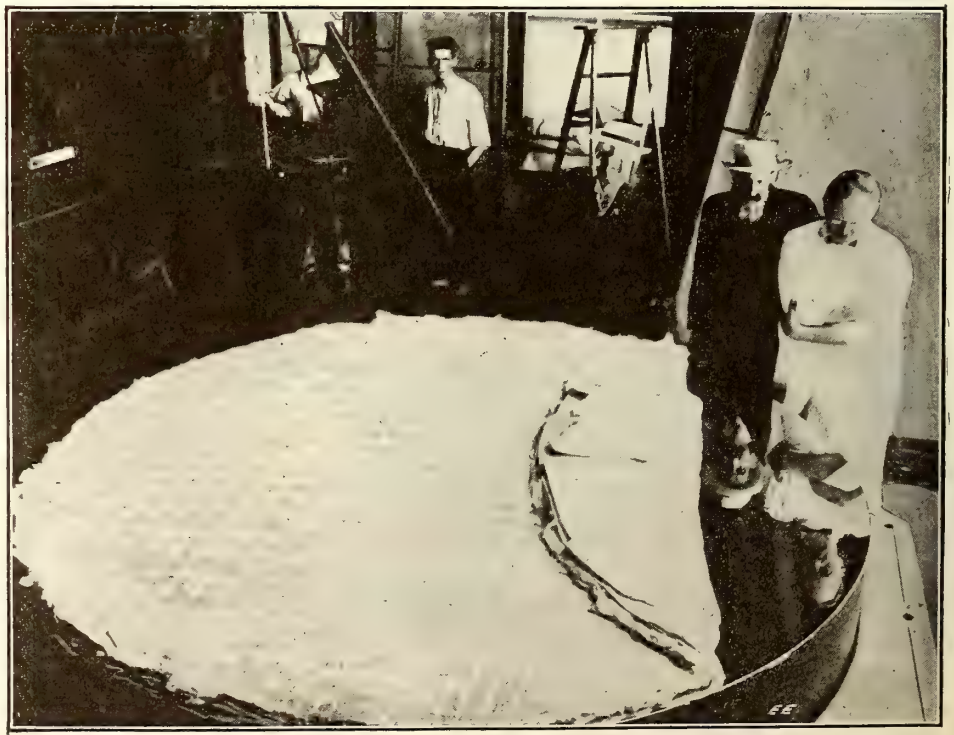
To whom belongs credit for the invention of the telescope has never been definitely settled. About 1590 a Dutch optician, Zacharius Jensen, arranged in a tube a combination of lenses with which he was able to magnify small objects. A few years later a fellow countryman, Johannes Lippershey, experimented with a similar set of lenses and made the discovery that a distant church steeple was brought much nearer by their aid. But certain it is that Galileo, the great Italian scientist of Padua and Florence, with no knowledge of these discoveries, invented the first astronomical telescope in 1610.

Galileo's telescope was of the refracting type and an explanation of its operating principles will be given in a later article. There were certain very serious defects in these early refracting telescopes, however, and Sir Isaac Newton set about the invention of another type of telescope which should depend for its optical properties, not upon the refraction of light thru lenses, but upon its *reflection from a highly polished concave mirror*. His first telescope was a small affair but it greatly improved the definition of the image and eliminated the troublesome color-fringe always present about the images produced with refracting telescopes. Newton quickly followed it with a larger instrument and from that day until this the *reflecting telescope* has been a strong competitor for first place in telescopic achievement and astronomical discovery. The immense six-foot reflecting mirror made by Lord Rosse and now in the British Museum is a notable example of the last century.

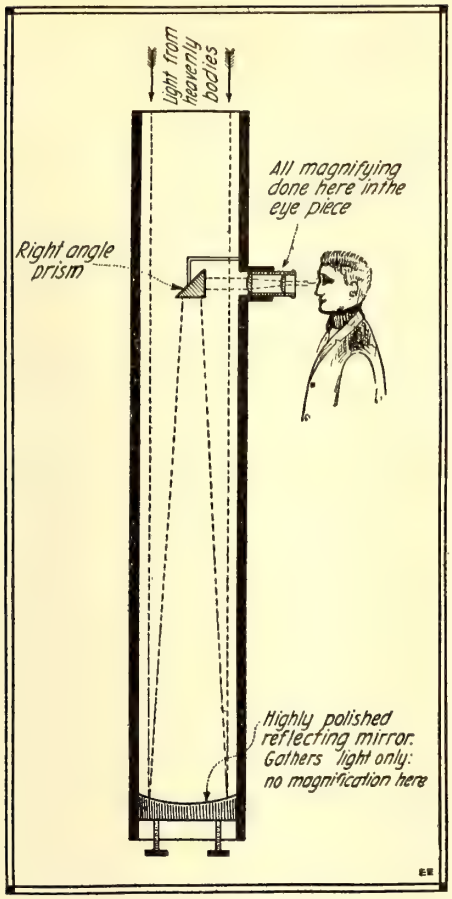
WORLD'S LARGEST TELESCOPE AT MT. WILSON

The latest and largest telescope of the world has just been erected in the Solar Observatory of the Carnegie Institution, located on Mount Wilson near Pasadena, California. This optical marvel was made possible by a gift of $45,000 to the Carnegie Institution by Mr. John A. Hooker of Los Angeles in 1906. Mr. Hooker specified that this money should be used for the purchase and grinding of a glass disc 100 inches in diameter and having a focal length of about 50 feet. As the making of optical glass was an unmastered art in this country previous to the Great War, the order was placed with a large firm at St. Gobain, France, in the autumn of 1906.

An order for so large a disc had never before been received and its casting taxed



Note the Perfect Reflection of the Faces in the Polished Face of the 100-Inch Reflector Used at Mt. Wilson.



The "Newtonian" Telescope — Here the Image of the Heavenly Body Is Reflected from the Mirror at the Bottom, Up to the Prism and Lens Magnifying System Shown.

to the utmost the capacity of the plant and the skill of the master craftsmen who executed the work. After eight failures the disc was cast in 1908. It was packed just as it came from the mold and shipt directly to Galveston, Texas, by water and thence by rail to Pasadena. In the rough state the disc weighed 5½ tons, it was a little more than 101 inches in diameter and was 13 inches thick. A special building was erected for its grinding. But a close inspection of the disc revealed the fact that it had been cast in three layers and flaws were disclosed which seemed to render it unfit for optical use. Word was sent to St. Gobain and a new furnace capable of holding 20 tons of molten glass was erected. Two more attempts were made but neither was as successful as the first. Prof. George W. Ritchey, of the observatory staff, and under whose direction the work of grinding was to be done then made a trip to France but found it a practical impossibility to cast so large a piece of glass at one pouring. Therefore the project of building the telescope must be abandoned or work must be begun on the original disc. Without hesitation the latter course was adopted.

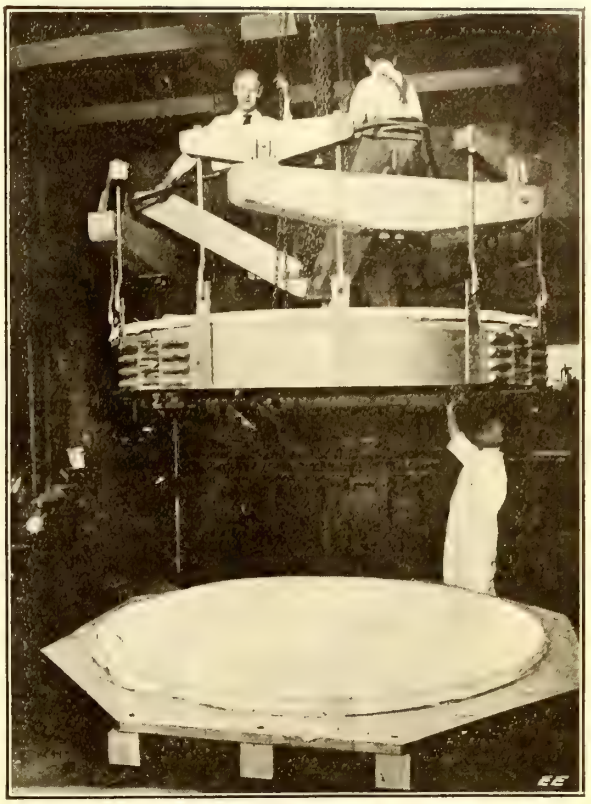
THE GRINDING OF THE 100-INCH LENS STARTS

Not until 1910 was the disc placed on the grinding machine. The actual work was done by Messrs. Kinny and Dalton. The edge and surfaces were first ground off until the glass measured 101 inches in diameter and 13 inches in thickness. This was followed by the rough grinding of the concave surface. The grinding and subsequent polishing and figuring were done almost entirely by machinery. Very fine emery flour mixed with water and applied by wooden brushes covered with cheese cloth did the work of abrasion. *No metal was allowed to touch the surface.* The brushes revolved very slowly and from the center outward. This first grinding hollowed out the mirror to a depth of 1¼ inches and was followed by a second grinding in which still finer emery dust was employed and the utmost care was exercised.

Then came the polishing—a far more exacting task than the grinding and requiring a series of the most delicate and thoro tests. One difficulty early encountered was the discovery that the glass was astigmatic, i.e., the curvatures at right angles to each other were not uniform. Altho these curvatures differed by only .0016 of an inch, it was known that even this slight variation would produce serious distortion of images. For a time this baffling defect seemed likely to render the glass unfit and to bring to naught long years of hope and painstaking labor. But a new kind of grinding tool devised for the purpose solved the problem. It consisted of a 1,500-pound plate of the same size as the glass, which exerted a uniform pressure at every point of the surface and thus smoothed out the inequalities of curvature.

One of the most important series of tests consisted in determining the effect of temperature changes on the qualities of the glass. It was subjected to variations ranging from 30 degrees to 105 degrees Fahr. and was found to suffer no harm if these changes were gradual. Rapid changes did

(*Continued on page* 942)



Lowering the Great 100-Inch Mirror Onto Cover, Preparatory to Transporting It to Summit of Mount Wilson.

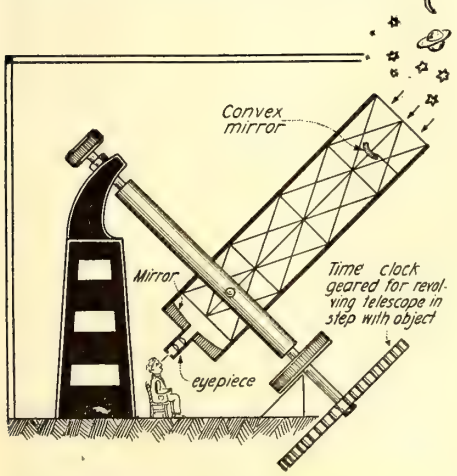
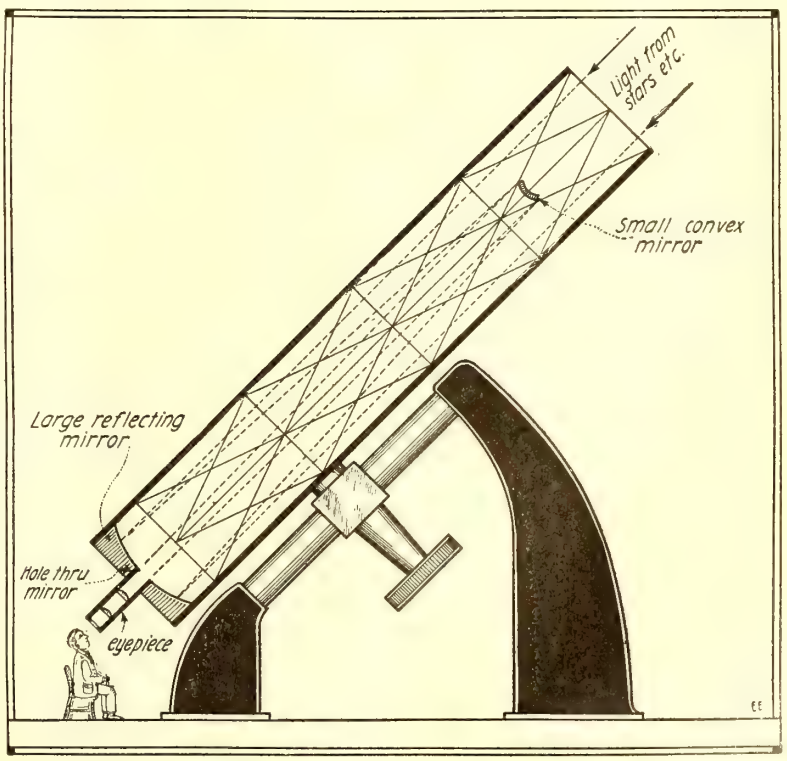


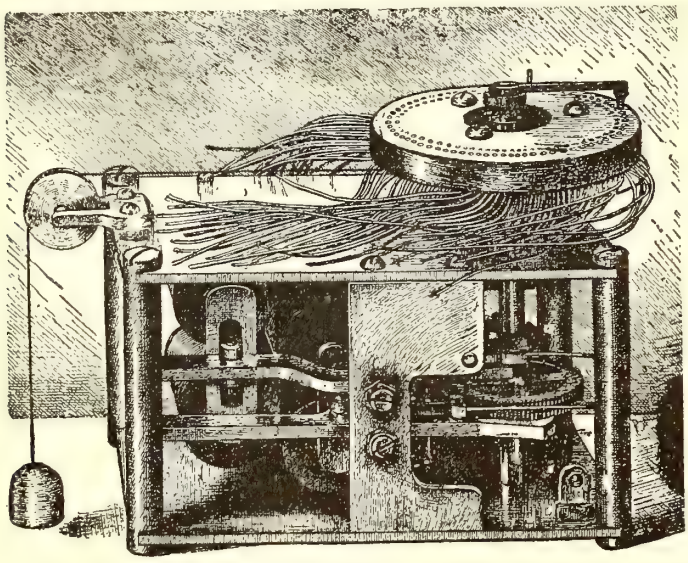
Diagram of the Mounting of 100-Inch Reflector at Mt. Wilson. Large Pedestal (North One) Bears 40 Tons, Small Pedestal (South) Bears 60 Tons. Large Wheel at Lower End of Polar Axis Is Toothed Wheel Engaging with the Clock Mechanism. Rectangular Yoke Is Shown Only in Side-View.

Usual Mounting of a Reflecting Telescope of the Cassegrain Type. Here the Star Image Is Reflected Upward Again to a Second and Smaller Mirror of the Convex Type, Whence the Image Is Projected Downward Thru the Hole to the Magnifying Eye Piece.



The First Automatic Telephone

Last November marked the twenty-sixth year since the first public *automatic* telephone exchange was put in service in the city of La Porte, Ind. The La Porte exchange was an experiment, a novelty, a bold attempt to do what was generally deemed impossible. The exchange served less than 100 stations and its capacity was strictly limited. Five wires ran to each station in the early days. Now but two wires are needed. Over these the connection is set up, the bell is rung, the talking is carried on, the release accomplisht. No ground or common return is required.



Speaking of Milestones and Historic Electric Do-Funnys—Meet the First Automatic Telephone Exchange. Last November Marked Its 26th Birthday. It Served Less Than 100 Subscribers. Instead of the Present Two Wires to Each Station, Five Wires Were Required.

In this first automatic exchange the subscribers pushed buttons to make calls. To obtain 25, for instance, the *tens* button was prest twice and the *units* button five times. Now a disk or dial, but little larger than a watch, controls the switches. After making a connection the bell was rung by means of a magneto in La Porte.

Local battery current was used for talking 25 years ago—that was the universal custom then. The automatic today is common battery for connection, ringing and transmission. In La Porte 60 to 70 volts were required to operate the magnets in the switch. Now 48 volts, actuating sensitive relays, are sufficient. This telephone epoch-making equipment was built in a small shop by clock-makers and model builders. Today a great factory, employing over a thousand people and operating the most improved machinery, is turning out tens of thousands of lines of apparatus. Then the switches were in a tentative state. No two installations were alike, each one was an experiment. Now the mechanisms are standardized in their essentials. Modified in their assembly to meet particular requirements, they are all practically alike. Maintenance in those days meant fine adjustments, painstakingly made by men trained in delicate work. At the present time in a number of automatic exchanges girls with no special mechanical training or experience are doing a large part of the routine inspection and adjusting which keeps the equipment in perfect condition.

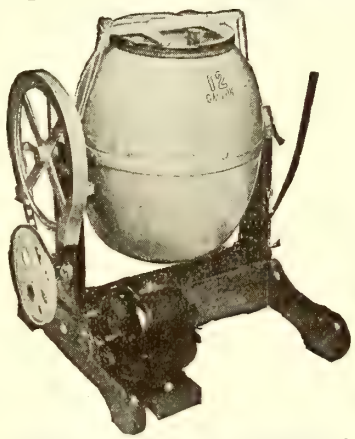
This early switchboard was of the disk type, 100 lines capacity, and required five wires to operate. The line terminals were placed on the circumference of a flat rubber disk, thru the center of which was a shaft carrying a wiper. The rotary motion of the wiper shaft was supplied by two sets of magnets actuating pawls; one set moved the wiper over ten contacts at a time, the other set revolved it over one at a time. A release magnet disengaged the pawls, allowing the wiper to return to zero.

In order to avoid the friction involved in dragging the wiper over each contact, the shaft was so arranged that at every revolving impulse there was a corresponding upward thrust, which lifted the wiper above the line terminals. — *Photo courtesy of "Telephony."*

DAIRYMEN WILL APPRECIATE MOTOR-DRIVEN CHURN.

Remember the days back on the farm, when "Ma" set you to work on the pump-handle butter churn? Those were the happy days! Yes, they were, NOT!!! That's what the electrically operated churn-makers thought also, and here's the answer.

The laborious and tiring work of churning butter daily by means of the old-fashioned churn is all done away with by the modern motor-driven butter churn. Machines are now available which perform in a few minutes the complete operation of churning and working up the butter without the product being touched by hands. For the farmer and dairyman, the motor machine saves hiring additional help, and often makes it possible for the farmer or some member of his household to take care of this part of the work.



Glazed Stoneware Churn Operated by a Small Electric Motor.

In the electric churn illustrated the barrel is of glazed stoneware, which will not absorb injurious matter, and contains no parts difficult to clean. The cover is clear annealed glass one-half inch thick, which can retain nothing injurious. The sealing ring is rubber, three-eighths inch thick, non-absorbent and easily removed for washing purposes.

The frames are of yellow pine, finished with two coats of varnish. All metal parts attached to the barrel are finished with aluminum. All bearings are of steel. The electric motor driving the churn is very small, and consumes no more current than an ordinary incandescent lamp, in the small churns. Several sizes of churns are built.

A VERSATILE ELECTRIC RUBBING MACHINE.

By Frank C. Perkins

Here is a novel electric rubbing machine, developed by a Beloit, Wisconsin, inventor. It is pointed out that the advantage of electric drive for a portable rubbing machine is beyond argument. It requires no hose, piping or special equipment and it is a power unit in itself. All one has to do is to attach it to a lamp socket, turn the switch and go ahead. There is no installation expense; and it can be used in any part of the factory where there is electric wiring.

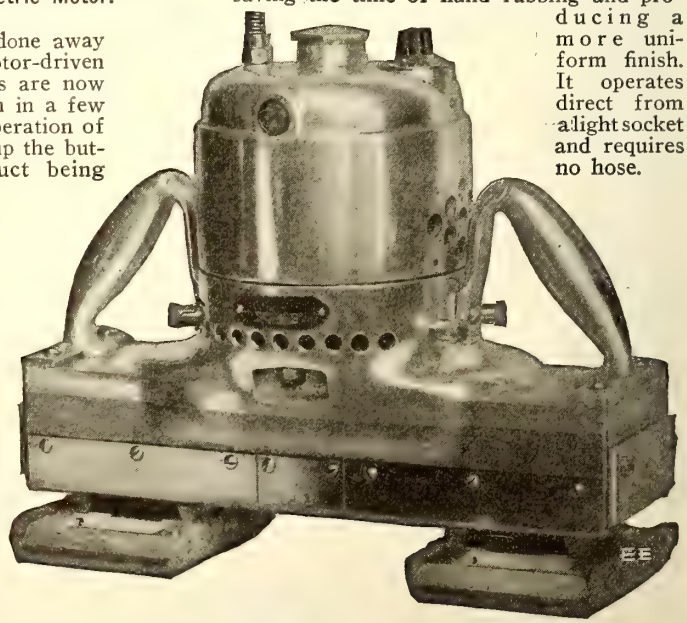
It will be seen that it uses power only when working, and very little at that. It consumes about as much current as three or four incandescent lamps—less than it takes for your wife's flatiron. The machine is 13 inches long and can be used for rubbing surfaces 15 inches and longer, and of practically any width.

This labor saving machine weighs about 35 lbs., which gives the correct pressure for the average class of rubbing, but the motor is amply strong to take care of any additional pressure the operator may want to exert on surfaces that will stand it. A regulator is provided to vary the speed of the rubbing blocks to suit the work in hand. Varnish that is comparatively green will not stand as high speed as when thoroly dry.

It will be noted that the rubbing blocks reciprocate toward and from each other which gives the machine a perfect running balance. There is no tendency to creep or jump. In eliminating friction and wear in this smooth-running instrument, ball bearings play their part.

By means of a special sliding-shoe arrangement the interior mechanism and bearing surfaces are protected from grit and slop being thrown up from underneath by the action of the rubbing blocks. The latter which carry the felt pads are readily interchangeable, and several sets may be kept at hand fitted with felts for different classes of rubbing.

This electric rubbing machine is utilized in a prominent New York furniture factory, saving the time of hand rubbing and producing a more uniform finish. It operates direct from a light socket and requires no hose.



A Powerful Electric "Rubbing" Machine Suited to Many Purposes. It Is Widely Used in Preference to Hand Rubbing for Varnished Surfaces, with Extreme Satisfaction.

Recording Daylight

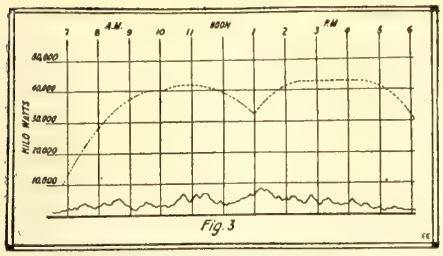


Fig. 3. Daylight Recorder Chart for April 24th—Solid Line Indicates Daylight Record; Dotted Line is the Electric Load Curve for the Same Date.

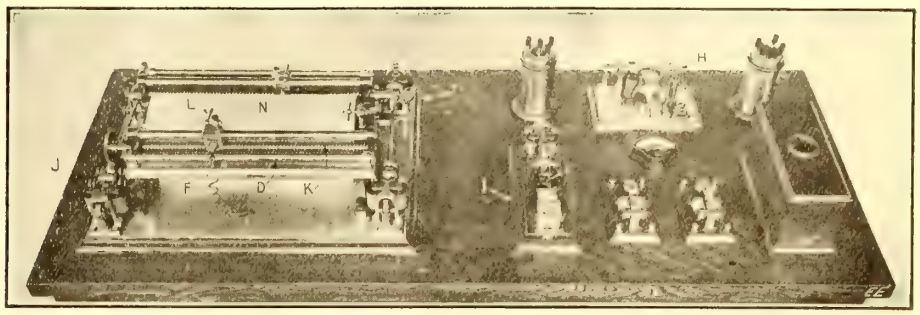


Fig. 2. The Laboratory Instruments Used in "Measuring Daylight"—Not Sunlight. The Daylight Acts on a Bank of Tungsten Lamps and Has the Effect of Changing the Resistance of the Lamps, Which is Measured and Indicated on a Wheatstone Bridge Circuit.

THE United States Weather Bureau publishes daily figures giving the percentage of sunshine, and these figures have been used by the Boston Edison Company for some time in compiling statistics on the generation of power. This sunshine record is obtained by means of a thermo recorder, which consists of a bulb filled with mercury, very similar to an ordinary thermometer, and enclosed in an evacuated glass tube. This bulb is exposed to radiation from the sky, and the action of sunlight upon it causes the mercury index to rise in a stem and close an electrical circuit. The passage of a cloud across the face of the sun will cause the index to drop and open this circuit again. It is therefore obvious that altho this data represents the *amount of sunshine, it does not necessarily represent the amount of daylight.* A day when the sky is overcast with a light cloud film would still have a sufficient amount of diffused daylight to preclude the necessity of artificial lighting, altho the Weather Bureau data would show *zero per cent sunshine.*

For this reason, the Boston Edison Company experts desired to obtain some simple method of measuring the intensity of daylight, and the problem of accomplishing this was presented to the electrical laboratory. Mr. F. A. Swan, of Boston, finally devised an instrument to record variations of sunlight and temperature on a moving paper chart, which was being developed along lines suitable for the requirements of weather observers

The *meteorograph,* as this apparatus is called, consists of two principal parts, the *receiver* and the *recorder.* The receiver is located on the roof of the Laboratory in such a manner that it is exposed to radiation from all parts of the sky. The recording apparatus is contained in a cabinet in the Standardizing Laboratory.

The device operates on the principle of a Wheatstone Bridge. In the diagram, figure 1, the resistances "A" and "B," each of approximately 100 ohms, are mounted in the receiver. Resistances "C" and "D" of similar value are located in the recording apparatus, "D" being adjustable by means of a sliding contact, as indicated in diagram. A galvanometer "G" and a battery "Bat" complete the conventional form of bridge.

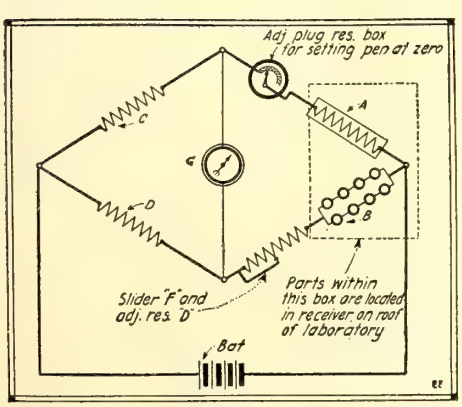


Fig. 1. The Wheatstone Bridge Circuit Employed with Tungsten Lamp "Daylight" Indicator.

The resistances "A," "B," "C," and "D" are adjusted to be equal when no light falls upon the receiver. Under this condition no current flows thru the galvanometer and the bridge is in balance. The action of light on the receiver causes a change in the value of the resistance "B." This throws the bridge out of balance and causes a deflection of the galvanometer "G." The galvanometer is combined with a relay, and the action of this relay causes the slider "F" to move along the resistance "D" until the bridge is again in balance. The slider "F" carries with it a pen arm and by this means a curve is drawn on a chart in accordance with every change of resistance in the arm "B." As the change of resistance in arm "B" is caused by the action of daylight, it is obvious that the pen will make a record which will bear a certain relation to variation in the intensity of daylight.

The resistance arm "B" in the receiver is composed of a bank of 40-watt, 220-volt Type "B" Mazda lamps. It was discovered by the inventor of this apparatus that the resistance of a *tungsten* lamp varies in accordance with its exposure to light rays; *in other words, if the resistance of a tungsten lamp is measured with a bridge, first in complete darkness and then when exposed to daylight, the value of its resistance will be found to have changed.* The amount of this change varies in accordance with the strength of the light to which it is exposed, *the resistances increasing with an increase of illumination.*

It is necessary, however, to keep the current in each lamp below two milliamperes, to avoid resistance changes due to the current in the filament. In order to obtain a sufficient amount of current to insure positive operation of the galvanometer, a bank of lamps in series multiple is used. This arrangement permits a current of thirty-two milliamperes in the bridge arm.

For the purpose of preventing error in registration due to the effects on the lamps of variable air temperatures, use is made of a compensating resistance or "dark arm," which is marked "A" in the diagram. It consists of a coil wire, of the same resistance as the lamp bank, mounted in a lamp bulb which is sealed and evacuated, and covered so as to exclude the light but to permit circulation of air. The resistance of this coil will be affected only by variations in air, temperature, and will serve to compensate for similar variations from the same cause in the lamp bank.

Figure 2 shows the construction of the recording apparatus. "H" is the contact maker. This is operated by an impulse every two seconds from the standard clock and by means of a toothed wheel closes a set of contacts in sequence for operating the recording mechanism. "I" is the galvanometer relay. The impulses from the contact maker are transmitted thru this relay and actuate certain of the driving magnets "J." These magnets rotate the worm "K," which carries the pen arm "L" and the slider "F." The slider moves along the resistance arm "D" and rebalances the bridge. The chart "F" is carried on a drum which is driven by an electric clock mechanism in the cabinet below. The feed of the chart is one inch per hour. The recording apparatus has been constructed with two galvanometer relays, and two pens so that a record of temperature may be made on the same chart if desired.

Figures 3 and 4 show charts for April 24 and 25, 1916, taken from one of the earlier machines. The solid line curve is the record made by the daylight recorder and the broken line represents the load curve of this company for the same period. The weather was rainy on April 24, and it will be seen that the daylight curve did not rise very far above the zero line during the day. The following day was sunny; some thin white clouds in the southeast caused variations in the curve until about 11:15 A. M., when the sky cleared and the curve rose rapidly, reaching its maximum at about 12:30 P. M. Shortly after 2 P. M. the sun entered a bank of clouds in the southwest, reappearing for a short while between 3 and 4 P. M. and again for a brief interval at 5 P. M. It will be noted that the peak load of 43,000 kilowatts on April 24 was reduced to 39,000 kilowatts on April 25.

Occasionally a customer objects to the charge rendered for electricity during the winter months on the ground that it is too high, and bases his objections on the amount of his bill for the corresponding month in the previous year. If the company has data on file showing the percentage of clear and cloudy days for these two months, however, it is sometimes possible to show the customer that the increase is due to a period containing many cloudy days.

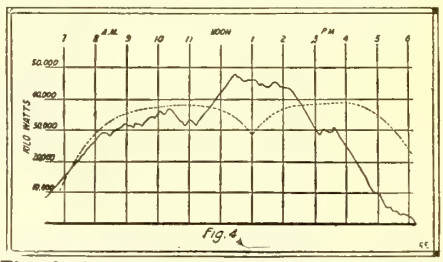


Fig. 4. Note the Coincidental Points Along the Two Curves of "Daylight" and "Electric Load." These Curves are Very Valuable to All Central Stations. Curve for April 25th.

The Structure of Electricity

By Dr. Alfred Gradenwitz

IN the course of the last few decades our views regarding the nature of electricity have undergone great changes. Once upon a time a theory was generally held, according to which two imponderable fluids, a positive and a negative one, would by their shifting arrangement give rise to the electrical phenomena then known. Maxwell in England and Hertz in Germany, however, at the end of the last century introduced another theory according to which electrical and electromagnetical phenomena would be due to ether waves of a similar nature to those of light.

More recently there has, however, been a general tendency for a revival of material conceptions on the nature of electricity. The same as matter is made up of indivisible small elements, *atoms,* electricity would consist of elementary quantas, *electrons.*

In opposition to this doctrine an Austrian scientist, Dr. Felix Ehrenhaft, Professor of Physics at the University of Vienna, however, already at the Königsberg Congress of Naturalists in 1910, drew attention to the fact that this would-be minimum charge—the electron charge—though being ascertainable as average value, is inaccessible to human observation in the individual particles. In a paper recently read before the Austrian Society of Architects and Engineers, he exposes his further researches on the same subject, which not only give an insight into the very structure of electricity, but at the same time into the physics of minute particles—of the order of the millionth part of a centimeter.

A Glance into the World of the Millionth Part of a Centimeter

Globules of such incredibly small dimensions are arranged between two parallel, horizontal plates connected to a positive and negative tension respectively and, accordingly, constituting an electrical condenser, the globules themselves being charged negatively. Each globule then is by its weight drawn downward, while the electrical tension acting on its charge is pulling it in an upward direction. If, now, the condenser be connected to a tension just sufficing to draw the globule slowly towards the upper plate, the upward pull, which is dependent on the charge of the globule and the tension applied, will exceed the weight of the globule. The tension applied is afterwards reduced by degrees, until the globule just falls downwards in a vertical direction, thus confining the tension between two boundary values, the rising and falling tension, respectively. Inasmuch as these tensions are read off from a sensitive voltmeter, the charge of the globule thus is ascertained with the same accuracy as its weight.

In order now to obtain globules as small, and accordingly charges as minute as possible, it would be best to cause individual atoms to float in the interval between the condenser plates. This, however, is unfeasible, atoms being invisible even to the most perfect optical instruments. In fact, the smallest particles ascertained by means of our best optical instruments have diameters about a hundred times greater than individual atoms. Such particles, however, can neither be produced by crushing nor by stamping. According to the process suggested by Ehrenhaft they are produced by means of the very electricity the nature of which is to be ascertained, an electrical arc being made to pass between mercury, silver or gold electrodes, which are so intensely pulverized or evaporated that the intermediary space is filled up by a rain of particles some millionth parts of a centimeter in diameter.

If, now, the surroundings of these minute metal globules be lighted up with an intense beam of light, a microscope pointed vertically to the beam will disclose a sight comparable to a firmament of surprising splendor and variety of colors; each single luminous point falling, under the influence of gravity, in vertical trajectories, the stronger ones more rapidly, the weaker ones more slowly. The falling speed of all of them is, under the microscope, accurately measurable. Furthermore, each of these minute particles will, under some mysterious impulse, perform vibrations and move to and fro on zigzag lines. These Brownian movements, so far known only in liquids, are due to the nearly molecular dimensions of the particles in question.

These metal globules having been charged with variable amounts of electricity, Prof. Ehrenhaft each time—in accordance with the above—determines the tension at which a rising or falling respectively can be observed in the microscope. He therefrom ascertains the actual charge, the size—or weight—of the particles being known. Apart from the mechanical method—by means of the speed of falling—this weight

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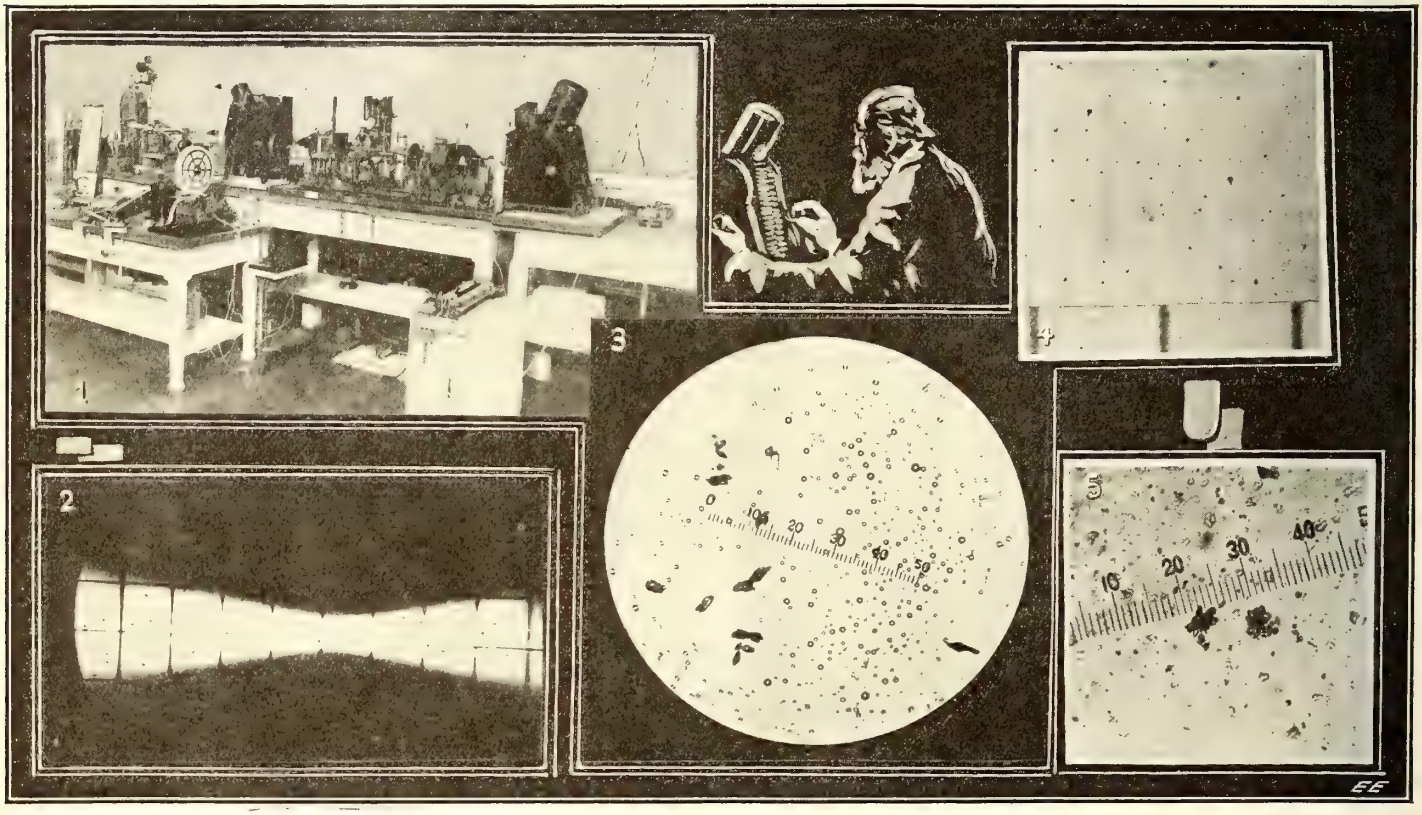


Fig. 1—Prof. Enrenhaft's Experimental Laboratory Apparatus Used in Examining the Structure of the Electron and Atomic Family. Fig. 2—Powerful Beam of Light Rendering Minute Particles Visible in Microscope. Fig. 3—Minute Sulfur Globules Mixed Up with Particles of Other Shapes. One Division of Ocular Scale 35.8 x 10^{-5} cm. Fig. 4—Minute Silver Globules Under 2870 Fold Magnification. One Division of Objective Scale: 1.10^{-3} cm. Fig. 5—Zinc Wool (Not Globular) Powder 1305 Fold Magnification. One Part of Scale: 11.5.10^{-5} cm.

How Does Submerged Lady Breathe?

This clever invention, or rather illusion, apparatus is particularly intended to mystify and afford entertainment. By means of this device the performer, let us say, a lady, appears to observers to be totally submerged and to live and breathe in the water, the same as in the air, even to eating, drinking and smoking.

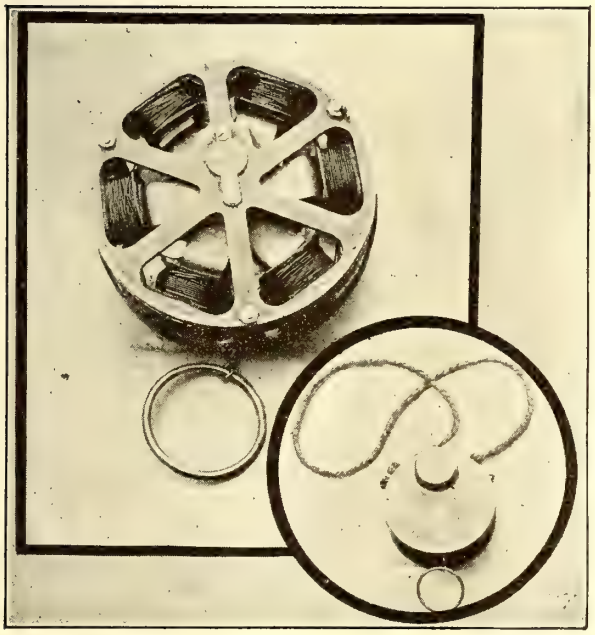
The illustration shows how this trick is performed. A watertight compartment is placed at the top of the structure, while the whole affair is housed in a covering either with cloth or other suitable material. Several water-lilies or other flowers should be arranged in the manner illustrated, one-half of the lilies, for instance, being rigidly mounted inside the glass-bottom water tank, while the lower and large part of the stem is placed in the compartment to be occupied by the performer under the glass bottom of the water tank, but in exact alignment with the upper portion of the plant. In this way it is impossible for an observer looking down from above to see any break in the stem of the plant, particularly when the surface of the water is ruffled, as for instance may be occasioned by allowing the water from the supply pipe to drip slowly into the tank at the top, or else by providing a slight draft of air from a hidden pipe, the stream of air being blown over the top of the water so as to create ripples.

It goes without saying, of course, that the performer, whether lady or gent, has to enter the chamber underneath the water tank unknown to the observers or audience. This trick can be shown on the regular stage by means of a large mirror or series of mirrors placed just back and above the tank so that the audience can see the movements of the performer, who is apparently submerged in the water constantly. In this case the lights can be turned on and then off in the opening and closing presentation of the illusion, or the curtain may be raised and dropt at the opening and closing of the performance.



How Does the Lady Under the Water Breathe? It Proves Very Mysterious to the Uninitiated. The Answer Is—She Is Not in the Water, But in a False Compartment Below the Glass Bottom of the Water Tank.

A Novel German Trench Light



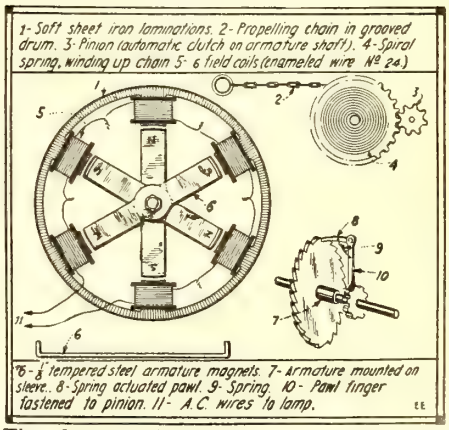
The "Heinies" Ran Out of Flashlight Batteries and Materials As Well As Their Breath, and Here We See the Consequence—a "Dynamo" Flashlight. A Pull on the Chain Ring and the Dynamo Was Spun Rapidly, Generating Sufficient Current to Light the Five-Volt Bulb. A Lens Was Fitted Over the Lamp Bulb.

The accompanying illustrations show an ingenious design of dynamo-electric trench light which was captured from a Boche by an American doughboy. As will be recollected it was very difficult and in fact impossible to secure the many necessary materials in Germany during the war, to manufacture the hundreds of thousands of dry cells required by the Teutonic army and navy. The electric flashlight was one of the most used devices in the lines. The Germans, however, were not so fortunate, at least in the latter part of the war, and so it was that we find this interesting relic of the Teuton military regime in the form of a dynamo excited flashlight.

To obtain a light with this device which was built so as to withstand heavy wear such as is encountered on the battlefield, you simply pull the chain, the lower end of which can be seen in one of the photos, and to which a finger ring is attached. The propelling chain on this generator was about 14 inches long, having a gear inside of the dynamo casing, arranged to co-act with a ratchet in such a manner that the six legs of the permanent steel-magnet armature were spun around repeatedly in one direction. The details of this clutch mechanism are shown in one of the illustrations, and it is very clever in its design. The rotor is composed of three U-shaped steel magnets, as shown in the drawing, and the three magnets are clamped together to form an armature or really a rotating field. The stationary coils of which there were six, were wound with fairly heavy copper magnet wire, about No. 24 B. & S. gage. These are connected in series alternately, in the usual fashion, so as to give north and south polarity successively.

The casing of the flashlight is finished with a substantial oxid effect, so as to withstand the weather while a braided cord attaches to two rings on the casing, so that it can be suspended from the neck of the user while he pulls on the generator ring as he walks along. The lamp throws a good beam of light, the bulb itself being a small screw-base type, fitted in a reflector with a lens in front of it. The dynamo generates a low voltage, equivalent to a few cells of battery, and the current is surprisingly steady—almost flickerless in fact, when the generator chain is pulled in a fairly rapid manner.

There are several American concerns developing a magneto light of this type—i.e., one in which a small dynamo is rapidly spun by hand or finger action to produce electricity for lighting the lamp, instead of depending on a battery for the purpose. The problem appears very simple, but apparently is not as easy to solve as would at first appear, especially in a small lamp.

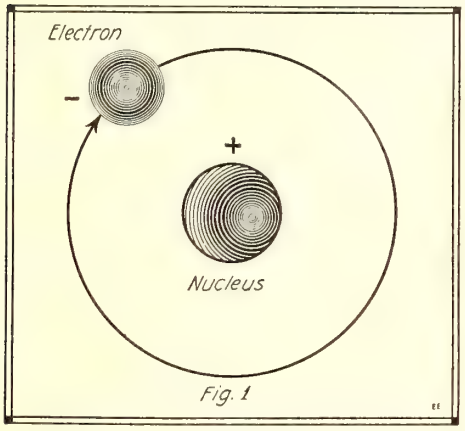


The Interior Mechanism of the German Trench Light, Showing How the Dynamo Armature Was Arranged To Be Spun By a Chain and Drum Clutch.

Is There a Sub - Electron?

By ROGERS D. RUSK, M. A.

ALL atoms are composed of electrons, but are these electrons composed of still smaller electrical particles? Few scientists dare attempt to say what may or may not be possible. It has not been so very long since the atom itself was believed to be the smallest possible particle of matter and scientists loudly



The Usual Atom in Which a Positive Nucleus Is Surrounded by Negative Electric Charges, or Electrons.

affirmed that it could by no means be subdivided. But they were mistaken.

When the electron was discovered a new age of electrical science was ushered in and Sir William Crookes, with a flash of marvelous scientific insight, said that matter had been discovered in a fourth state, neither solid, liquid or gaseous, but more ethereal than the lightest gas. How true that statement was, was later seen when it was found that the electron was really nothing more than a particle of electricity a *hundred thousand times smaller than the smallest atom.* Here indeed was matter in a fourth state and the atom had been divided!

The question which confronts us now is this: Can the electron be divided into still smaller particles of electricity which we might call *sub-electrons* or is it indivisible? Is *it* the natural unit of electricity which is invariably the same, or are there different sizes of electrons? The discovery of the electron first revealed to us the electrical nature of all matters, and we hesitate in even guessing what the discovery of a sub-electron might not reveal. Notwithstanding this there are those who already believe they have strong evidence in support of the existence of such a quantity.

In the past twenty-five years since the discovery of the electron the science of Physics has almost been revolutionized. Phenomena which could not be explained before are now being explained by it, and the discoveries and inventions such as X-rays, radioactivity, vacuum tube valves, amplifiers, etc., are too numerous to mention. No scientist in the face of these facts would dare predict what the discovery of a sub-electron might not bring about.

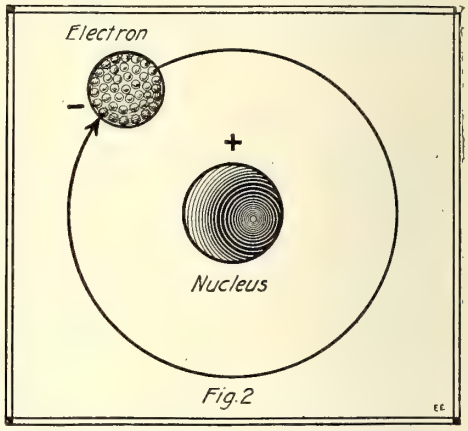
As the matter stands today, those who believe the electron is the fundamental and invariable unit of electricity do so because they hold that the electron is indivisible, as did the older scientists who held the *atom* to be indivisible. On the other hand those who believe in the existence of a sub-electron say we have no right to assume the electron is indivisible and that we may be as badly mistaken as the older scientists were about the atom. Let us see what the evidence really is on each side of the question.

In the first place no two men have ever been able to measure the size and charge of an electron and obtain exactly the same values. Even measurements by the same man vary so that only an average value can be obtained. Just what the exact values are, if there really are any, no one knows. Ehrenhaft of Vienna claims this variation is due to the electrons not all having the same size, shape and charge. In order to explain these seeming variations of the electrons, Ehrenhaft claims they are composed of sub-electrons and that not all of them have the same number. Some may have more and others less according to some unknown law of chance or variation. This is an interesting point because it immediately brings up the question as to whether there is a variation of this kind in the physical world like there is in the world of living things. It is such a common fact that we scarce think it strange that no two human beings are exactly alike; no two flounces are exactly alike, and no two animals, even of the same species, are identical. Can it be that there is similar variation in the physical world of inanimate objects? So far the science of atoms, molecules and electrons has always been based on the assumption that all particles of one kind are identical, partly for the purpose of avoiding mathematical intricacies.

Prof. Millikan, whose work on the electron has made him justly famous, takes strong exception to the views of Ehrenhaft and others who claim there is a sub-electron. He maintains that the variation in measurement of the electron is very small and within the range of experimental error. Table I shows some of the earlier and some of the more recent values for the charge of the electron. It will be noticed that the more recent values *do* agree quite closely. The strongest point of Prof. Millikan's argument, however, is based on his famous experiment with the charged oil droplets in which he obtains some of the most remarkable results of modern experimental science. In measuring different charges on the oil droplets he found that they were almost exact multiples of the value of a still smaller charge. And this smaller charge was the electron itself, showing that greater charges were all built up of groups of electrons, and that these electrons must constitute the fundamental electrical unit. The agreement of the values is so remarkable that some of them are shown in Table II. The number 4.917 was taken for convenience and is proportional to the charge on the electron. The different charges were measured in the same ratio. Exact multiples are given in the first column and the observed values in the second column. For instance, five times the value 4.917 for a single electron would be 24.59 while the value which was actually observed was 24.60. That Ehrenhaft's own values show no such striking agreement may as likely be due to errors in observation as to actual variations in the electrons themselves.

The difference between the two theories can be easily visualized by means of the accompanying diagrams. Figure I shows the usual atom consisting of a small nucleus about which one or more solid electrons or electrical units revolve. In Figure II the opposite view is indicated by an atom which is exactly the same except the electron is pictured, not as a unit particle of electricity, but as a *composite* body composed of a greater or lesser number of still smaller particles of electricity or energy in its *ultimate form.*

Up to the present time most of the evidence is in favor of the idea that the electron is the natural unit of electricity, and the evidence in favor of the *sub-electron* theory is hardly substantial enough to obtain general credence. It would be folly



In This Hypothetical Atom, the Positive Nucleus Is Surrounded by Negative Carriers or Electrons, Each Electron Being Composed of Sub-Electrons.

to think however that nothing of the kind may not occur in the future. As the matter now stands there is no experiment which proves the existence of a sub-electron, while on the other hand the existence of the electron is a pretty well established fact. We must remember, however, that the existence of the still smaller particles or sub-electrons has not been disproved and those who believe in the existence of such have both an interesting and a powerful point.

To sum up the arguments on both sides; those who contend there may be a sub-electron say we have no more right to think the electron is indivisible than we had to think the atom was indivisible. In addition they say there is no reason for believing that Nature has established any unit or definite particle of electricity, and lastly they claim that the disagreements between the measurements of electrons by different people indicates that the electrons are not all the same size.

Those who argue against the notion of the sub-electron declare the evidence is all on their side. They claim that the latest and most careful measurements agree within a small fraction, and that the differences are easily due to unavoidable experimental errors. Furthermore from Prof. Millikan's work they claim it is evident that all charges must be built up from multiples of a single charge, hence this single charge must be the natural unit.

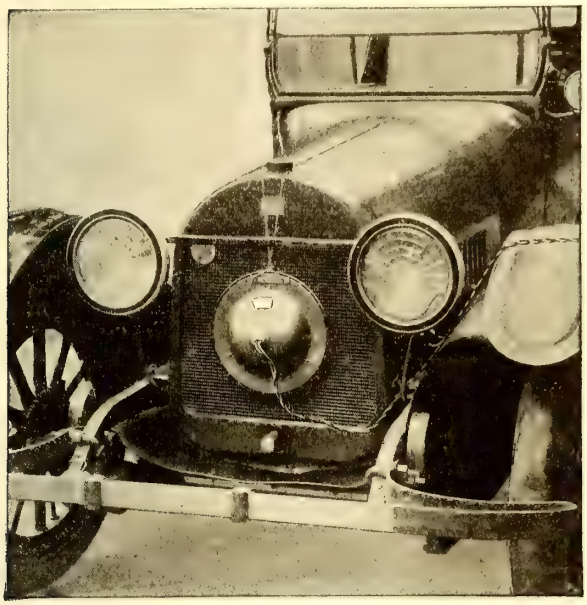
It is hazardous to attempt to tell what wonders the discovery of a sub-electron might not lead to. It might enable us to solve the mystery as to what the *positive particle* is. It might reveal to us the secret of the real nature of electricity and energy. It might—but then what is the use of trying to guess what it might do? At least it would be as important in its turn as the discovery of the *atom* and the *electron* were in theirs. But at present there is no practical advantage to be obtained in considering it, as such an advantage will only result when we have sufficient data concerning a thing to make use of it in our calculations and to take it into consideration in our experiments.

(*Continued on page* 961)

. . . AUTOMOBILE NEWS . . .

ELECTRIC HEATER FOR AUTO RADIATOR.

Herewith is shown a new electric engine and radiator heater for the auto. It will keep any radiator and engine from freezing in the coldest weather while the car



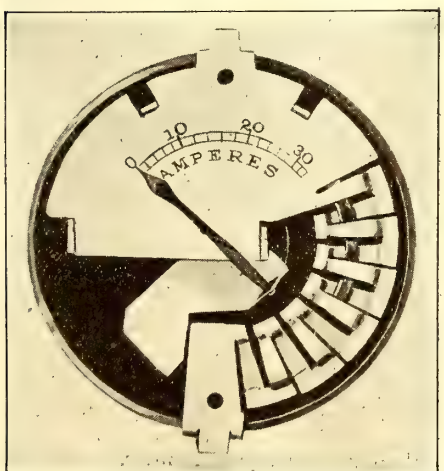
In the Garage Hook Up This Electric Radiator Heater to Your Car. It Will Save You Much Trouble and Expense.

is in the garage. The heater hangs from the filling cap, snugly against the radiator and sends waves of hot air thru the radiator into the engine. Every inch of the cooling system is reached and the water is always kept at an above-freezing temperature. You don't have to lift the hood to adjust it. It is on and at work in a minute. With it on the job, no matter how cold the weather, you can step in your car—push on the starter and it hits on all cylinders immediately. It attaches to an ordinary electric light socket. The building of more and more private garages, the undesirable expense and care of a garage heating system and the increased demand for an efficient and practical automobile heater make it a favorite device for the purpose intended.

NEW METER MADE FROM ONE PUNCHING.

This meter is designed primarily to test dry cells and affords the only means of indicating the condition of the cell. It is constructed so that contact may be made directly to the battery without the use of a wire lead, but a terminal is provided so that a lead can be used if so desired.

A dry cell may be tested by placing the metal insertions on the back of the ammeter to the terminals of the cell. Each small division on the dial represents two amperes.



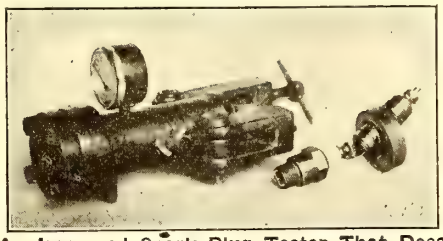
Beat This If You Can! A Battery Meter Made From One Punching.

A one-piece aluminum punching serves as the coil or solenoid, the terminals, the dial plates, the mounting for the armature and the supports for the glass. The whole is placed in a rubber composition case, thus comprising an ammeter of very simple design and construction. This unique construction eliminates soldering and screw connections common in other meters, making a more durable, dependable and accurate instrument.

SPARK PLUG TESTING DEVICE.

It will be of interest to know that Chicago engineers have succeeded in producing a useful and efficient spark plug tester. It has been known for years, that carbonized and cracked spark plugs often produce very puzzling results. They seem to fire correctly in the open air but when replaced in the engine cylinder, their serviceability becomes questionable, in many cases causing a great loss of time.

Compression chambers have been attempted, in which efforts were made to place spark plugs under heavy air pressure to simulate compression. The questionable plug to be tested, was to be screwed into a tapt hole in the wall of a chamber, air pumped into the chamber, and then the condition of the spark on the plug observed thru a thick glass lens. However, this method proved a failure as the average spark plug permits air to escape and if one happens to be air-tight, the joint between it and the chamber usually leaks.

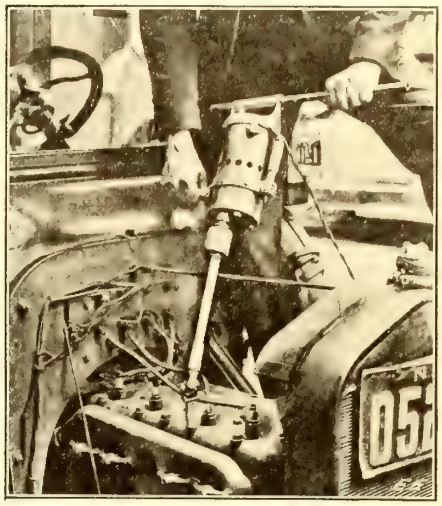


An Improved Spark Plug Tester That Does Not Leak Air.

The new spark plug tester which has just been completed and which is being fully protected by patent proceedings, places the whole plug inside of the chamber. Access to the interior is obtained by using a removable cap prest firmly against the cylinder end with suitable yokes. The terminal of the plug within is connected to an exterior source of high voltage current, thru an insulated connector passing thru the cap. All fixt joints are made air-tight as well as the joint between the removable cap and the end of the cylinder. A heavy glass lens at the end of the cylinder opposite the cap, permits a view of the interior.

AN ELECTRIC WRENCH, DRILL AND SCREWDRIVER.

The new electric wrench, drill and screwdriver illustrated is a new power driven combination wrench by which nuts or bolts can be readily screwed in place and driven home, or removed, without danger of breaking the bolts, or stripping the threads or injuring the wrench. It is a simple mechanical device that can be used as a drill or screwdriver. It is a light hand



New Electrical Valve Grinder, Nut and Screw Driver—a Tool of Many Uses.

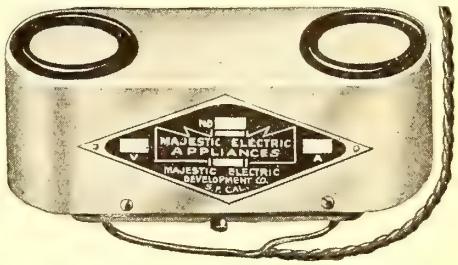
tool that makes available in a safe and efficient way large amounts of power for a considerable number of different uses. It may be briefly described as a small high speed electric motor controlled by a suitable rheostat all encased in a metal cylinder with specially arranged steel worms and gears.

The device can be used as a *power drill* for any size portable drill or revolving tool used by miners or stone cutters. It can also be used as a *power screwdriver* for any size or character of screw where power and speed are desirable. The chuck which holds the screwdriver can be placed in the clutch in such manner as will automatically release the screwdriver when the screw is firmly seated. Also as a *power grinder* for grinding out auto cylinders and valves or as a *power buffer*.

The motor operates in either direction, having three speeds forward and three speeds in reverse. The motor operates on either direction current or alternating current on 110 to 120 volts.

A. C. OR D. C.? USE NEW CIRCUIT TESTER.

The new Current Determinator is an instrument as simple in operation as it is certain. To operate it, all that is necessary is to place the end plugs to the wires or terminals, press the button at the bottom of the Determinator, and if the current is direct, the letters "D. C." will instantly appear within one of the circles at the top of the instrument; if the current



New A. C. and D. C. Tester.

is alternating, the letters "A. C." will appear within the other circle. The brilliancy of the light back of the letters A. C. or D. C. tells whether the voltage is 110 or 220.

The Amateur Magician

By JOSEPH H. KRAUS,

THE MAGIC "FIRE-BOWL"

A SHORT time after I stept off the train, I arrived at the pretty Long Island home of Professor Henri Hargrave, the noted magician. The servant admitted me a few moments later, and ushered me into the professor's study, requesting that I make myself at home. Somehow or other I never was able to do this when there are surroundings of the same nature as those at the Hargrave estate, consequently the servant's invitation was, I am afraid, superfluous.

The spacious study filled with weird, mysterious objects was now under scrutiny, each piece of workmanship was critically examined. While thus engaged the Professor entered, just as I turned to meet him.

"Well, well, how are you?" he exclaimed, presenting his hand in a hearty shake. "Have a chair, have a cigar, have a—— What can I do for you?"

These questions were fired at me so quickly, I stood there wondering which one to answer, and while still pondering, altho for only a short time, Professor Hargrave thrust one of the cigars between my teeth, eliminating the necessity of answering his inquiries.

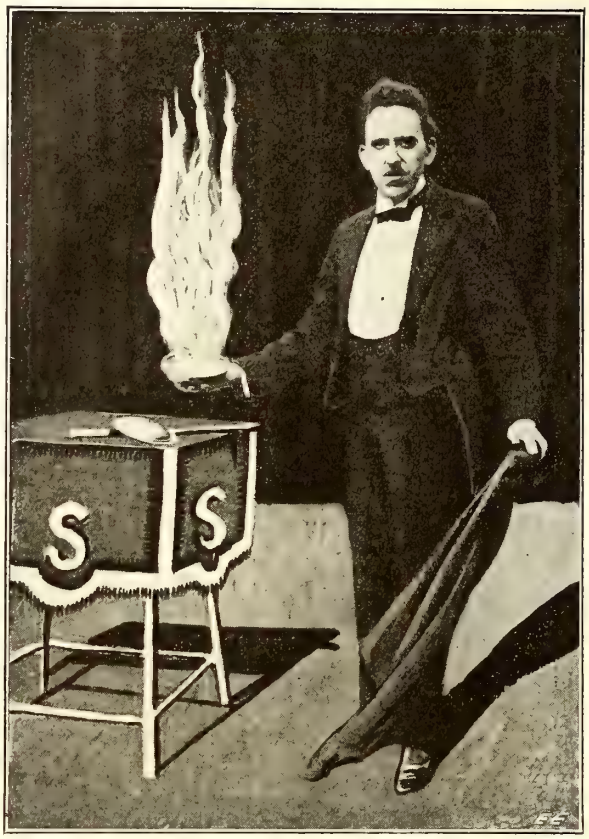
After a few puffs on his cigar, he rose to his feet and said, "Well, 'Old Timer'—what shall we give them this time? Will the 'fire-bowl' do?"

I nodded in the affirmative.

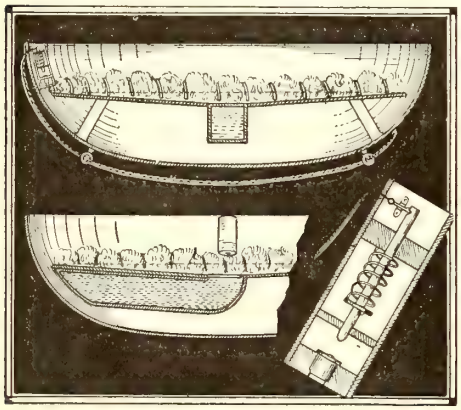
"Don't shake your head, because I can't hear it rattle," he added jocularly, repairing to the back of the study.

A few moments later he stept forward waving a large red cloth in his hands. Showing both sides of this repeatedly, he suddenly produced from its folds a nickel plated bowl, from which poured forth streamers of fire which licked the ceiling.

"You will note that there is very little 'gift of gab' necessary for this trick. It depends more on the result than on the ability to talk. I've performed this same stunt before all the crowned heads of India, the big heads of America and the boneheads of Germany, and it never fails to produce an effect short of miraculous."

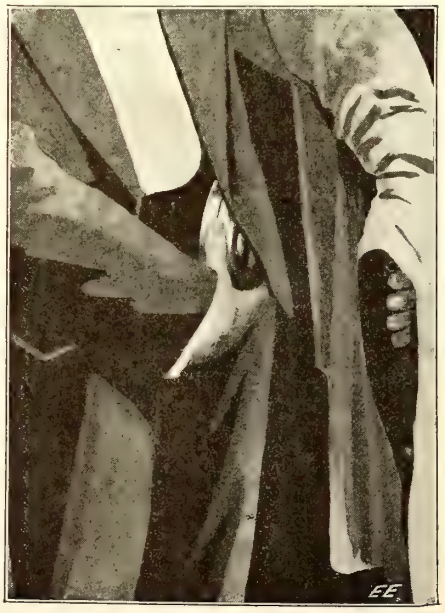


Making Fire While You Wait and So Simple That Anyone Can Do It. Read on MacDuff, Read On.



The Above Drawing Depicts the Construction of the "Fire-Bowl." The Tube Containing Alcohol Is Seen Slightly Inclined, Likewise, the Position of the Pistol-Like Device for Setting Off the Inflammable Mass. Slight Pressure on the String Is Sufficient to Cause the Mass to Burn, Its Flames Reaching to a Height of Four Feet.

While thus engaged with his little epigram, he lifted a cover from the table nearby and placing it on the bowl, extinguished the mass of flaming gases. Removing the cover again with the same speed which characterized all his motions I beheld the same bowl, which only a moment before was belching forth streams of fire, full of flowers of all hues and shapes!



Note How the "Fire-Bowl" Is Suspended from the Belt. It's Great to Have a Little Heat Under the Belt in These Days of "Prohib.," and Just Imagine!—"Real Alcohol" Is Used as Fuel.

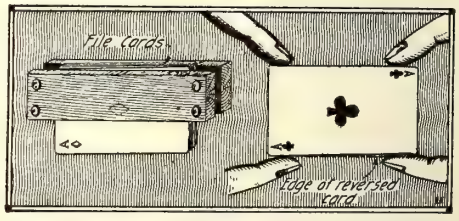
Placing the bowl upon the table and drawing his chair alongside of mine, he said, "Do you think that will do?" and seeing that no reply was forthcoming, he added, "I think so. But what's the matter with your 'weed,' is it out again?"

This, in reference to my cigar which I had forgotten about during the performance. Lighting up both our cigars, he continued with his discourse.

"I think that the best way that I can explain the trick is to show you how it is done, and then you will be more able to grasp the meaning of the various parts and their relation to each other, together with their proper functioning."

Reaching for the bowl on the table he hung it from his vest under his coat in such a position that it covered the lower left vest pocket—then secured the cloth. Waving it in such a manner that one is convinced that there is nothing on either side, he slung it over one arm, covering, in this way the movement of the other hand in it's journey to the bowl. This time it was quite apparent that the bowl did not come from mid-air as it seemed to do originally; but the clever manipulations which the performer executed could only have been gained thru practice.

"You see," he exclaimed, removing the bowl from the table, upon which he had replaced it, and handing it to me, "The bowl is suspended from this little hook on the edge, from the performer's belt, and held in a vertical position, being covered by his coat. In its center you will note a small hollow saucer-like affair, which communicates directly with a long tube. This tube slopes a trifle so as to allow its contents to leak out when the bowl is placed on a level keel. The tube is of course filled with alcohol or some other inflammable material, in an upright position, whence it acts much the same as a bottle with it's cork removed.



Method of Making a Deck of Cards Which You Should Never Use in a Poker Game Unless You Care Nothing for Your Life. The Cards Clamped in a Wooden Vise Are Shaved Down at One End, Whence by Simply Reversing Any Card It May Instantly Be Withdrawn from the Deck, the Fingers Being Placed as Shown.

"Gently sloping toward the central tube receptacle is a round sheet of asbestos, covered with a layer of absorbent cotton fastened in place by wire, and sewed onto the asbestos. The asbestos sheet holds its position by virtue of several sheet iron legs, which are fastened to the bowl with ordinary solder.

"So much for the bowl and it's reservoir. Now we come to the method of igniting the inflammable mass. This consists of a simple holder which will take an

(*Continued on page* 925)

Practical Chemical Experiments

By ALBERT W. WILSDON

HEATING THE HOUSE

At the outset the writer wants to impress upon the reader that he is not aiming to pass upon the merits of the various commercial heating systems now in use, but merely intends to give data on some of the systems and fuels as used for heating in certain

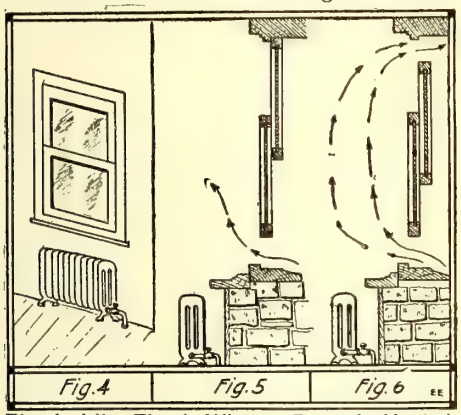


Fig. 4—Like Fig. 1, When a Room Is Heated with the Windows Closed Both Top and Bottom the Highest Efficiency of the Heating System Is Not Obtained, to Say Nothing of the Consumption of Unnecessary Fuel. While the Results Are Not So Vivid As in the Case Where a Candle Is Burned As in Fig. 1, the Principle Is the Same and the Heating System Will Fail to Work Satisfactorily If Provision Is Not Made for the Escape of Foul Air from a Room, As the Fresh Air Will Not Continue to Flow In Unless an Equal Amount Escapes.

Fig. 5—A Fair Method of Ventilation with Radiator By Window, But Not the Best.

Fig. 6—Here a Circulation of Air Is Maintained Constantly, with the Window Open Top and Bottom.

localities that demand certain heating substances be used on account of the facilities at hand to obtain them.

There are at present four extensively used substances employed for heating: 1, Coal; 2, Oil; 3, Gas; and 4, Electricity; and these will be taken up under the various systems utilizing them. Conveniences and disadvantages enter into the question of selecting either of these. In houses coal apparently holds its own as a favorite, probably because once lighted and with proper attention the fires may be kept in for considerable periods of time, and also on account of the number of rooms which may be heated by means of radiators or heated air systems.

Ventilation is as important a factor in heating rooms as the actual heating itself, and mention of this will be referred to thruout this article with practical laboratory experiments.

There are three common methods of heating, i. e., by means of 1, direct radiation; 2, indirect radiation; 3, direct-indirect radiation.

Direct Radiation. Under this heading may be included the open fireplace, stoves or else by pipes or radiators carrying steam or hot water. The open fireplace is not an economical method of heating, because it wastes from 75 to 95 per cent. of the fuel. This form was utilized before boilers and furnaces were introduced and are now used in regions where the supply of wood is abundant and coal or other mediums non-accessible. When heating by means of a stove, air being essential for combustion of fuel, it is thus removed from the room thru the chimney; consequently an equal amount of fresh air must enter the room to make up for that lost. When using a stove, it should be large enough to thoroly heat the room, even in the most severe cold weather, without running at its fullest heating capacity. It is false economy to heat a room with a small radiating surface on account of the air of the room that is in contact with this surface becoming overheated. Stoves largely heat a room by convection, that is, by heating the air that is directly in contact with the stove, and when this becomes heated it rises and gives way to the colder air.

There are openings or draft slides and dampers on the stove which perform special functions and few people bother themselves to find out their uses, being content with merely adding coal as the fires need it, not thinking of the waste of fuel caused in this manner. The openings at the bottom of the stove should be so arranged as to completely shut out the air if necessary, thereby controlling the fire. This method is much safer than the practise of shutting the damper in the pipe as this will drive the products of combustion into the room, which if it occurred during the night, and more particularly if the wind abates, would cause to be liberated the dangerous sulphur dioxid, carbon monoxid and the suffocating carbon dioxid to the detriment of the occupants. It should be borne in mind that when insufficient air is admitted below the fire, more carbon monoxid will result, and the full heating value of the fuel will not be obtained.

Indirect Radiation. The ordinary hot air furnace represents this form of heating. By this means the air to be circulated is admitted thru a duct from the outside of the building and passes over the heated surface of the iron and is then distributed thru pipes to the rooms. Owing to the fact that the warm expanded air leaving a register can hold much more moisture than the cooler denser air that entered the heating passages of the furnace, it has a drying effect and may cause the furniture and woodwork in the rooms to crack and split. By evaporating water in the hot air passages the dryness of the air may be reduced.

New Chemistry Series

The publishers have great pleasure in announcing that they have arranged for a new series of EXPERIMENTAL CHEMISTRY papers, to be prepared by Prof. Floyd L. Darrow, Instructor in Chemistry and Physics at The Polytechnic Preparatory Country Day School, Brooklyn, N. Y. Prof. Darrow is the author of numerous articles and books on the subjects of Chemistry and Physics, and possesses a clear and very interesting style of writing on these topics, which we feel sure our readers will find a real treat.

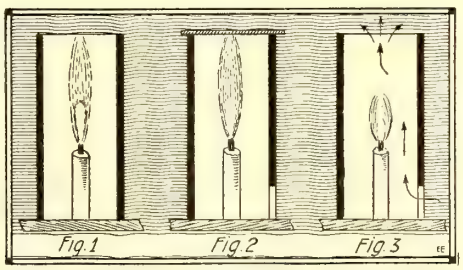


Fig. 1—By Placing a Candle in an Ordinary Lamp Chimney Open at the Top and Fitting Close to the Table at the Bottom It Will Be Found That the Candle Will Soon Stop Burning. This Illustrates That the Fresh Cool Air Will Not Enter Freely at the Top. Fig 2—If We Now Take a Chimney Closed at the Top and Open at the Bottom and Once More Introduce the Burning Candle, the Candle Will Again Go out, Illustrating That the Warm Air Within Prevents the Fresh Air from Entering.

Fig. 3—If We Now Take a Chimney Which Is Open at Both Top and Bottom It Will Continue to Burn. The Cool Air Will enter Below and Drive the Warm (Less Dense) Air Out.

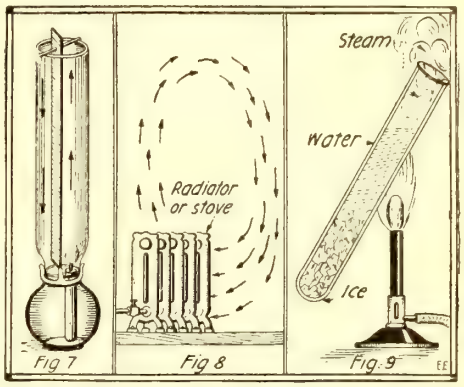


Fig. 7—Let Us Place a Partition In a Chimney with the Bottom Closed As in Fig. 1; the Candle Will Continue to Burn, for Now the Cool Air (More Dense) Flows Down on One Side of the Partition and Pushes the Warm Air Up the Other.

Fig. 8—Illustrating a Familiar Example of Heating By Convection and of Convection Currents in Air. For Laboratory Experiment See Fig. 9.

Fig. 9—Let Us Place Some Pieces of Ice In a Test Tube Fastening Them There with a Coil of Wire and Pour In Water Till the Tube Is Nearly Full, and Then Hold It Over a Burner So That the Heat Will Be Applied At a Point Covered by the Water and We Will Show That the Water Above the Ice May Be Boiled, While There Is Ice Only a Short Distance Below.

In the use of *Steam* with indirect radiation it is convenient to have steam coils in the lower part of the building so situated that fresh air can pass over them, and then by means of suitable flues into the rooms above. Once more it is essential that some provision be made to keep the incoming air moist, and this may be accomplished by placing pans of water upon the steam coils or radiators. If direct radiation is used, one disadvantage of this system of heating is that the air in the room is dry.

Water is used for heating on account of its great capacity for retaining heat. The hot water can be carried thru the pipes to some distance from the boiler, give up its heat and then be returned by means of another series of pipes to the boiler.

The *Hot Water System* has this advantage over steam that as soon as the water is warm enough to circulate it begins to warm the room and the heat is retained for a long time after the fire has been allowed to die down. In the case of steam there is no heat from the radiator till the water in the boiler is above the boiling point. With the use of hot water the temperature of the radiator is never above 100° C. and usually much below this, and with a suitable surface for evaporating water in the rooms the air will be very agreeable. As the temperature of the radiating surface is lower than in the case of steam, the heating surface must be much larger and consequently the cost of installation is greater than the steam system.

In the direct-indirect method of heating air is brought from the outside either behind or below a steam or hot water radiator standing in the room, and is heated in its passage over the radiator. This is also theoretically very satisfactory, as excellent ventilation is secured, tho not often attempted on a large scale.

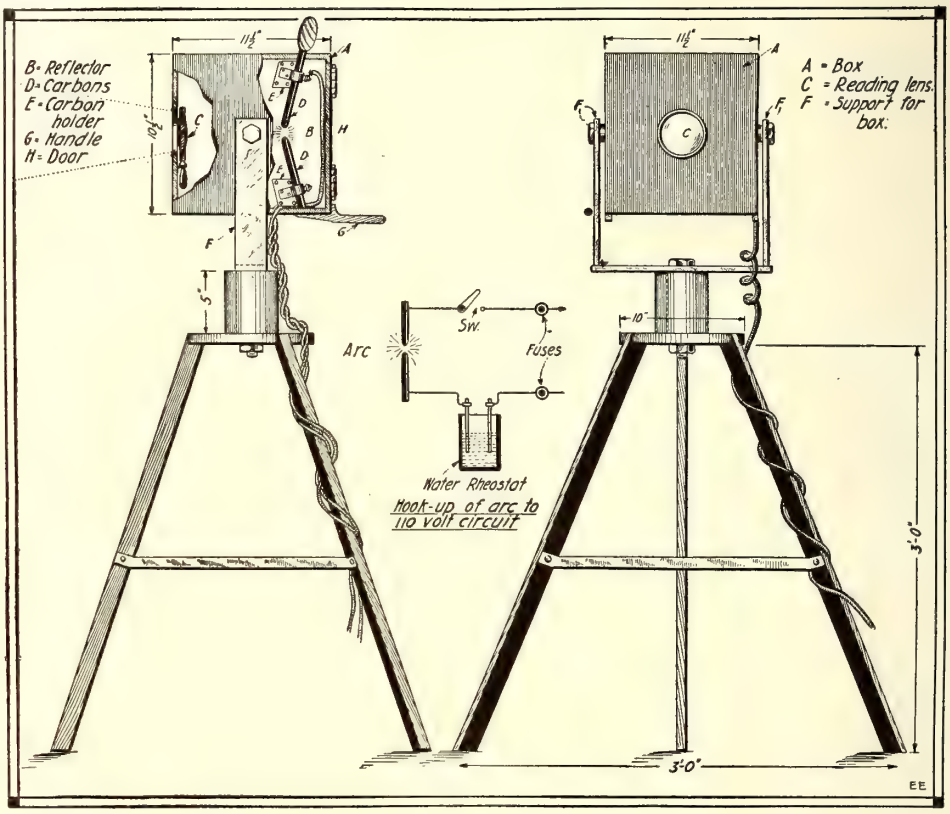
In order to secure good ventilation the fresh air introduced into the room must be ample in volume. It must be free from contamination with dust and germs.

THE CONSTRUCTOR

Home-Made Arc Searchlight

By FRANK CALVERT, Jr.





At Right—the Constructional Details for Building a Home-Made Arc Searchlight of 1,000 to 1,200 C. P. It Is Operable on 110 Volts D. C. or A. C. Above—the Arc in Operation, With Rear Door Open.

I PRESENT herewith plans of an arc type searchlight which I have just built, and I hope fellow experimenters will be able to make use of them.

The search-light is crude but will prove very interesting. It is easily built. It is connected with 110 volts, in series with a suitable resistance. We used a tin can filled with salt water, having two electrodes immersed in the solution thus made.

The box was lined with asbestos. The carbons are fastened to the blocks with strips of tin. The bottom carbon being stationary and the top one loose enough to permit adjustment. The lens was an old reading glass.

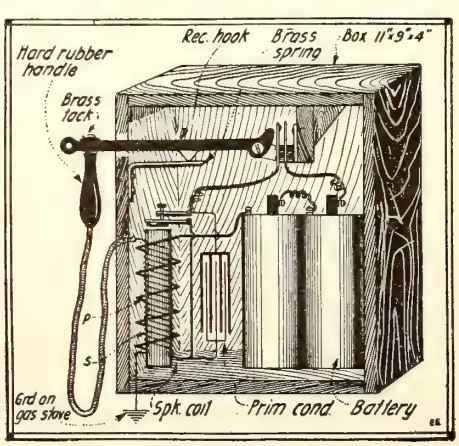
We found that by moving the carbons backwards or forwards the beam can be made smaller or larger. The addition of a door at the back of the box makes it easier to handle the arc. The search-light can be built of pine and the principal dimensions are given in the plans.

I am enclosing a photo which was taken at night-time with the door slightly open. This light will prove highly interesting.

Electric Gas Stove Lighter

I believe every experimenter should be able to construct this electric gas stove lighter, as it is very simple to make, being made of old or discarded parts of a telephone, a spark coil from an auto, a carved hard rubber or Bakelite handle to replace the receiver, which with a sharp knife and sand-paper can be readily made, two dry cells, and a box of the dimensions given in the drawing, to contain the above mentioned articles.

A suitable one-half inch spark coil can be obtained from an old auto, or probably your friend or the local garage has one which can be obtained for the asking. The receiver hook can be taken from any old telephone. There are always three contacts on the hook, but that will not interfere as long as only two are used. The box can be made of ½" white pine and a hinged door attached so that the inside can be accessible at all times.



A Useful Gas Stove Igniter.

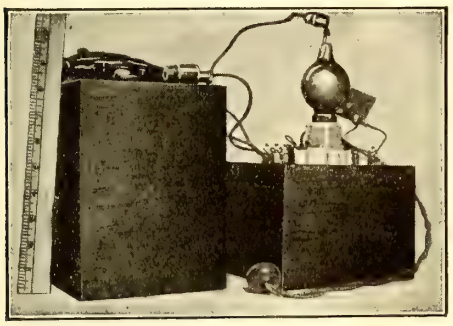
The handle "H" in the drawing, should be at least ½" thick surrounding the wire inside, where the hand grasps it so as to insure safety against a shock while operating it. A hole large enough for the wire to slide thru, should be bored the entire length of the handle. A brass tack or screw can be inserted, after being soldered to wire leading from secondary in spark coil. The other wire leading from secondary should be grounded to gas stove to get a healthy spark, altho the handle wire should be sufficient. This device can be attached to the gas stove or any convenient place near the stove.

Contributed by ALVIN WALSTAD.

A Small Rectifier for Charging Storage Batteries

By ELLIOTT A. WHITE

A SMALL Tungar rectifier for charging storage batteries from 110-volt 60-cycle alternating current requires a General Electric Company's Tungar rectifier tube and standard Edison base porcelain socket, and a step-down transformer giving 2 volts for

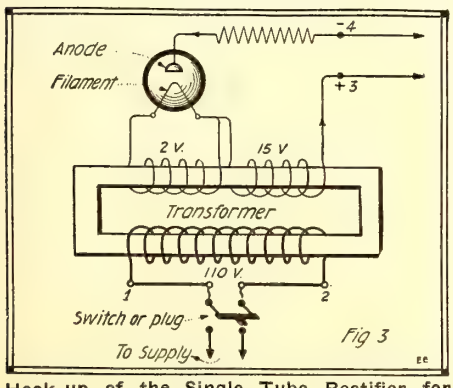


How the Author's Complete Vacuum Bulb Rectifier for Battery Charging Appears. The Size of the Apparatus Can be Judged by the Rule at the Left.

the tube filament and 15 volts for charging. The small tubes are made in two sizes, of 2 and 5 amperes carrying capacity respectively. The outfit illustrated has a 2-ampere tube, costing a little over two dollars, and is suitable for charging storage batteries at a low rate.

The transformer, shown in Figure 1, has extreme dimensions of 5" by 5⅛" by 2¾", and is of the closed core type. The core is 4" by 5" outside dimensions, with a 1½" by 2½" window and a cross-section of 1¼" by 1½", built up of L-shaped stampings. For 60-cycle alternating current and a flux of 60,000 lines, the transformer equation $E = 4.44 \Phi f N \times 10^{-8}$ the winding formula $N = \frac{6.25\ E}{A}$ where N is the number of turns required for a given voltage E, and A is the area of cross-section of the core in square inches; that is, the number of turns required for any winding is equal to six and a quarter times the required voltage, divided by the cross sectional area of the core in square inches. Allowing for loss of area in stacking the core, the following table shows the number of turns required for the three windings for various sizes of core, so that material on hand may be used if desired.

The 1¼" by 1½" core was the one used in the rectifier illustrated in the photograph, and its construction will be described. Other sizes of iron may be used equally well, with proper allowances in



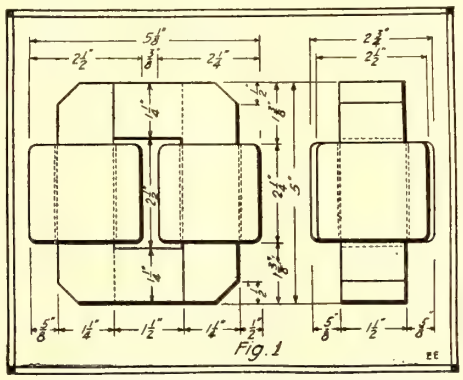
Hook-up of the Single Tube Rectifier for Half-Wave Rectifications of A-C to D-C for Battery Charging.

dimensions. The sizes of wire are: No. 10 D.C.C. or enameled for the 2-volt filament winding to carry the current of around 10 amperes, 8 turns being needed,

Cross-section of core in square inches.	Turns per volt.	Turns No. 20 DCC for 110-volt power winding.	Turns No. 18 DCC for 15-volt charging winding.	Turns No. 10 DCC for 2-volt filament winding.
1 " by 1¼"	5.5	605	83	11
1¼" by 1¼"	5	550	75	10
1" by 1½"	4.5	495	68	9
1¼" by 1½"	4	440	60	8
1½" by 1½"	3.5	385	53	7
1¼" by 2 "	3	330	45	6
1½" by 2 "	2.5	275	38	5

or 4 turns per volt; No. 18 D.C.C. or enameled for the 15-volt winding, to carry the 2-ampere charging current, 60 turns being required; and No. 20 D.C.C. or enameled to carry about 0.5 ampere for the 110-volt winding to be connected to the power supply, 440 turns being required. The 110-volt winding is on one leg, and the other two windings together in one coil on the other leg.

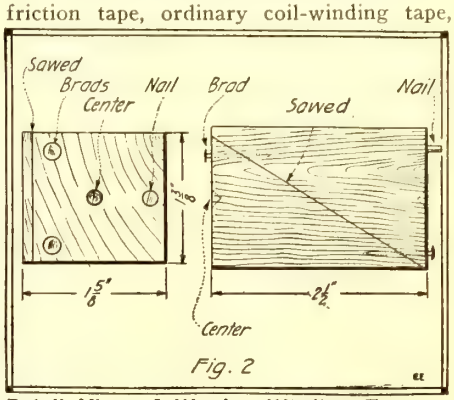
The windings are in the form of coils wound on a wooden form, the core being built up inside the coils afterward. Figure 2 shows the construction of the winding form, a block of either soft or hard wood 1⅜" by 1⅝" square and 2½" long.



Side and Top Views of Rectifier Transformer.

It should be cut 1/16" larger than 1⅝", that is, about 1 11/16" to allow for the width of the saw cut which, made diagonally, divides it into two lengthwise wedge-shaped pieces, held together by brads during the winding but easily removed from the finished coils by extracting the brads and pulling out one of the parts. The form may conveniently be placed between centers in a lathe, with a nail projecting from one end to catch in a dog so that it will turn with the chuck, which may be rotated by hand.

In making each of the two coils the form should first be wound with several layers of heavy paper, the ends of which are secured with shellac. This paper should be allowed to extend ½" or more beyond the ends of the block, to be used later. The wire is then wound on in even layers 2¾" long, to the required number of turns. At the end of each layer the turns may be held from slipping off by 4 short pieces of friction tape, folded once around the end turn (one piece on each side), the tape ends laid back on the surface of the coil, and succeeding turns wound over them to make them fast. When the coil is complete the form is removed from the center as detailed above, and the projecting paper cut in with shears as far as the coil at each corner, then folded up over the outside of the coil. The whole is then covered with friction tape, ordinary coil-winding tape,

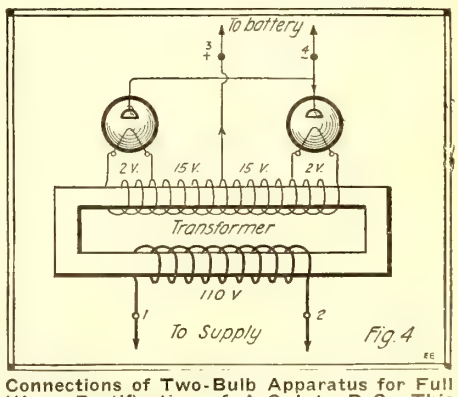


Detail View of Wooden Winding Form on Which Transformer Coils Are Wound. The Diagonal Split Allows of Removing the Core From the Coil Easily.

or cheap cotton tape ½" wide or more, threaded thru the coil and over the outside. This makes a neat and solid job. The tape may then be further secured with shellac. Sleeving should be slipt over the leads before putting on the tape. One coil consists of 440 turns, the 110-volt winding; the other coil of the 60-turn 15-volt winding inside, with the 8 turns of large wire for the 2-volt winding on the outside. The first coil will then have two leads, and the second coil four, two of which may be soldered together (the No. 10 wire being left for the lead), as the 2-volt and 15-volt windings have one terminal in common (see diagram in Fig. 3).

After the coils are finished they may be laid alongside of each other on a table, and the core built up inside of them. To make this easy, they should first be lined with heavy cardboard or fiber, projecting ⅛" beyond them at each end. The core is built up of ordinary transformer iron stampings 1¼" wide, cut in L-shaped pieces 5" by 2¾", the short side of the L being 1½" in length (measuring from the *inside* edge of the long side of the L), to leave a window 1½" wide by 2½" long, as shown in Fig. 1. Two of the L-shaped pieces form one layer. They abut, and, in the same layer, do *not* overlap; therefore they should not be placed tightly against each other, but a space of 1/16" or more should be left between abutting edges. These gaps may be easily closed up afterwards with a hammer; but if they are put in tightly together

(*Continued on page* 958)



Connections of Two-Bulb Apparatus for Full Wave Rectification of A-C Into D-C. This Type Is the Most Satisfactory.

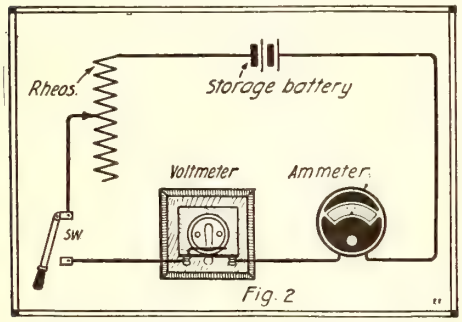
Calibrating Electrical Measuring Instruments

By THOMAS W. BENSON

THE experimenter usually has in his possession electrical measuring instruments of somewhat doubtful accuracy. The checking of these is quite a problem when standards are not available but by the method described here it becomes practical to check their readings with a high degree of accuracy.

By making use of a voltameter we have certain standards that can easily be converted to our purposes, the more common forms of this instrument being the silver, copper and gas voltameters. The silver voltameter is unquestionably the most accurate of the three but, like the copper, it demands a sensitive balance to determine the amount of metal deposited. On the other hand the gas voltameter requires but the measurement of the volume of gas liberated and since such measurement can be made with inexpensive pieces of apparatus this type was selected as the more suitable for general application.

A gas voltameter can be constructed as shown in Fig. 1. A small glass bottle of wide mouth and two and a half inches high is arranged to be mounted on a base which supports an upright of wood one foot high and two inches wide. The cork for the bottle, which should be of rubber, has cut in it four holes. Two holes take carbon electrodes obtained from small flashlight batteries. These carbons are thoroly cleaned by boiling in water for fifteen minutes to dissolve any soluble chemical that may be in the pores of the carbon. Flexible leads six inches long are soldered to the brass caps on the carbons before inserting



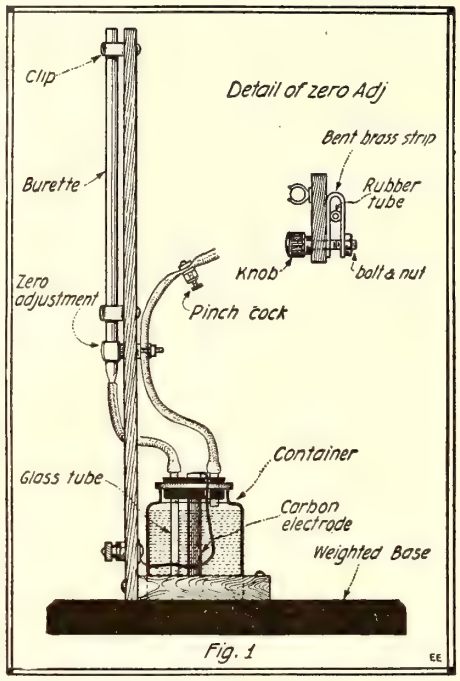
Hook-Up for Checking Ammeter With the Aid of the Voltameter (at Left). Ammeter to Be Checked Is at Right of Circuit.

them in the rubber stopper. These leads to be connected to binding posts in the completed instrument.

Two glass tubes are put into the other holes, one reaching to within one-quarter inch of the bottom of the bottle, the other being flush with the bottom of the cork, both tubes extending one-half inch above the top of the cork.

The cork can then be fitted tightly into the bottle and sealed by painting the top of the bottle and cork with sealing wax dissolved in alcohol. The result is an air-tight seal, a necessity if the work is to be accurate.

This completes the apparatus for generating the gas, it remains to arrange some method for measuring it. The most suitable instrument is a Mohr burette of 10 C. C. capacity graduated to read .05 C. C. This can be purchased for 75 cents. Two clips are fastened to the upright to hold the burette. A hole is drilled in the upright four inches from the bottom to pass the rubber tube connecting the burette with the gas generator. The joints formed by the rubber and glass tubes must be perfectly tight,



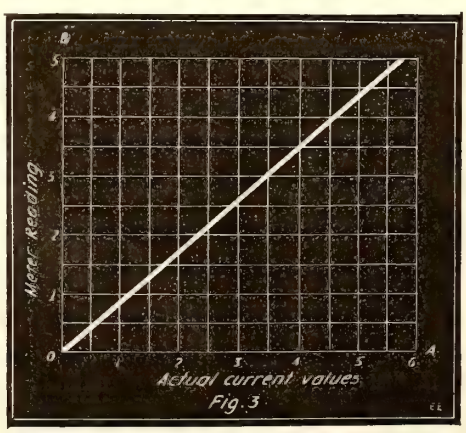
Homemade Calibrated Voltameter. It Is of the Gas Type and Depends on the Measurement of Gas Liberated.

applying vaseline and binding with silk thread will assure this.

A second rubber tube is slipt over the other glass tube extending from the generator. This passes thru a clip operated by a knob on the front of the upright and is arranged to be closed at the top by a screw pinch-cock.

The adjusting clip is made from a strip of brass one-half inch wide and three inches long. Holes are drilled in the ends and the strip doubled in half. An 8/32 nut is soldered over one hole, a long 8/32 bolt fitted with a knob passes thru the upright and one end of brass strip and threads into the nut. Turning the knob one way or the other compresses or releases the tube.

To set the apparatus up. Assemble as shown in the illustration. From C. P. sulphuric acid and distilled water prepare sufficient 10 per cent electrolyte to slightly more than fill the bottle. Open the pinch-cock on the rubber tubing and pour the solution into the burette till the bottle is just full then close the pinch-cock. Pour in more electrolyte till it reaches the zero



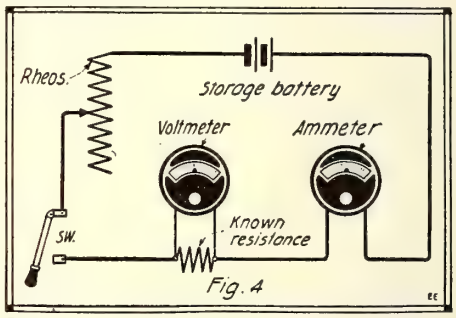
Correction Chart for Checking Up and Calibrating Ammeter. Chart Shows Meter Reading 10 Per Cent High.

mark on the burette or graduate tube.

The solution must first be saturated with oxyhydrogen gas. Connect the voltameter to a source of current allowing one ampere to pass for a minute. The solution will rise in the burette in direct proportion to the gas generated, but take care that it does not flow over the top. Cut off the current and gently shake the apparatus for several minutes.

A wad of absorbent cotton can be put in the top of the burette or a short test tube inverted over it to keep out the dust. After each experiment the solution is returned to zero by opening the pinch-cock on the rubber tube, allowing the gas to escape. This should be done carefully so no electrolyte will be forced out of the tube. Fine adjustment of the column is obtained by the clip controlled by the knob on the front of the instrument. Careful workmanship and neat finish gives a very handsome instrument of value to every experimenter.

The instrument is now ready to be used as a standard for calibrating an ammeter. It has been determined by experiment that one ampere will liberate 0.1740 C. C. of oxyhydrogen gas in one second or 10.44 C. C. in one minute. The instrument described has a rating of nearly 60 coulombs, that is, it will measure current values to that amount. The maximum current, however, should not exceed five amperes; at this density the run should not exceed ten or eleven seconds.



Circuit for Checking Voltmeter, Utilizing a Standard Resistance, and a Voltmeter as Well as Ammeter of Known Accuracy.

To check an ammeter connect as shown in Fig. 2. Two storage cells should be used to supply the current, a rheostat being inserted in the circuit to limit the current. Close the circuit and adjust the rheostat till the ammeter reads one ampere.

Open the circuit and bring the solution in the voltameter to zero by opening the pinch-cock till it drops to zero. Final regulation is obtained by turning the knob on the adjusting clamp, thus compressing or releasing the tube, causing the column in the burette to rise or fall as necessary.

Now, with a watch in one hand, close the switch when the second hand reaches 60, note on a sheet the reading of the ammeter and open the circuit after 50 seconds. Read the C. C. of gas evolved directly from the level of the column in the burette, the actual amperes in the circuit being obtained by the formula:

$$I = \frac{G}{.174 \times S}$$

Where

G = C. C. of gas evolved as indicated by rise of solution in burette.

S = Seconds circuit is closed.

.174 = C. C. of gas evolved per second per ampere.

(*Continued on page* 958)

Instrument for Measuring Radio-Activity

By IVAN CRAWFORD

THERE are many ways of measuring the Radio-activity of various substances, and perhaps the best is by means of the *gold-leaf electroscope.* The author has described this method of measurement in the January, 1919, issue of this journal. Do not think, however, that this is the only method which will give good results. The instrument which is described in this article is a combination of a torsion balance and an electroscope. With some care very accurate measurements can be made.

The torsion balance as devised by Coulomb consisted primarily of a non-conducting rod, having a small piece of metal on one end, suspended by means of a fine metal wire. A glass rod is arranged so as to have one end in the vicinity of the end of the non-conducting rod. When the glass rod is charged it attracts the metal on the end of the rod, and the force thus exerted is measured by the torsion exerted on the wire. Using this apparatus Coulomb, establisht the following laws of electrical action:

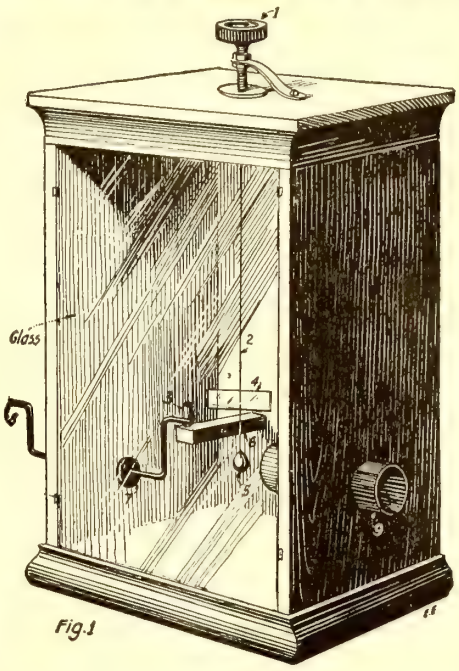
1. *The repulsions or attractions between two electrified bodies are in inverse ratio to the squares of their distance.*

2. *The distance remaining the same, the force of attraction or repulsion between two electrified bodies is directly as the product of the quantities of electricity with which they are charged.*

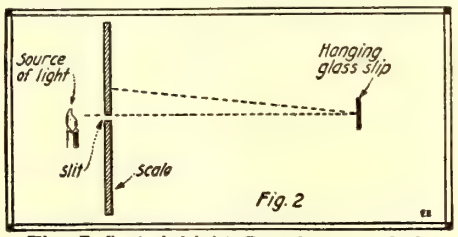
It will be found that these laws affect the working of the instrument which will now be discust. For this attraction works also between two bodies, one charged and the other supposed to be uncharged. For a more detailed account of the action of the torsion balance, the reader is referred to any good physics text-book.

The construction of this instrument, which we shall call the "Torsion Electroscope," is illustrated in Fig. 1. The case is made of half inch oak, 12 inches in height, 5 inches broad, and 4 inches deep. The front of this case is a piece of ordinary window glass, which is held by means of spring clips. In the top of the case a small hole is cut, over which a brass strip is fastened. A spring clip or binding post is attached to this, thru which a round brass rod passes, having a hard rubber knob mounted on the upper end. The torsion portion is attached to the lower end of this rod by means of a drop of sealing wax. This permits easy adjustment of the torsion element of this instrument.

This torsion element is constructed as follows: A small lead weight is attached to one end of a silk fiber or hair, the other end of which is attached to the adjustable knob in the top. A small glass slip is attached to the hair about an inch above the weight. This slip is formed by cutting in two a thin square cover glass, such as is used in microscopical work. A small piece of gold leaf is now attached to one end of this glass slip, which in turn is attached to the hair by using a dab of sealing wax.



1- Black composition knob. 2- Hair 3- Brass rod. 4- Thin glass slip. 5- Weight. 6- Sulphur insulation. 7- Sulphur insulation. 8- Charging rod. 9- Tube for introduction of active compounds.



The Reflected Light Ray System of the Radioscope.

A wood support about three inches long is now fastened to the back of the case about three-quarters of an inch below the glass slip. The correct position for this support can only be found by direct experiment, as it varies on different instruments. A round hole is bored in the end of this support. One end of a round brass rod about an inch and a half long, well smoothed and rounded, is inserted in this hole. The hole is now filled with melted sulfur, which when cold *insulates* this rod from the support. This is very important.

In order to *charge* this brass rod from the outside, a charger is arranged in the side of the case. A round hole about half an inch in diameter is cut in one side of the case, and a No. 14 copper wire past thru this. Melted sulfur is now poured into this hole. The wire is bent as indicated in the illustration, and in this manner the brass rod may be charged from the outside. In the other side of the case a round brass tube is placed in order to introduce *radio-active substances* into the case. This is accomplisht by means of glass tubes and slides.

The movement of the glass slip is viewed by the use of apparatus illustrated in Fig. 2. A long cardboard scale is placed about a foot away from the case, having a slip cut in the center. A light placed behind this slit sends a beam of light to the glass slip, from which it is reflected back to the scale. The movement of the slip is thus greatly magnified on the scale.

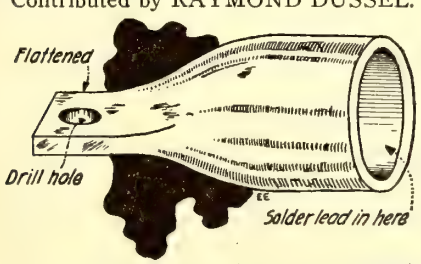
The instrument is used as follows: The round brass rod is charged by turning the charging wire so that it makes contact with same, and then applying an electrified hard rubber rod to the outside end. The wire is then turned away by means of the charged rod so as not to discharge the rod. The hard rubber knob on the top is now adjusted so that the reflection from the glass slip is in the center of the scale. This means, then, that the *attraction* of the round brass rod for the gold leaf on the glass slip is exactly counterbalanced by the *torsion of the hair.* When a radio-active substance is now introduced into the case, the air is *ionized* by the rays, and the round brass rod slowly loses its charge. This allows the torsion of the hair to turn the slip, which movement is seen on the scale. The speed with which the reflection passes over a set number of divisions on the scale is a measure of the radio-activity of the substance. By this means, then, the radio-activity of substances can be accurately measured by watching the spot of light on the scale.

There are many other uses to which this instrument may be put, such as the measurement of the ionization caused by X-rays, ultra-violet rays, incandescent metals, et cetera, and it would be a useful acquisition for any Amateur Physicist's laboratory.

Wire Terminals from Rifle Shells

Good wire terminals can be made by securing copper rifle or revolver shells and placing them in a vise so as to flatten the cap ends. The holes can then be drilled easily. See illustration herewith.

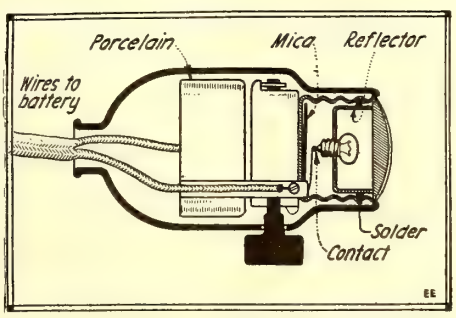
Contributed by RAYMOND DUSSEL.



Good Wire Terminals or Lugs Can Be Fashioned from Copper Rifle Shells.

Bicycle-Lamp from Old Socket

Here is a drawing and description of a simple bicycle or trouble lamp.



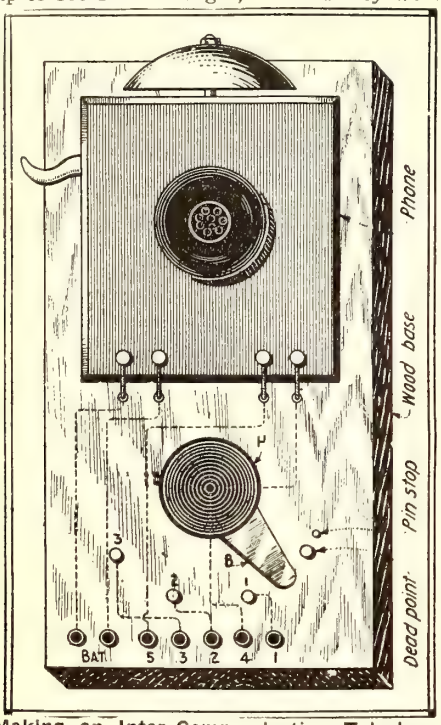
How to Construct a Bicycle-Lamp from a Discarded Socket.

This light can be made from an old electric light key socket and the reflector, together with the glass from a small two-cell tubular flashlight. The reflector is soldered inside of the socket in such a manner that it does not short-circuit it, but when a flashlight bulb is screwed in it, it will make a good connection with the center terminal. The glass is now filed around the edge until it is a tight fit for the small end of the socket case. But be sure it is in good and tight so that it will not be knocked out when the light is carried around. This makes a useful light for a bicycle or a trouble light for a car.

Contributed by CHAS. M. QUEEN.

Selective Switch for Three or More Interphones

Having occasion to use three of the ordinary Interphones, such as are used on lines up to 500 feet in length, I found they were



Making an Inter-Communicating Telephone From a Common Battery Type Instrument. A Switch and Base Board Are the Only Extra Parts.

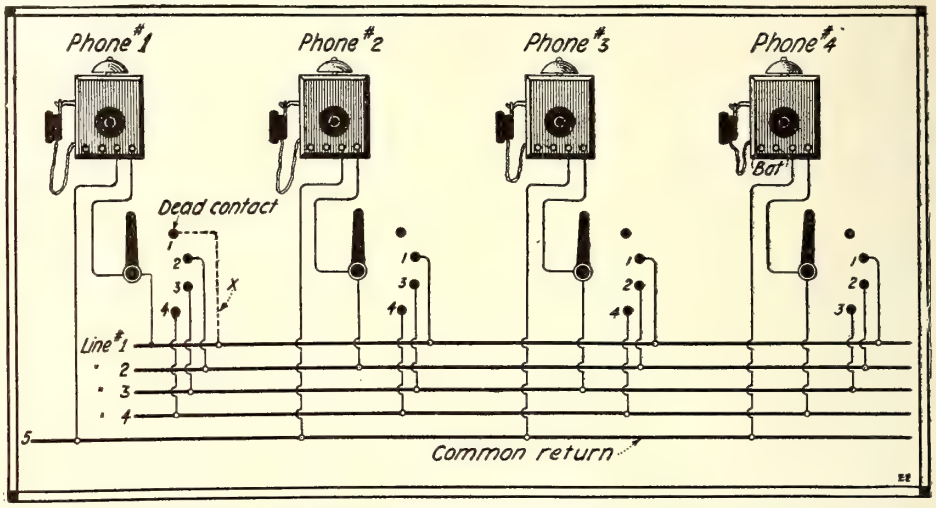
only intended to be used between two stations.

The solution is in the selective switch and wiring diagram illustrated. The switch is simply made up of parts obtainable at any electrical supply house. This switch is normally kept at the right, on dead contact point.

When the user wishes to call a station, he moves the switch blade to the point corresponding to the number of the station he is calling. The 'phone is then employed in the usual way. Upon finishing the message, the handle H must be turned so that switch-blade B is on dead contact, or as far to right as it will go.

This system takes care of as many 'phones as desired. If the user wishes to connect another 'phone, he needs only to run one additional wire and add one contact to each switch. Connect one side of the 'phone to wire No. 5. Connect switch-blade to new wire and also connect new switch contacts to this wire. Other connections are made in duplicate of those in sketch.

Contributed by RAYMOND A. RANSOME.



A 4-Station Inter-Communicating Telephone System Employing Simple Battery Instruments, Converted to Multiple Station Types as Shown in Drawing at Left. A Battery Is Used at Each Telephone, the Ringing Buttons Being on the Instruments Themselves.

[Ed. Note: It is usually found in practice that more satisfactory results are obtained if the "home line" connection "X" is made to the "home point" on the switch instead of directly to the switch-blade as here shown by the full line. Otherwise, when two parties are talking, for instance Nos. 1 and 3, then party No. 2 or 4 can ring in your ear or cause interference.]

Home Made Electric Iron

Here's how to convert your sad iron into a glad iron. This is an electric iron that any amateur electrician can make. It is useful, cheap and can stand a great deal of use and abuse. Its construction is simple, and the parts easy to obtain. The drawing will explain the iron fully. The iron is an ordinary flat-iron fixt up as shown in the drawing.

The *nichrome* resistance wire for the element may be obtained from an electrical supply dealer by getting him to save the old elements he takes out of the standard electric irons for you. The nichrome wire referred to in the drawing was obtained from a Westinghouse heating element. The material was 1/16" ribbon nichrome. New elements for irons may be bought, but are somewhat expensive. The wire is unwound and flattened out. It is wound on 1/32" mica cut out as per drawing. In rewinding, care should be taken to follow the drawing closely as it is very puzzling at first to bring out an end of the wire at each side. By carefully following the drawing there should be no trouble in constructing it. A layer of mica is put on both sides for insulation. The bottom plate is made of cold rolled steel and cut out the shape of the iron. To conserve the heat there should be a piece of thin asbestos of the proper thickness placed around the edge between the top and bottom of the iron, indicated at XX.

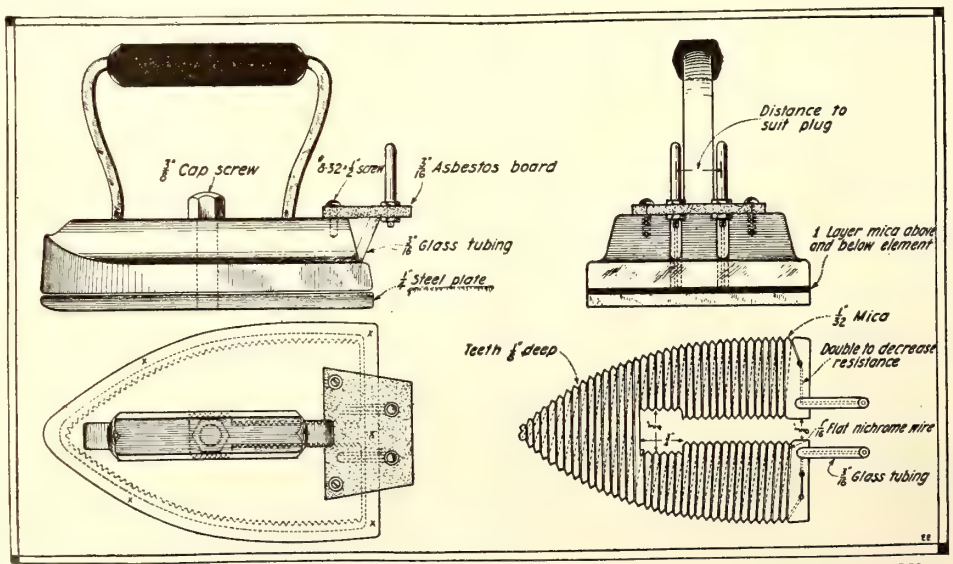
The connection block is made of transite or asbestos board. A connection plug may either be bought or made. If you have an electric appliance with a plug on it a very good idea is to use it for both, such as I have done. The distance, therefore, between the plugs on the connection block depends on the plug used.

The cap screw should be tightened up real snugly and the bottom filed flush. It should then be smoothed and polished. The iron is now ready for use.

Such an electric sad iron will prove a boon to mother and the girls and you will gain their everlasting gratitude by giving them such a convenience—indeed a necessity, today. The longer the ribbon, the higher its resistance and the lower the current as well as the heat produced.

Contributed by PAUL LIFSCHITZ.

[Editor's Note:—On receipt of stamped, addrest envelope, names of concerns supplying suitable resistance ribbons and wires will be furnished gratis.]



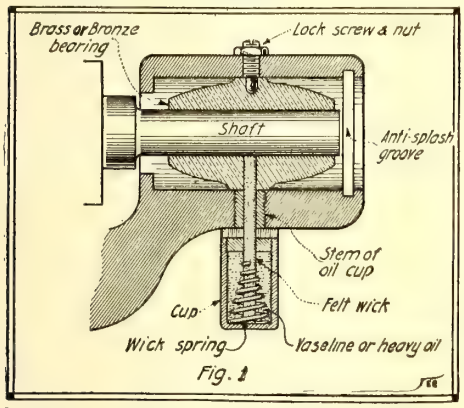
A Good Design of Home Built Electric Sad Iron. The Resistance Wire Is Wound on a Mica Sheet as Indicated.

The Electrical Machinist

By H. WINFIELD SECOR

No. 3—Motor Journals and Bearings.

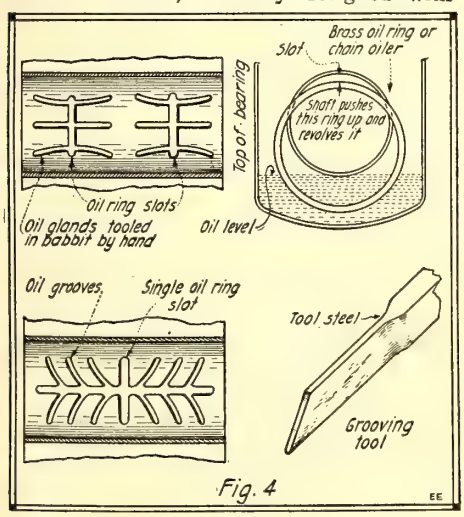
IN the repairing of electric motors and dynamos, particularly in the smaller sizes, and a great deal of which is encountered in the electrical machine and repair shop, there are a number of interesting wrinkles which we will consider here. At figure 1, is shown a typical small size motor bearing with its oil feed cup of the wick type. This type of bearing is used on many different makes of electric motors of 1/6 to 1/8 H.P. It is also used on practically all electric fan motors. This oil cup and bearing design is simple and time has shown that it is thoroly satisfactory for small and medium size bearings.



Typical Small Size Motor Bearing, Fitted With Wick Oiling System, Grease Cups, etc.

The brass cup is threaded onto a shoulder provided with a threaded stem which fits up into the bearing in the manner shown. The cup is usually filled with a cheap grade of vaseline or else heavy machine oil. The lubricant is fed to the bearing by capillary attraction thru the wick, and the wick is prest against the journal of the shaft revolving in the bearing, by the wick spring, —this spring being clamped or riveted thru a hole, or otherwise, onto the wick, so as to maintain steady pressure upward on this member.

The bearing housing is, in the better class of motors, carefully designed with oil retaining rings or anti-splash grooves on both front and back, so that in the event that too much oil is fed to the bearing, it will not be thrown out.



How Rebabbited Bearings are Grooved to Distribute Oil to Shaft Journal From Oil Rings.

The bearing itself is usually of *brass* or *phospor bronze*, preferably the latter, and phospor bronze bearings are used in all size of motors and dynamos, and other machinery, it having proved one of the very best metals for this purpose.

Many motors and dynamos above 1/4 to 1/2 horsepower are provided with *babbitt metal* bearings, and several makes of even the larger size machines are provided with *steel* and *cast iron* bearing sleeves, held in the bearing proper by babbitt metal, as shown in Fig. 3.

In repairing machines in general, it is usual to try and purchase a new bearing from the manufacturer or from a supply house dealing in these parts, which often saves considerable time and makes a far better job all around. Fan bearings are usually procurable from any fan supply dealer or else from the manufacturer of the fan, whose name appears on the name plate thereon, invariably. The amount of play in the shaft can be easily judged at any time by taking hold of the commutator or the end of the shaft, by working it first sidewise and then up and down, and vertically. If this motion exceeds 1/32 of an inch in the smaller machines it is not usually permissible to let this pass, and a new bearing should be substituted or else a relined one, more about which will be said anon.

REBUSHING WORN SHAFTS.

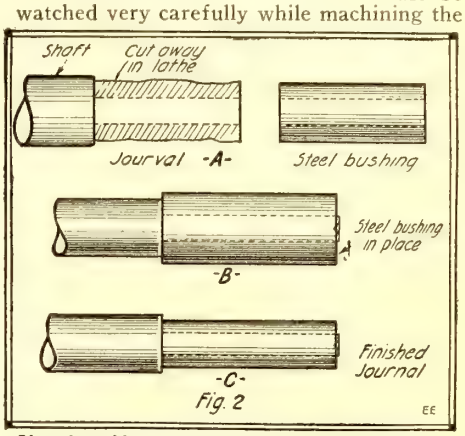
It is not always the bearing that wears, however, as in some cases the shaft, particularly if it is a very mild or soft steel, will "cut" until it is filled with grooves, even to the point where it resembles a machine screw. Of course it is foolish to place a new bearing or bearings in a machine in which the shaft is worn to such an extent.

Some electrical machinists follow the easiest road in such a case and simply take a pair of somewhat smaller bearings and turn down the shaft to fit it, thus obtaining a new and smooth cylindrical surface on the shaft. This is sometimes permissible, but usually it is unsatisfactory for the reason that the designer of the machine made the shaft of its original diameter so that it would not heat up on long runs, etc. Therefore the original size of the shaft should be retained whenever possible, and it is the standard rule in all first class electrical repair shops, to maintain this practise.

Figure 2 shows how such a worn shaft is "rebushed," in this case, with a steel sleeve shrunk onto a turned down journal. At figure A, the worn journal is shown clearly and also the part which is to be cut away in the lathe.

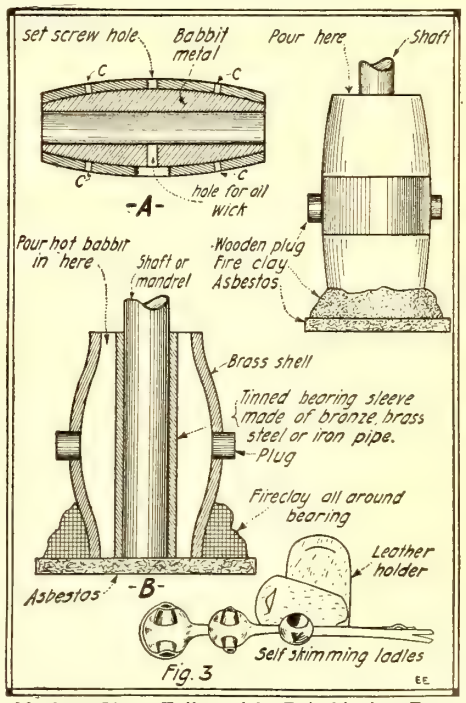
By means of inside and outside calipers, the reduced portion of the journal is machined with a diamond-point shaped tool, until it is of the same diameter as the inside bore of the bushing, finishing the turned down shoulder as smooth as possible and touching it up a bit with a fine-cut file. The steel bushing is then expanded so as to be driven onto the stem without too much pressure, by heating it cherry red in a gas or other flame.

Fig. 2-B shows the steel bushing driven into place on the journal, and it is then allowed to cool. Provided the fit has been properly made, it will be held very firmly on the shaft. The new journal is then turned down to the proper size to fit in the original bearing as shown in Fig. C. Hundreds of armatures have been saved in this way from the scrap pile in several large repair shops with which the writer has been connected, and a first class job is invariably the result. At this point it should be mentioned that the armature must be watched very carefully while machining the shaft in this manner, so that the tool carriage, etc., should not touch the armature and damage the winding. A trick of the electrical machinist in connection with this work is one which, while fraught with the danger of short-circuiting the winding and necessitating the entire rewinding of the armature, is to turn down or file very carefully, the surface of the armature drum. This is sometimes done when after a repair job of this or similar character, the armature is slightly out of center, and comes too close to the pole-pieces of the machine. As before mentioned, it is hardly to be recommended, but as this has been done many times in electrical repair shops, it is mentioned here for what it is worth, and providing the laminations of the arma-



Showing How a Badly Cut Shaft Was Rebushed so as to Fit Standard Size Bearing.

(*Continued on page 952*)



Various Steps Followed in Rebabbiting Bearings. At Bottom—New Self-Skimming Ladles and Leather Holders for Ladles.

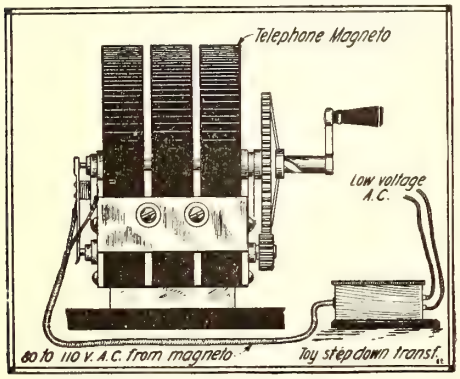
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

USING MAGNETO ON TOY TRANSFORMER.

An inexpensive source of current for our young Experimenters can easily be ob-



A Clever Stunt—Using the Magneto on a Step-Down Transformer for Ringing Bells, Operating Small Motors, Etc.

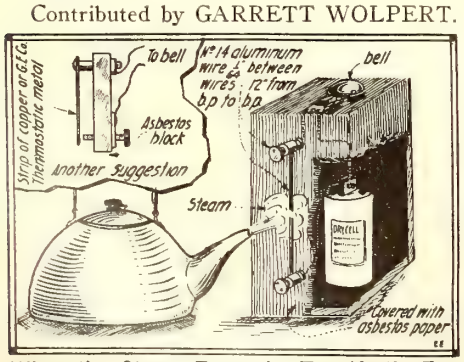
tained with the following apparatus: A 110-volt telephone magneto generator, and a toy step-down transformer are all that is necessary. The plug should be removed from the transformer and the wires connected to the magneto as shown in diagram. The magneto may be operated by crank handle or attached to sewing machine, water motor, or other surplus power. The current obtained from the terminals when the magneto is run at a moderate rate of speed, is strong enough to ring bells, operate buzzers, etc., and should prove very useful when a small amount of current is required.

Contributed by JOHN P. SORENSEN.

A TEA-KETTLE ALARM.

Now that the winter days are here, the housewife will be anxious to have a kettle alarm undoubtedly, one that will tell her when the water is boiling, instead of having to wait in the kitchen to ascertain this fact. This electric alarm device should be of convenience to her. The aluminum which is heated by the hot steam expands, thereby making a circuit which rings the bell.

Contributed by GARRETT WOLPERT.



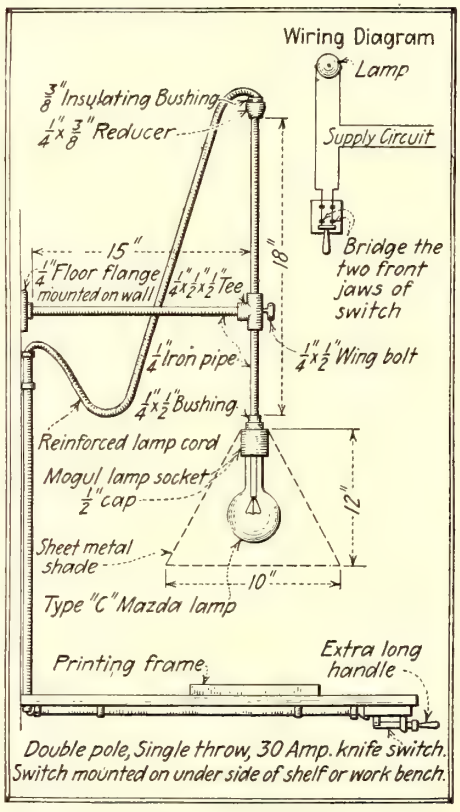
When the Steam From the Tea Kettle Expands the Metal Strips, They Touch and Close the Alarm Bell Circuit.

SECOND PRIZE, $2.00

A HIGH-POWER PHOTO PRINTER OF TRIED DESIGN

Having been a reader of ELECTRICAL EXPERIMENTER for some time, being an engineer by profession, also a hobby rider, the writer is taking the liberty of submitting to this Department a device which it is thought many people inclined to do photographic printing will appreciate.

The accompanying sketch explains the device in detail. It is designed from one which was constructed from shop odds-and-ends, and has for some time been doing continuous daily service in one of the Government photographic laboratories at Washington, D. C.



A Rapid Photo-Printer Which Has Been Tried by the Author.

Printing machines, boxes and other devices have their advantages, but this device is possest of a number of valuable features.

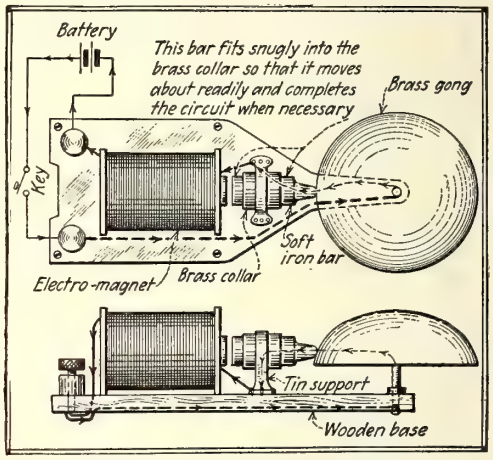
Some features: Inexpensive to make; readily adjustable; very little maintenance required; simple to operate; has maximum factor of safety; all forms of "dodging" and "shading" printing readily performed; if desired medium lamp socket may be used in place of Mogul socket and intensity of printing light easily varied by changing various sizes of light bulbs or an adapter may be used in the Mogul socket to accommodate bulbs with medium-sized bases.

Contributed by C. A. PURDY.

THIRD PRIZE, $1.00

THE SIMPLEST BELL—WORKS BY GRAVITY.

Herewith is a sketch of a gravity-operated bell which I have made.



Very Simple Form of Electric Bell—the Circuit Is Made and Broken by the Rise and Fall of the Hammer by Gravity.

The simplicity of this bell enables anybody to make one for his own use. It consists of an electro-magnet, an iron bolt-head or bar (which is able to slide readily thru a brass collar) and a brass bell or gong.

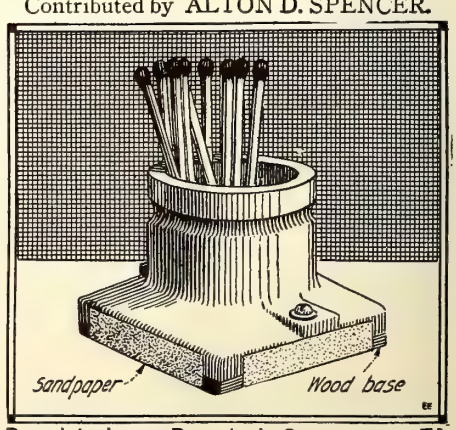
When the circuit is closed the magnet is energized and attracts the iron core. This opens the circuit as the core is pulled away from the gong; and the weight of the hammer forces it down upon the bell, thus completing the circuit once more. This action is continuous. This type of bell does not necessitate a spring.

Contributed by MANUEL E. SPRING.

LAMP RECEPTACLE A HANDY MATCH HOLDER.

A match holder may easily be made from the porcelain portion of a discarded electric light receptacle. A piece of cigar box or other wood may be fastened to the bottom by means of screws. A piece of sandpaper may be glued to the side if desired.

Contributed by ALTON D. SPENCER.



Porcelain Lamp Receptacle Serves as an Effective Match Holder.



SILVER PLATING SCIENTIFICALLY DONE.

Silver plating by electrolysis, the amateur usually finds a difficult operation. But this is because he does not know and observe the necessary precautions. In electroplating of all kinds the prime consideration is absolute cleanliness.

Set up your plating bath as shown in the diagram, using about 8 gravity cells or 4 storage cells. An ammeter connected as shown is highly desirable. A solid silver anode about the size of a quarter must be suspended at the positive pole and the object to be plated at the cathode or negative pole.

First polish the object to be plated after

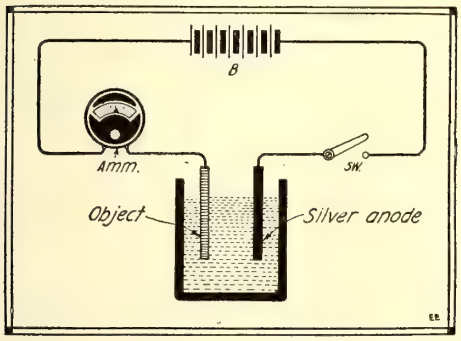


Diagram Showing How to Set Up the Silver-plating Outfit.

which remove the grease that will surely adhere to it by dipping in water and then for a half minute in a cleaning solution made as follows:

Caustic soda.....100 grams
Water (preferably distilled).....1000 c.c.

The temperature of this solution should be about 40 degrees Centigrade, or 104 degrees Fahrenheit. Remove the object, rinse in clear water and then to remove certain oxides that still remain on the surface dip for a half minute in the following solution:

Potassium cyanide (very poisonous) 25 grams
Water (preferably distilled).....1000 c.c.

After removing from this solution rinse as before in clear water and avoid thruout handling with the fingers, which will again leave grease upon the surface.

Now to roughen the surface so the silver will get a firm grasp place the object for a few seconds in the following solution:

Mercury (dissolved in *dilute* nitric acid) 1 gram
Water .....2000 c.c.

Then quickly rinse in about 2 quarts of clean water.

The plating bath itself is made as follows: Dissolve 56 grams of silver nitrate in a small volume of water and likewise 50 grams of common table salt in another equal volume of water. Mix the two solutions and white silver chloride will precipitate. Filter this precipitate in the ordinary way with funnel and filter paper, or better still thru clean unbleached muslin. Wash the residue left on the filter by pouring water thru it.

Then make another solution of 225 grams of potassium cyanide in 1600 c.c. of water and in this solution dissolve the residue of silver chloride from the previous operation.

Heat the plating solution to about 45 degrees Centigrade or 113 degrees Fahrenheit and place in the plating jar. Having placed the object to be plated at the cathode, close the switch and allow a current of 2 amperes to flow for 30 seconds.

Then remove the work and rub with very *fine* sand to determine whether the silver is depositing evenly. If it is not, repeat the whole process, starting with the first cleaning solution and ending with the electrolytic deposition of silver having as before a current of 2 amperes.

Now cut out all but one cell and with a current of about 3/10 of an ampere continue the process until the requisite thickness of silver has been deposited.

Remove the object, rinse in water, burnish and buff it. Rubbing with rouge—red oxide of iron—is the best method of buffing.

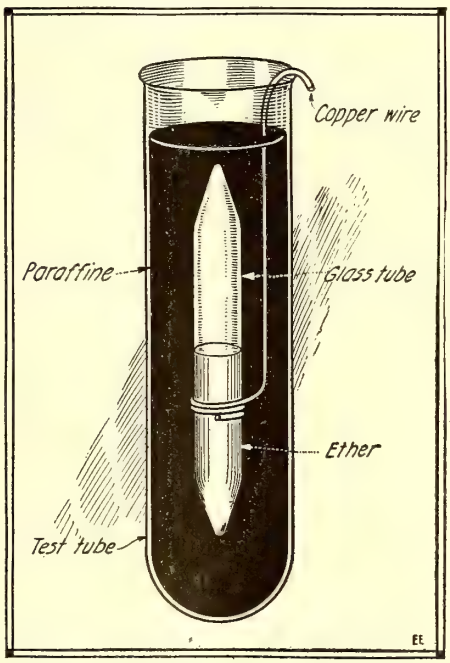
In using cyanides exercise the utmost care. Do not inhale cyanide fumes, for they are poisonous.

Contributed by FLOYD L. DARROW.

THE CRITICAL STATE OF MATTER.

When a gas is at the critical temperature and at the critical pressure also, the increase of pressure or decrease of temperature will convert it into a liquid. When in this condition a gas is said to be in its critical state.

The phenomena of the critical state can be beautifully shown as follows:—Select a test tube at least 8 in. in length and 1 in. in diameter. This should be filled with paraffine. Also procure a glass tube about



A Fine Experiment to Demonstrate the Critical State of Matter. Caution! Use Wire Netting Over Your Gas Flame When Sealing Ether Tube. Very Inflammable.

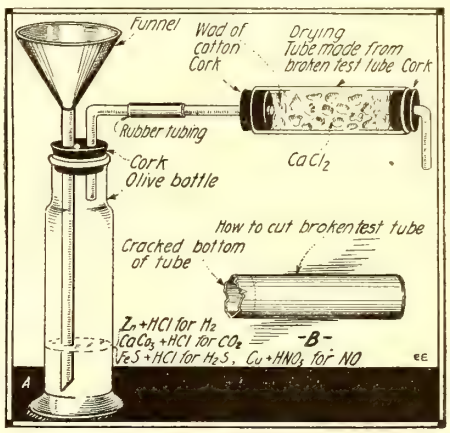
4 in. long and 5 mm. outside diameter. Seal one end by holding in a flame. Fill one-half full with ether, and seal other end with blowpipe. The paraffine is now melted by holding test tube in flame, and the small tube suspended in it by means of a wire, as shown in illustration. On continuing to heat the wax the ether will go thru the critical state.

The first indication of a change of state is the disappearance of the meniscus (the upper curved surface of a liquid), immediately following this flickering striae appear, unrest pervades the tube, and then the liquid has become a gas.

Contributed by ERNEST LINDER.

NOVEL DRYING TUBE FOR GAS GENERATOR.

Large or medium size test tubes break quite frequently, and these tubes may be put to good use by making *drying tubes*



Gas Should Be as Dry as Possible. This Inexpensive Gas Dryer Should Be Welcome in Every Laboratory.

from them. This is done by cutting off the cracked part (B). Procure two corks to fit the ends, each having a hole thru which a small straight or curved piece of tubing passes. (A). Insert one of the corks, and on top of this a small wad of cotton. Then fill the tube with calcium chloride, leaving enough room for another wad of cotton and the other cork. This dries the gases very well.

The generator can be made from a small olive bottle. (A). Bore two holes in its cork, and in one insert a funnel tube, thru the other a delivery tube. This apparatus when made costs practically nothing. Even the funnel can be made from glass tubing, with a little care.

If it is charged with hydrochloric acid (or sulfuric) and zinc; hydrogen is generated, and is freed from moisture on passing thru the drying tube. It is then good for the marsh gas test, it being necessary to have the gas dried for this test. If charged with calcium carbonat or marble, and hydrochloric acid, carbon dioxid is generated. If iron sulfid and hydrochloric acid are placed in it, hydrogen sulfid is produced, and this apparatus can be utilized for making nitrous oxid by charging it with scrap copper and dilute nitric acid. Of course, separate ones can be made for each gas, which would be better, as the material is not very expensive.

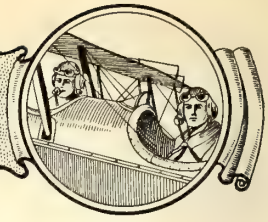
Contributed by EDWARD MARENZANA.

CEMENT TO MEND LEAKY BOILERS.

Powdered litharge, 2 parts, very fine sand, 2 parts, slaked quick lime, 1 part. Mix all together. To use, mix the proper quantity with boiled linseed oil and apply quick. It gets hard very soon.



RADIO DEPARTMENT



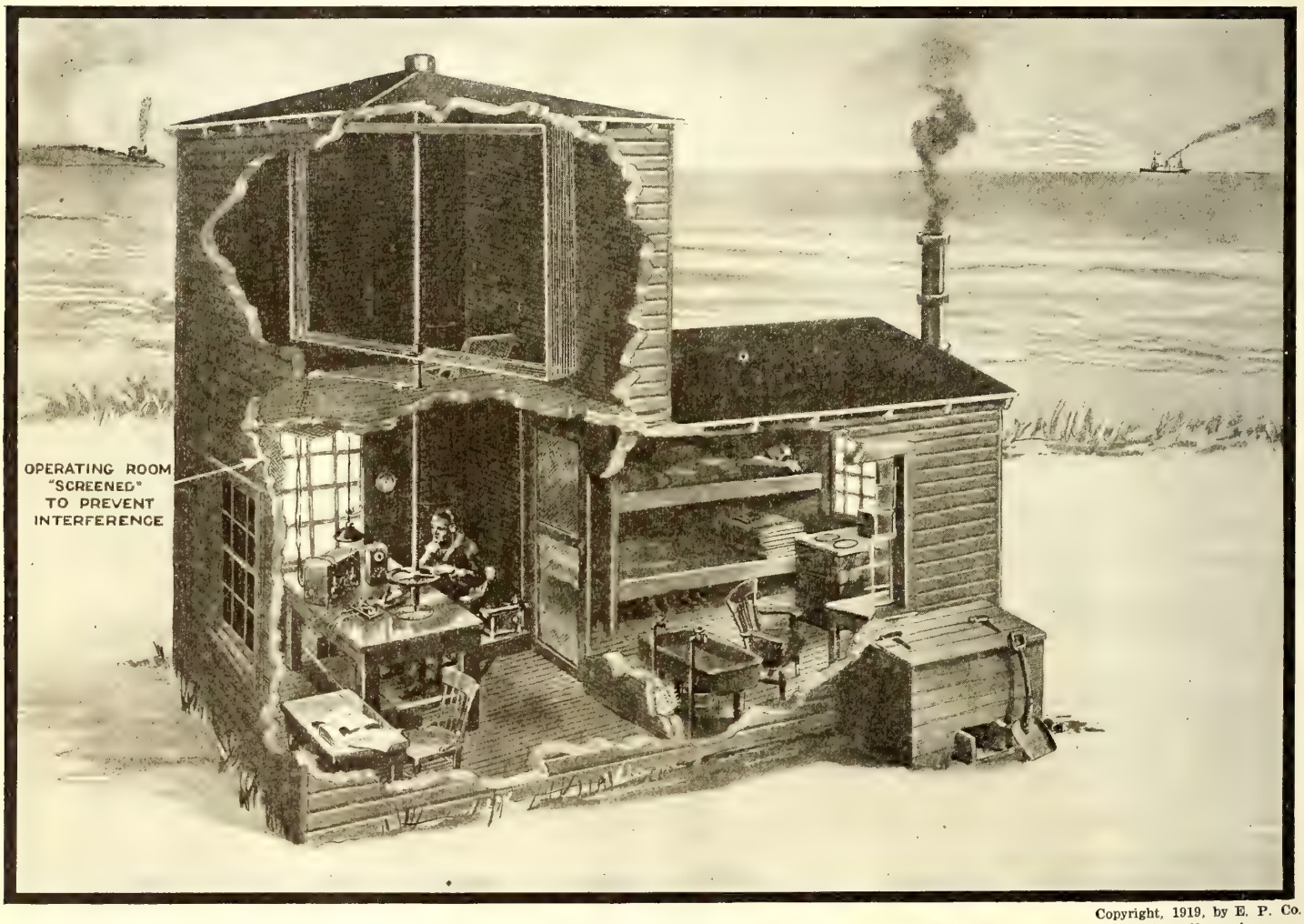
The Radio Compass

By PIERRE H. BOUCHERON, Ensign U. S. N. R. F.

IN the bewildering maze of inventions and discoveries which have been developed during the very short years following the entry of the United States into the World War, there stands out an instrument which has the unique feature of being at once a formidable aid to naval and aerial maneuvering during war-time, and war having ended, takes a prominent place as a new and valuable aid to the navigation of all maritime nations. Behold, that important and valuable instrument is—the *Radio Compass.*

What It Is—What It Does—How It Does It—Who Makes Use of It

It is perhaps a strange fact that this invention comes to the aid of a science which, altho a very ancient one, has changed very little in its broad fundamental principles. Modern *navigation methods* differ slightly from those of olden times and for that reason the radio compass may be considered as one of the first practical inventions of the day designed to aid and make the navigation of ships almost fool-proof.



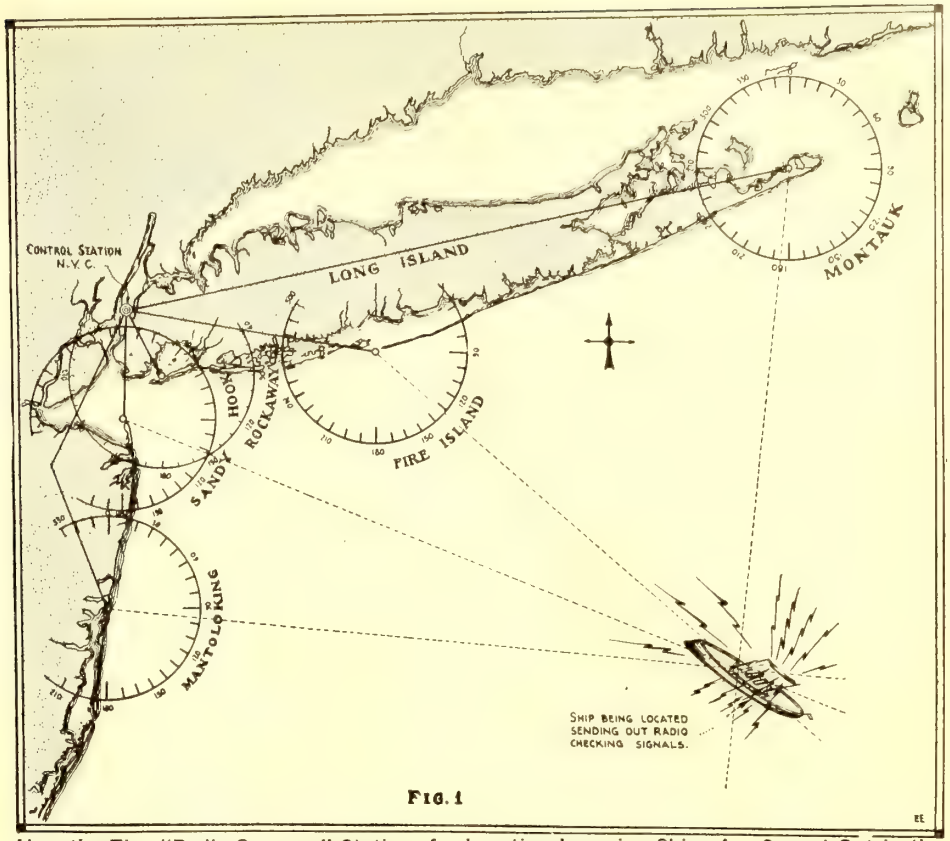
Copyright, 1919, by E. P. Co.

This View of a Typical "Radio Compass" Station as Maintained by the U. S. Navy Along Our Seacoasts is Correct in Detail and was Drawn by the Artist From Sketches of Actual Stations Furnished by the Author. These Ship Locating Stations Provide An Invaluable Service to All Mariners Approaching Large Harbors, Such as That at New York City, and the Layout of the Several Radio Checking Stations is Shown in the Map on the Opposite Page. The Loop Antenna is Swung on Its Pivoted Vertical Shaft Until the "Weakest" or Critical Sign is Heard from the Ship and the Position of the Coil, in Geographical Degrees, is Read Off the Scale and This Information Telegraphed to the Central Checking Station in New York City. When All the Stations Have Been Heard From the Resultant Information or the Exact Location of the Ship is Radioed Her Captain by the Navy Station.

HISTORY.

Before serious attempts were made at radio direction finding, much experimenting was conduced by such pioneers as Messrs. Hertz, Zenneck, Marconi and Pickard to discover methods of directing transmitted waves in certain desired directions. That is, large metal screens were employed to deflect the emitted waves in single lines of directions; these screens or reflectors having the effect of causing little or no radiation in one direction—the maximum energy being reflected to the opposite direction. Messrs. Bellini and Tosi did their share in developing the present day radio compass by devising their so-called transmitting and receiving "radio-goniometers." The receiving goniometer was later modified and adopted by the Marconi Co., and at the beginning of the war was considered the most developed and accurate radio compass of the day. It took a war to bring the device up to its present degree of perfection, and the U. S. Navy Department, with the assistance of Dr. F. A. Kolster of "Kolster Loop" fame and other U. S. Bureau of Standards experts, as well as Lieut. C. W. Horn of the Third Naval District sector, is directly responsible for its present efficiency. The adage "Necessity is the mother of invention" proves its truth in the fact that upon the United States' entry into the war, Navy radio found itself confronted with the immediate necessity of supplying itself with accurate means of locating enemy radio stations, be they high-power long distance shore stations—which seemed to spring up like mushrooms over-

night—or raiders, submarines, etc. The result is that today the American Atlantic coast is literally dotted with groups of radio compass stations ready to aid any vessel equipt with radio, merely for the asking. The radio compass is being installed on the Pacific coast as well; and while an invaluable boon to peace-time navigation, will also prove itself indispensable during war-time by readily locating the positions of hostile warships approaching the America coasts. For, much as may be said to the contrary, there are times when war-craft are obliged to use their radio apparatus, and vigilant radio compass operators stationed along the coast will readily determine their approximate positions and courses so that effective counter-maneuvers may be directed against their approach.

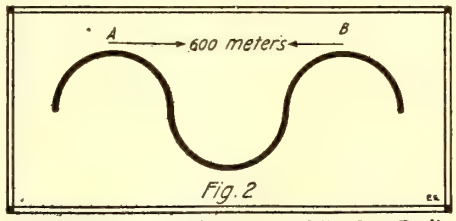


How the Five "Radio Compass" Stations for Locating Incoming Ships Are Spread Out in the Vicinity of New York Harbor. Lines Drawn on the Chart From Each Station Intersect at a Point Indicating the Position of the Ship Sending Out the Signals.

GENERAL DESCRIPTION.

The radio compass is nothing more than a highly developed receiver employing a so-called "loop" instead of the usual straight antenna and ground. The loop consists of a box-cage arrangement built of light wood six feet square, upon which is wound 12 turns of insulated stranded copper wire No. 12 B. & S., gage, making all told approximately 288 feet of wire. The framework of the loop is supported upright by a long *brass* shaft reaching from the top of the loop to the bottom of the compass house. The two loop wires lead to collector-rings, the brushes of which further lead to the receiver, thereby enabling the loop to swing at all angles. The compass dial is installed in a stationary position convenient to the operator and has a reading scale graduated from 0 to 360 degrees, corresponding to a ship's compass. An adjustable pointer is made fast to the brass shaft supporting the loop and running thru the center of the dial; this pointer pointing to zero of the scale when the plane of the loop is pointing directly at right angles to north. This adjustment, of course, is made at the time the loop is erected.

In order to eliminate all possible magnetic influences, all parts of the loop and surrounding objects are devoid of steel or iron fittings; non-magnetic metals, such as brass and aluminum being used thruout instead. The upper and lower ends of the brass shaft rest upon bearings, making it possible to revolve the loop 360 degrees with ease. Contrary to popular belief the loop is not exposed outside of the compass house. Instead, and as will be noted from the accompanying figure, the loop is inclosed within the house and thus protected from the elements. The house or cabin is built entirely of wood and other non-magnetic materials; *copper nails* being employed thruout in construction. Unlike the regular land radio stations there is no visible external evidence that the queer looking shacks along the coast are even remotely associated with radio work.

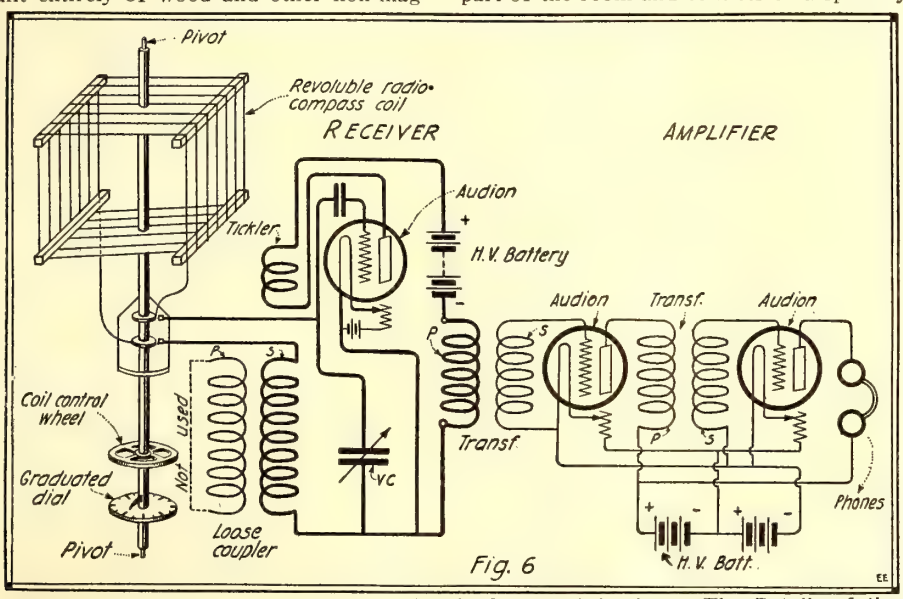


Illustrating the "Wave Length" of a Radio Wave, or Oscillation.

The receiving apparatus which accompanies the loop is situated in the lower part of the room and consists of a specially designed set having a primary, secondary, loading coil, vacuum tube connected to act either as detector, amplifier or oscillator, as well as the usual receiving appliances. Next to the receiver proper is connected a Navy-Standard type two-step amplifier with a plugging device for the very sensitive pair of high resistance telephone receivers furnished with each installation. This two-step amplifier is a very necessary adjunct when it is considered that the *minimum* amount of received energy is the one utilized when bearing readings are made.

The operating room containing the receiver is carefully "screened." That is to say, it is surrounded from all sides by a *grounded copper netting.* This precaution is necessary in order that possible stray external oscillations be warded off from the receiver, otherwise these undersirable currents would influence the receiving apparatus and render loop bearings inaccurate.

Fig. 6 is a schematic circuit diagram of the radio compass. It will be noted that no ground circuit is employed and that the loop leads are connected directly to the loading coil of the secondary inductance, instead of the primary, as is customary in other receiving circuits. No use is made of the primary; the loop circuit being a direct-coupled one.



The Connections Used in U. S. Naval "Radio Compass" Stations. The Details of the Loop Antenna Are Given in the Text.

THEORY OF OPERATION.

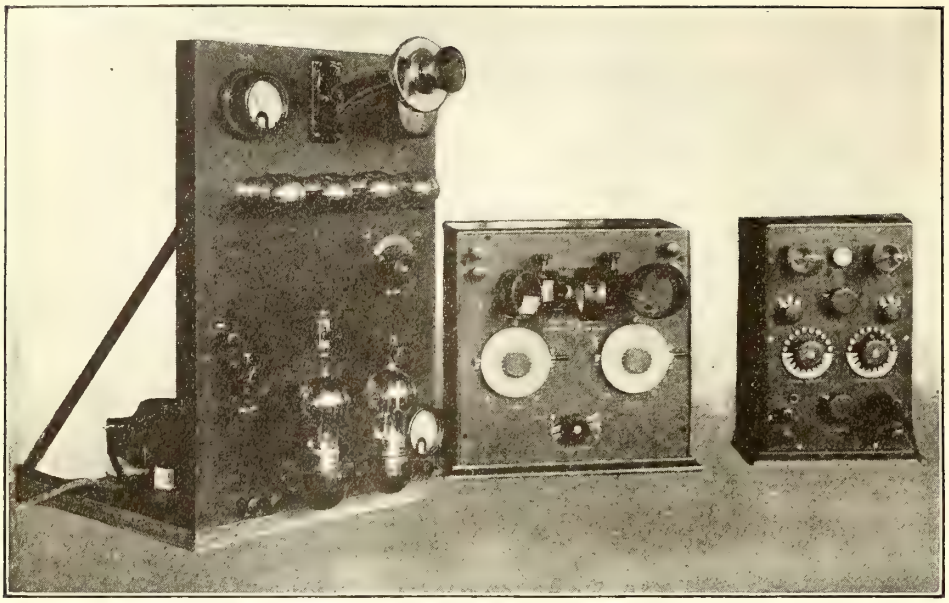
In order to properly understand how the radio compass functions, it is perhaps not untimely to explain a few fundamental facts concerning its *theory.*

To begin with, one may as well be reminded that present day investigators have decided that the radiated oscillations from any radio transmitter travel over the earth's surface in undulating waves having a broad flat front; in other words sine waves, similiar to alternating currents, shown in Fig. 2. The distance from A to B is equal to the actual wavelength of that particular transmitter, which in this case we assume to be 600 meters.

Now if the plane of the loop windings is set at *right angles* to the advancing wave

(*Continued on page* 949)

An Oscillion Radio Telephone and Telegraph



The New De Forest Radio Phone, So Simple That a Child Can Operate It. It Works on A. C., Thanks to the Two Rectifier Tubes Seen at the Bottom of the Apparatus at the Left. Just Press a Button and Talk—More Simple Than the Regular Telephone, Eh?

ALTHO the A. C. Oscillion Radiophone Transmitter is something entirely new on the radio market, it has been so carefully designed and constructed that it is claimed to be a practical instrument which may be relied upon to give excellent service over short ranges. The operation of the instrument is quite simple. All that is necessary is to connect the power leads of the set to the ordinary house lighting circuit, connect *antenna* and *ground* to the terminals of the set, push a button and *talk*.

The set needs to be adjusted but once. This may be done when it is installed and once these adjustments have been made it will need no further attention. Absolutely no knowledge of radio telephony is necessary to successfully operate the set, and the non-technical man can run it just as well as the most up to date radio engineer. It is as simple in operation as the ordinary house telephone.

One of the advantages of this radio telephone which will be duly appreciated by those who have had experience with the older types is the remote control system, by which the antenna is automatically connected to either the transmitter or receiver, by merely pushing a button.

The telephone is designed primarily for 200 meter transmission, but sets can be made to operate on other wavelengths when desired. One 6-volt storage battery is needed in connection with the telephone to operate the microphone and the remote control relay. Any standard storage battery will be satisfactory for this work. Using this radio telephone in conjunction with standard receiving equipment ranges of ten miles and over may be reliably covered with a moderate sized antenna.

The panel on which the apparatus is mounted is of Bakelite 14x20 inches. It sets on an oak base 14x15 inches so that the complete set occupies a minimum of space. At the top of the panel is mounted a microphone transmitter of the usual type on an arm, to the right and left of which is located the plate circuit milliameter and the filament ammeters respectively.

(*Continued on page* 954)

New Undamped Radio Receiver

Have you enjoyed the thrill of listening to the piercing whistle of the numerous undamped wave stations now operating here and abroad? Well, the pleasure is all yours, especially so as the number of stations using this method of transmission is increasing yearly, already all the Government land stations of importance are equipped for sending and receiving, while all the battleships are equipped for receiving, their transmitters being installed as quickly as time will allow.

The tone of the undamped signals can be varied from the lowest known to inaudibility; it is therefore possible to select any pitch best suited for receiving. This phenomenon is indeed interesting and in strong contrast to the spark method whose tone is fixt.

A glance at the illustration will disclose the advantages of the vertical mounting over the cumbersome horizontal method which occupies unnecessary space on the operating table, besides being harder to operate.

The principle is regenerative in action, resulting in amplification. In its construction a high grade of insulating material is used upon which are mounted all the metal parts carrying the oscillating currents. The windings are machine wound with enameled wire on substantial tubes. The compound switch permits fine adjustment on the primary inductance. The counter-balanced secondary is a unique feature which eliminates all difficulty in tuning, instantly responding to the slightest touch and remaining in any position. The balancing weight is contained in the long brass tube which permits the secondary to be loose-coupled six inches, resulting in highly selective tuning.

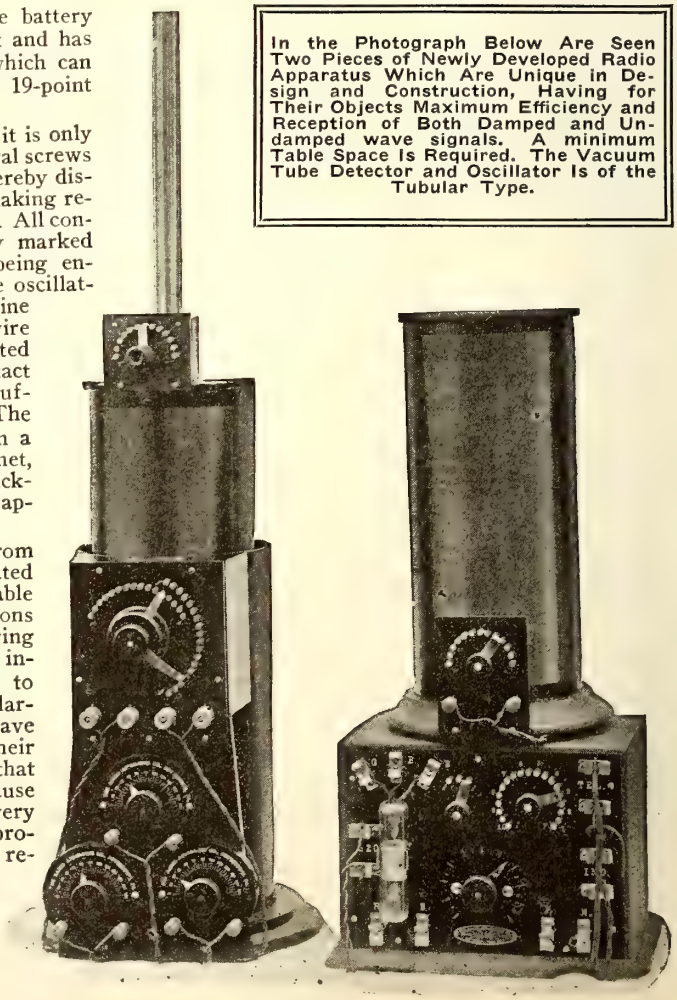
The set has a wave length range up to 18,000 meters on a moderate size antenna.

The detector is of the panel type, using the tubular bulb producing a pure electron discharge. The telephone battery is enclosed in the cabinet and has a pressure of 40 volts, which can be finely adjusted by the 19-point high voltage switch.

To renew the batteries it is only necessary to remove several screws on the panel and base, thereby displacing the cabinet and making renewal easily accomplished. All connecting posts are clearly marked in white letters, these being engraved in the panel. The oscillating inductance is machine wound with enameled wire on a substantial tube fitted with a positive contact switch, which allows of sufficiently fine variation. The entire set is furnished in a mahogany-finished cabinet, all metal parts being nickeled. The height of the apparatus is 32 inches.

Loose couplers have from time to time demonstrated their efficiency in being able to tune out all those stations not desired and allowing those which the operator intends to receive from to come in with marked clarity and intensity. Many have raised objections to their use, however, stating that they were inefficient because of their coupling, but very few have been able to produce other apparatus to replace them, and which would be so universally accepted "the best ever." So it stands to reason that they are to remain.

In the Photograph Below Are Seen Two Pieces of Newly Developed Radio Apparatus Which Are Unique in Design and Construction, Having for Their Objects Maximum Efficiency and Reception of Both Damped and Undamped wave signals. A minimum Table Space Is Required. The Vacuum Tube Detector and Oscillator Is of the Tubular Type.





Shore Radio Station Used In Fog Signaling Tests by Bureau of Standards.



The Simple Radio Compass Loop and Receiving Set Used on Ship to Locate Its Position From Shore Stations Fitted with Automatic Radio Transmitters.



Typical Light-House Fitted with Antenna for Fog Signaling Experiments, Which Proved Successful.

Radio Fog Signaling A Success

THE Bureau of Standards, of Washington, D. C., is carrying on experiments in cooperation with the Bureau of Lighthouses, to establish a radio fog signaling system. This system, when perfected, will give a navigator a reliable signal under any conditions of fog and make him independent of the lighthouse light. The principal use is the sending out of a radio signal automatically from a lighthouse and the reception of this signal upon a ship by a very simple radio direction finder. If a number of the important lighthouses on the Atlantic coast are equipt with this apparatus, the safety of navigation will be greatly advanced.

In the experiments radio transmitting apparatus were placed at three lighthouses in Chesapeake Bay, and the radio receiving apparatus and direction finder installed on a lighthouse tender. Three lighthouses are used so as to give comparative information on different types of modern transmitting equipment to determine which is the best suited for this work. The apparatus is of a special type developed by the Bureau of Standards as a result of some of its researches on radio problems during the war.

The Navy Department already has a fog signaling system under way which is, however, considerably more complicated and elaborate than the one upon which the present experiments are being made. The Navy system requires the use of several receiving stations on the shore and requires the boat to have *radio transmitting equipment.*

The Bureau of Standards system requires only a single radio station on shore and the ship to have simple receiving apparatus. The simplicity and low cost of apparatus required on the ship is such that it will be possible for practically every ship to be equipt and obtain the advantage of the radio fog signaling system.

FOG SIGNALING EXPERIMENTS ON CHESAPEAKE BAY

A set of experiments was made by the Bureau of Standards during September to November, in cooperation with the Bureau of Lighthouses, to test the practicability of radio fog signals from lighthouses to enable ships to locate their positions by use of a radio direction finder. The experiments aimed at determining the practicability of simultaneous signals from several lighthouses, the trial of automatic transmitting sets, the comparison of damped and undamped wave transmitting sets, the trial of an improved direction finder, and the determination of the accuracy of location of a ship by the radio signals.

Radio transmitting sets were installed at three isolated lighthouses, each located off shore, on Chesapeake Bay, between the Potomac River mouth and Norfolk. The installation took about a month. It was found necessary to work at shorter wave lengths than had been planned, because the limited space forbade erection of sufficiently large antennas. A great many practical difficulties had to be met and overcome during the installations.

Two of the three specially designed transmitting sets were rotary gap spark sets. These gave more satisfactory signals than the third set, which utilized a large electron tube. Ample power was radiated by the electron tube set, but evidently the radio wave was not modulated in such a way as to affect the receiving apparatus used as much as the spark set. This will be investigated further.

Signals from the lighthouses were received with a direction finder on board a lighthouse tender. A four-stage amplifier, developed in the laboratory, was used on the direction finder. Experiments were made to find the best location on the ship for the direction finder. Calibrations were made to correct for the distorting effects from neighboring objects on the ship acting as receiving antennas.

Comparisons were made between the radio bearings of the lighthouses and the bearings obtained by magnetic compass and by visual observation. *The radio method located the ship to better than one-half mile at fifty miles from the lighthouse,* and proportionately better when nearer, which is eminently satisfactory to navigators. Difficulties connected with simultaneous operation of lighthouse stations were overcome by a time schedule of transmission. It was observed that radio waves apparently travel much more readily along the coast than inland.

It was concluded that this method of fog signaling is thoroly practicable. Radio signals sent out during fog by lighthouses can be received by any ship having a radio compass (direction finder). This is a simple and inexpensive apparatus. With this system, a ship can always determine its position with accuracy when near shore, without use of the regular ship's compass.

In January Radio Amateur News

The Priess Loop Set—Part II.
By Walter J. Henry

How to Build Arc Generators
By H. Winfield Secor

The Design of Multiple Stage Amplifiers
By Prof. C. L. Fortescue, M.D., E.E.

Static Elimination
By Greenleaf W. Pickard

The Construction of a Radiophone
By E. S. Rogers

A Case of Nerves
By Julian K. Henney

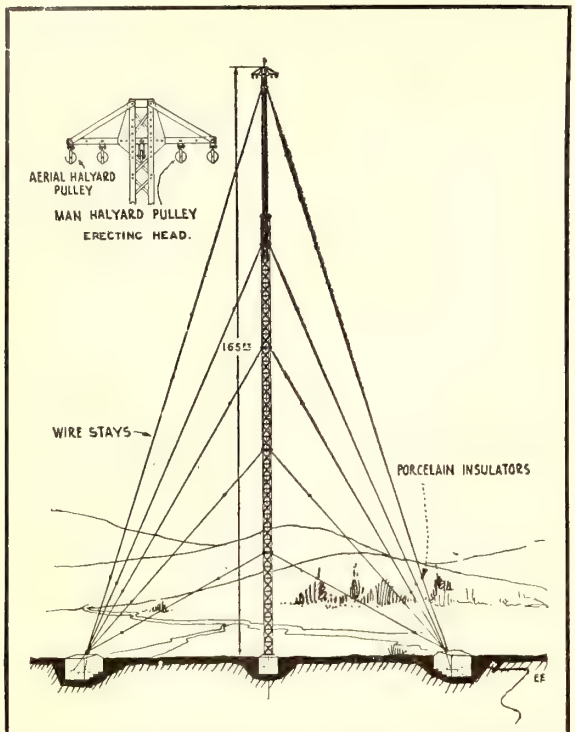
Radio Telephone on Mount Hood

Designing an Amateur Transmitting Antenna
By E. T. Jones

Multiple Loop Aerial Switch
By John G. Merne

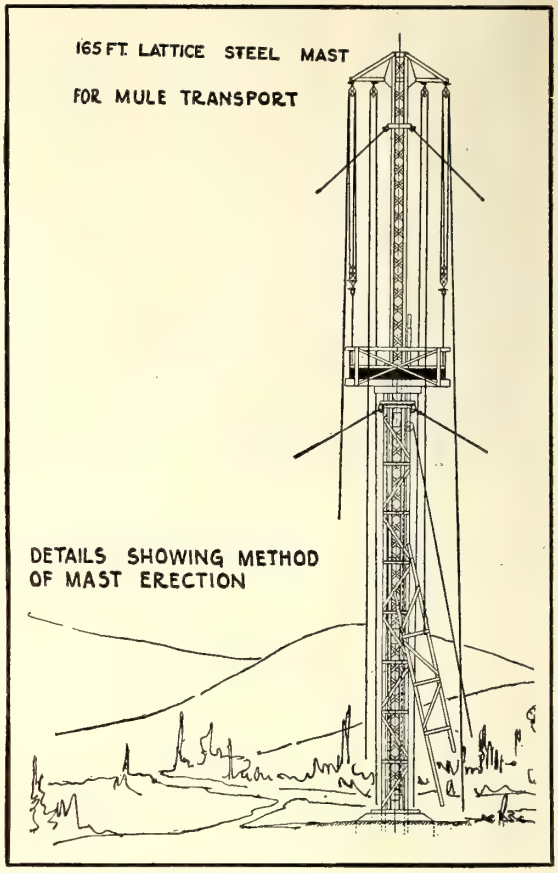
Junior Radio Section
By W. A. Heppner

New 165 Ft. Portable Radio Mast



A Remarkable 165-Ft. Steel Radio Mast Developed During the War by the Marconi Engineers. It is Adapted to Portable or Stationary Plant Requirements, and Can be Erected Quickly. It was Primarily Intended for Mule Transport and for Use at Army Corps Headquarter's Stations During the World War Operations.

The English Marconi Company has evolved a new type of mast which has found great favor both for portable and stationary plants. It is so arranged that it may be guyed to any temporary position such as occurs with a signal corps company, or it may be used in conjunction with the main station 100 miles back from the fighting lines. This type of mast is also applicable to small commercial stations. It consists mainly of a number of steel sections with a working scaffold. The raising of these sections takes place much along the same lines as the tubular Marconi masts as used in the New Brunswick station wherein men working in this cage raise themselves a number of feet and place a small section of the mast into position and raise themselves so on upward. The mast is then guyed at points where needed as the construction goes on, and within a short time a tall but rigid mast is the finished product,—lightly constructed, but rigid.



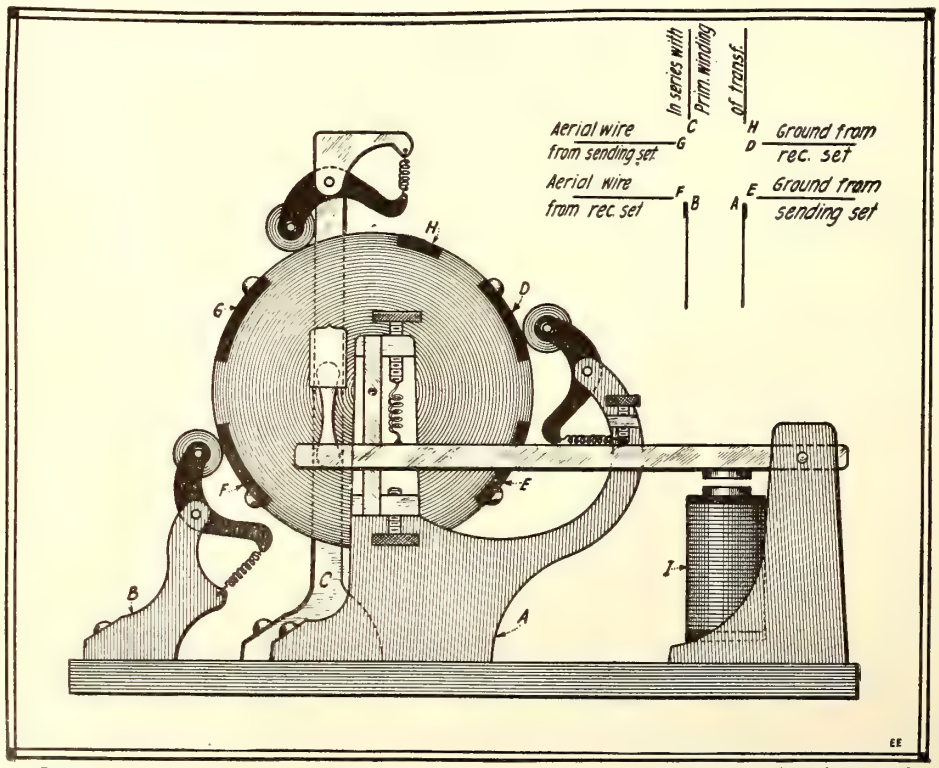
Automatic Aerial Switch

The following is a description of a very simple automatic aerial switch which I have devised and constructed and which works very well. The object of this switch is to provide means of simultaneously sending and receiving with the ordinary wireless set.

Referring to the accompanying sketch, the rotary drum carrying the embedded copper contacts H, D, E, F, and G is made of fiber and is pivoted in the center in brass casting A. A is grounded and carries a pivoted arm with a roller contact. Casting B also carries a similar arm and is connected to the aerial leads.

When an ordinary telegraphic key is deprest a local circuit of D.C. is completed thru the electro-magnets I. This pulls down the armature attached to the bar, which in turn revolves the fiber wheel sufficiently to bring copper contacts G and E in contact with the aerial and ground. G.E. being the sending set aerial and ground terminals, this connects it to the aerial and ground. It also completes the circuit thru the primary winding of the transformer by roller on C, coming in contact with H, which are in series with this circuit. This contact is not made until shortly after the sending set is connected to the aerial and ground, as can be seen by the arrangement in the accompanying drawing.

As soon as the key is released the fiber wheel returns to its former position, due to the adjustable spring shown, and thus connects the receiving set to the aerial and ground thru contacts F and D. The wiring diagram clearly shows how this instrument works.



A Design for an Automatic Aerial Switch Intended to Provide Means for Simultaneously Transmitting and Receiving Radio Messages.

There are a number of different arrangements for "listening in" while transmitting on a radio set. These include the break-in key system, having auxiliary contacts on the key, which short-circuit the receiving set, detector, etc., and then there is the Fessenden stunt of using a revolving commutator provided with a set of brushes, connected in such a way that first the transmitting set, and then the receiving set, are put into circuit successively and in rapid sequence. The experimenter will find these break-in systems worth while studying, for they are the coming thing in all modern radio stations, both amateur and commercial.

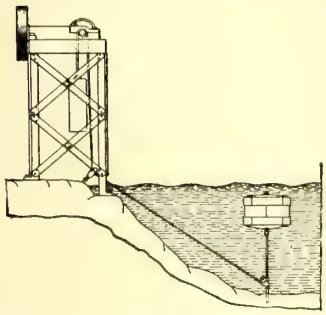
Contributed by
ERNEST OKE.

LATEST PATENTS

Wave Motor.

(No. 1,318,469, issued to John F. Wilkinson.)

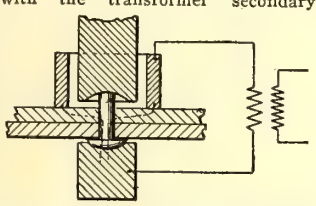
This invention covers a means for utilizing the rise and fall as well as the lateral surging movements of tidal waters, for producing power. Considered as a unit, of which any number may be used of course, there is a primary power cable attached to and partially wound upon the main shaft. Attached to the outer end of this cable is a hollow air-tight float. As the tidal or other movements of the water occur, the float naturally moves in or out, or up and down, and transmits the power thus gained to the main power shaft thru a special clutch, which causes the power from the float cable to be transmitted to the machinery in a unidirectional or continuous form, no matter which way the cable moves, —inward or outward.



Electric Riveting.

(No. 1,322,848, issued to E. Jannez von Henke.)

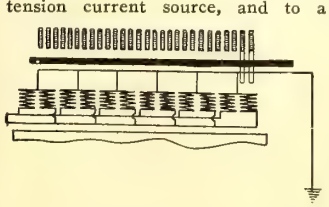
An improved technique and method of applying electric riveting to sheet metal, particularly heavy plates. As the drawing indicates, there is provided an annular contact block, electrically connected with the transformer secondary, while a second electrode is placed under the rivet as shown. As the rivet blank is inserted cold, it can be given a tight fit within the holes in the plates, so that when the circuit is established, a heavy current will flow from the top contact block, thru the plate, across the joint between the rivet shank and the wall of the hole, thence thru the rivet shank and thence to the lower contact block.



Transformer Protector.

(No. 1,317,767, issued to C. H. Thordarson.)

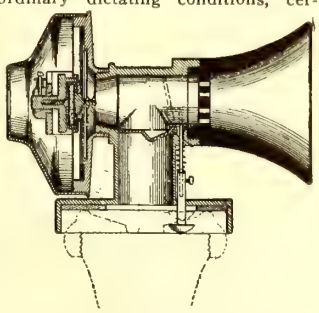
This idea aims to provide a protection in transformers between the low tension winding and the high tension winding. The inventor proposes to connect the coils of the low tension winding with the low tension current source, and to a grounded conductor, in such a manner as to prevent destructive stresses or surges being set up in the low tension winding, due to excessive surges thrown on the high tension winding. He further aims to provide an efficient electro-static shield between the high and low tension windings, also an arrangement of the low and high tension windings such that in a ratio transformer, the voltage of the high tension winding is maintained straight, and the low and high tension windings are automatically balanced.



Combined Telephone and Phonograph.

(No. 1,323,710, issued to John F. Malthaner.)

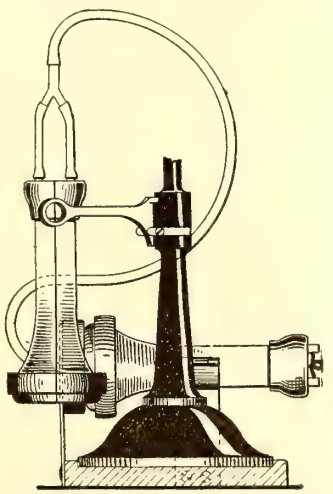
A very clever invention whereby a "dictaphone" may be used for recording ordinary telephone conversation, or else employed in the regular manner, as may be desired. In other words, the inventor provides a unique scheme whereby telephone conversations may be recorded upon the record cylinder of a commercial dictating machine, so arranging the electrical circuits that under ordinary dictating conditions, certain parts of the apparatus used for receiving and transmitting telephone messages may be used by the dictator. The dictating machine has only to be slightly modified, and fitted with a small electro-magnet so as to be operated by the telephone currents. In order to avoid any objections of telephone companies, no mechanical or electrical connection between the telephone proper and the recorder or dictaphone is necessary.



Telephone Receiver.

(No. 1,321,171, issued to Maximilian Weil.)

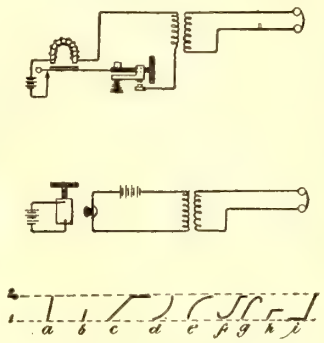
A scheme for utilizing aural receivers in conjunction with the usual telephone and in which scheme the usual electro-magnet receiver is supported in a guide or support on the base of the instrument in alignment with an acoustic receiving chamber. This acoustic receiving chamber communicates with a special form of aural receiver, which is held to the ear or ears. The sound waves are transmitted thru a rubber tube and in one form of the invention, the aural receiver is made in two halves, which may be separated and one half held to each ear.



System of Acoustic Signaling.

(No. 1,320,686, issued to John Hays Hammond, Jr.)

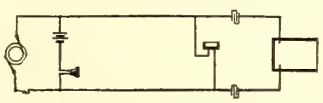
Relates particularly to a method for transmitting signals of varying characters, such as pitch and intensity, and receiving and interpreting them, so that they will produce characteristic tones or visible characters. These audible or visible characters form a telegraphic shorthand system. A transmitter may be used, capable of producing variable tones ranging in frequency from 200 to 500 per second, for example. The intermediate frequency changes may be made as slowly or as quickly as desired; thus a character such as shown at A, may be transmitted by starting with a frequency of 200 per second—raising it as quickly as possible to 500 per second—and then cutting it off.



Electric Ship Detector.

(No. 1,319,145, issued to Reginald A. Fessenden.)

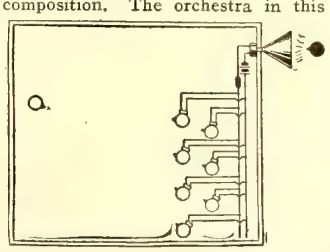
Professor Fessenden's scheme here shown, covers the detection and location of ships and other marine bodies, particularly when an approaching ship is located over a mine and in such a position that it will be exploded if the mine is detonated. The device proper comprises a large diafram, which the inventor has found very sensitive to distant sounds, and on the inside of this diafram there is mounted an inertia type carbon microphone, such as the Skinderviken.



Musical Composition Scheme.

(No. 1,323,218, issued to Thomas A. Edison.)

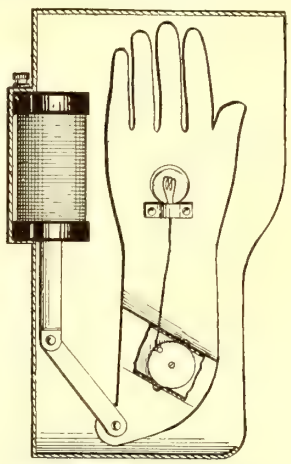
This scheme devised by Mr. Edison, relates to the rendering of musical compositions by a plurality of players, such as an orchestra, and is arranged so as to provide a method for enabling the various players to maintain uniform pitch and tempo while jointly rendering a composition. The orchestra in this case has to be supplied with an auxiliary leader, who is a master artist or player and termed the "pitch leader". The rendition of the master artist or player is telephonically and also individually transmitted to each player of a stringed instrument in the orchestra.



Electric Auto Signal.

(No. 1,317,906, issued to J. J. Benedict.)

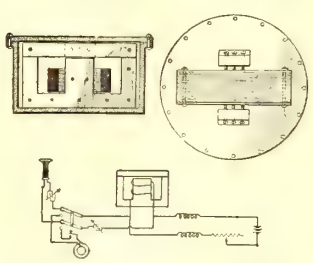
A novel device which may be used night or day on the rear of automobiles to warn the driver of a vehicle in the rear as to when and in what direction the driver ahead intends to turn. As will be observed, the signal is in the form of a human hand and an electric light mounted on it, makes it readily visible at night, so that any movements of the signal will be at once noticed. The lamp on the signal is not lighted when the signal is in the normal condition. The hand or semaphore is operated by an electric-magnet or solenoid; this solenoid being operated from the car battery by means of a push button conveniently located.



Sound Transmitter and Receiver.

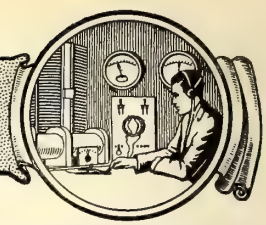
(No. 1,321,197, issued to H. J. W. Fay.)

An improved device for the transmission and reception of sound waves thru water. It comprises a device analogic to a telephone receiver with such structural changes as will adapt it when used as a transmitter to produce a maximum of mechanical vibrations with a minimum of electrical energy to cause said vibrations, as the telephone receiver may convert mechanical vibrations, such as sound waves received thru the water, into electrical energy, and such electrical current when used to actuate a telephone receiver, will enable one to detect vibrations of very minute intensity. When used as a producer of sound waves in water, a source of high frequency alternating current is employed. The frequency of this current should be equal to the natural mechanical period of the diafram. The value of the condenser in the circuit is adjusted until the power factor of the current flowing thru the helix is substantially unity.





WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER— R. N. RHODES

THE accompanying photos are views of my electrical "Lab." I have been for a number of years a close student of electricity. I am sixteen years of age, a high school student, and greatly interested in the scientific arts. I have seven different kinds of motors—one an induction motor, volt-ammeter, test tubes, electric bells, all kinds of copper wire, and small electrical fittings, etc. The electrical division contains among other things, 50 watt step down transformer, a four magnet generator which I use to test coils, lights, etc., and have lots of fun using it for a "shocking machine." Among the home-made apparata are:—an electric stove, a rectifier to change A.C. to D.C. and charge small storage batteries, also an arc light, and polarity indicator. I have also a collection of miscellaneous articles, commonly known as "junk." The usual collection of "miscellaneous," comprises telephone parts, coils, binding posts, aluminum, and other numerous accessories. I also have tools of all kinds, hand drill, gasoline blow torch, etc. The static machine is of the Wimshurst type. I made this machine out of two seven-inch grafonola records and with brass fittings that are found in every Amateur's work-shop. It has sixteen tinfoil sectors on each plate and is insulated from the frame by rubber covered knobs.

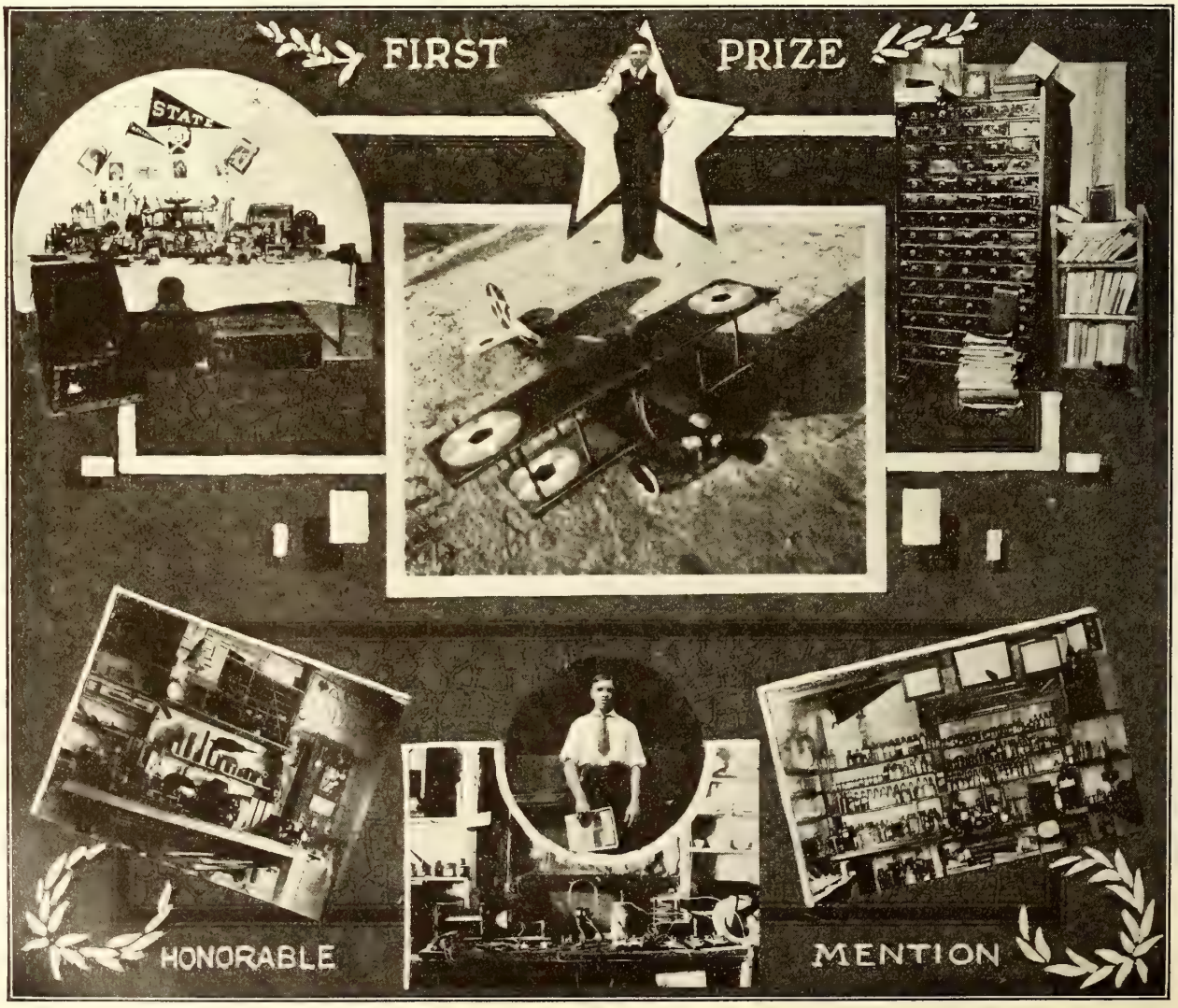
In the photo to the right can be seen my cabinet, which I made to hold small articles. It has 75 drawers, made of cigar boxes. The drawers are properly labeled. To the right of it is my home-made book-case, and I have 44 scientific books, as well as files of Popular Mechanics, the ELECTRICAL EXPERIMENTER, and "Hawkin's Electrical Guides."—R. N. Rhodes, Fordyce, Arkansas.

HONORABLE MENTION, ANTHONY MAG $2.00 PRIZE PAID EACH "HONORABLE MENTION"

I HAVE a large portable garage for my "Lab," and have gas and electricity installed therein. In my electrical section, I have a large grinding machine with three grind stones of various sizes and coarseness attached to it. This machine is run by a ¼ H.P. motor. I also own a large work bench and strong anvil vice. On the right of this bench can be seen my switchboard which controls the motor, lights, transformers, etc. On my bench are seen a number of generators, motors, a circuit breaker, two transformers, one storage battery, and various tools. Here I construct apparata which I often sell and trade. On the shelves I have resistances, three ammeters, two voltmeters, galvanometers, wire, tinfoil, lamps, a lamp bank, switches, static electricity apparatus, electroscopes, receivers, transmitters, buzzers, bells, electrolytic interrupter, Leyden jars, glass plate condensers, step-up transformer, two telephones, et cetera.

In my chemical section, I have over two hundred and fifty chemicals and a great deal of apparata, such as ring stands and rings, a large microscope—which is invaluable to me, a large gas and electric furnace, beam balance and weights, condensers, flasks, beakers, evaporating dishes, test tubes, test papers, graduates, pipettes, blow pipes, sand baths, etc. Under my microscope I test cloth, etc., and the chemicals that I make, I test and sell.

A book case and desk add to the many conveniences of the "Lab," and it is here that I do all my writing and calculating. I have a number of mechanical drawing instruments and I develop and print my own photos. I also have electrical, chemical and wireless books.—Anthony Mag, 4212 Penn Ave., Pittsburgh, Pa.



Science in Slang

By EMERSON EASTERLING



"THE Great White Way!" We had just turned into that modern accomplishment of the great God Obdura Mazda, and Bender had let loose with a young yelp.

"And we owe it all to Tommie Edison," put in Punk.

"If you want to have it that way," interposed a voice—and a body also interjected itself in between the members Punk and Bender.

"What the ———!" I exclaimed, seeing Jazz Stokes, "I thought you were at the power plant seeing the watts wattle along the wires."

"I was," he returned. "But I had to see the silk legs for a change—so I dropt down to the little metrop."

"We have nothing to do now but walk down to the theatre—we've gone on a strike with the cab drivers, I mean we walk—so let loose with some of your bull and enlighten us about the in(can)descent light stuff. I'm dark on the subject," Punk rambled along.

"Yes," put in Bender. "Get back to the very beginning. This bird Thade here is writing your palaver up for the ELECTRICAL EXPERIMENTER, and the darn fool seems to be getting away with it."

"Well," began Stokes, "to be real historic, our friend Sir Humphry Davy way back in 1810 in the Jack Ox country pulled the first boner in the 'lectric light stuff when he heated a platinum wire until it glowed out the primeval electro-spectro-radiation. It was primary stuff; any kid does it now—but, get the point, it was the *first* stuff in that line.

"When we discuss the practical electric light we stick up Tommy Edison as the *old man.* He had a lot of guys in his laboratory carbonizing everything around the place that could be made into a filament—why, he had a bunch of hoosiers galloping into the wilds of India and South America in quest of the elusive bamboo specie—he figured that bamboo was *the* stuff for the filament in his new impossibility. He would get a light about assembled and—whoof! she would go fluey!—he mopped his dome, gave a verbal recitation in slang, and began at the first act with the tragedy again. If at first you don't succeed, etc. He didn't write that. He executed it. After some forty 'leven fizzles he had the luck to get the juice squirting through his model of what the candle gave way to.

"For forty-eight hours he, and some of his attendants, sat gazing at the red-white glow on the wires and he seeing in it what we witness along this thorofare; finally, they satisfied themselves that the thing had 'got on' and that they had gotten away with their stunt and so they hit the pad for the big snooze that they had neglected. When they rubbed their orbs after the series of selections at nasal delivery, they saw that the light still burned. It was the light that never failed. And we still have it.

Light on Electric Light



"When We Discuss the Practical Electrical Light, We Stick Up Tommy Edison as the OLD MAN. Why He Had a Bunch of Hoosiers Galloping Into the Wilds of India and South America in Quest of the Elusive Bamboo—for he Figured that Bamboo Was THE Stuff for His Lamp Filament. It Was! Tom then Guessed that if the Gas Companies Could Pipe Gas Around and Peddle it to Unsuspecting Consumers—Why Couldn't He Do the Same With Electric Juice? He Did, You Betcha!"

"From that day on Tom has had his finger in the light game. It started when he figured that if the gas companies could pipe gas around and peddle it to unsuspecting consumers—why couldn't he do the same with the juice?

"He could and did, you betcha!

"Working with this in mind he constructed the Pearl Street central station with the big clumsy generators and everything. This was way back in 1882. Today—but you can see for yourself.

"For a long while before Edison came around with his impossibility, the public spraddles around in the flickering flare of the old arc lights. We had the great minds like Gramme, Thomson, Houston, both singly and combined, to be thankful to for the flickerers. Gramme is guilty for the reason for the arc lights on the corners and such guys as Brush and the others for the lights themselves.

"Edison had the right idea when he took out his patent. If you should investigate you will find that it covers the whole system of generation, distribution and what else he could stretch it to mean. He got a blanket patent, all wholesale, no retail either. He did not patent the light alone, to reap the millions off it. He patented the system, to reap billions from.

"A young American over in England, in 1845, got out a joke patent on the light question. We might have heard from the chap in other lines but he kicked the old oaken tub at the age of twenty-five—so ——

"In the old days before the transformer transformed the D.C. to A.C. we ——"

"Say," I interrupted, "but you put us wise to that a couple of issues ago and I have to have new junk or the space will be taken up with 'How to convert junk into wireless apparatus' or 'What I did with MY old buzzer'—get the idea?"

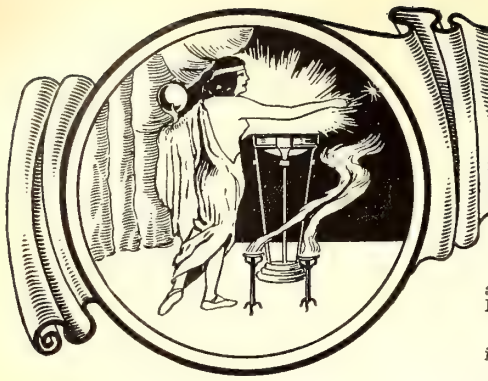
"Pardon me, Emerson, but we will then indulge in the subject of lights, electric, and those caused by electricity: firstly, we have two kinds—what? No, not *good* and *no good.* We have the arc and the incandescent—that is mainly—a vapor light is in reality an arc of great length—perhaps you think differently.

"In the arc class we have the Carbon arc, the flaming arc (carbon) and the same in both the open and enclosed type and the magnetic and mercury arcs and the quartz eradicators of darkness; also they come in the glass variety, all sizes and half a dozen colors; six shades of the colors around the high speed end of the spectrum. To be explicit; three tones of violet and three of the same with spasms of green and yellow.

"Cooper Hewitt is the guy who gets most of the credit for the vapor type as he gassed the world in the movie realm when he sneaked in and set up his brand of the artificial daylight and made it possible for the directors to get in on the night shift at the studio.

"When we get onto the incandescent type we have to dwell on the first dim carbon lamp made from grandma's old shoe lace

(*Continued on page* 933)



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

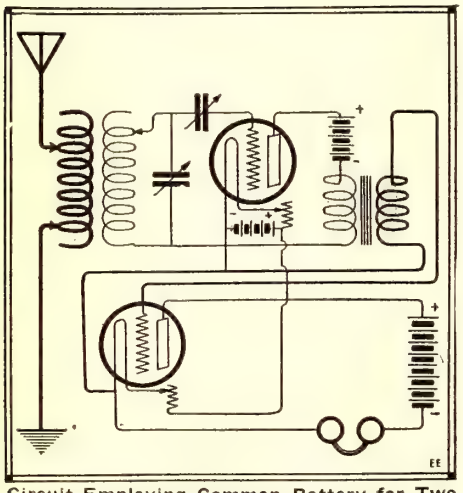
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

ONE FILAMENT BATTERY FOR TWO AUDIONS.

1033) Joseph R. Matteson, Philadelphia, Pa., asks:

Q. 1. Give diagram for using a common filament battery and two audions.

A. 1. Herewith is a hookup showing how to use a 9,000 ohm auto or a two-coil transformer, with an iron core, so that one storage battery will light the filaments of two audion bulbs. The diagram clearly explains connections.



Circuit Employing Common Battery for Two Audions. A Common Battery for the Plate Circuits of Two or More Audions is Quite Common.

ELECTRIC SPARKS FROM WATER AND GAS PIPES.

(1034) H. L. Allen, Jr., Arctic Center, R. I., writes "The Oracle":

Q. 1. Stating a peculiar case where electric sparks were obtained from a gas pipe and a heating furnace, in the same house.

A. 1. With reference to the peculiar electrical problem you describe, as near as we can judge from the meager details given, the spark obtained between the gas burner and the base of the heater in the house in which there was no electrical installation of any kind, undoubtedly can be accounted for by electrical *leakage currents* or straight *ground currents*. The electrical railway and trolley systems are particular offenders in this direction, and there was a case similar to this one on the outskirts of an Eastern city some years ago, where sparks such as you describe occurred, and where there was no electrical installation or wiring for over a quarter of a mile. It was possible *to light a 110-volt lamp* by connecting the lead wires to the water-pipes.

This peculiar phenomenon was finally accounted for by the fact that one of the trolley feed cables had broken down, thus causing a large part of the current thru the main line to pass thru the ground, adjacent to the trolley system.

Poorly bonded trolley or electrical railway tracks also cause this trouble in many instances. The heavy return current which normally is supposed to pass thru the rails to the power house being unable to negotiate the high resistance fish plate, joints at the junction of the rail sections, hence leaking away thru the ground and causing very serious disturbances in many cases.

In this same direction another peculiar incident may be mentioned where a trolley feed cable or auxiliary feed wire broke down, causing a heavy current to pass thru the ground to the trolley rail or return circuit, and a team of horses approaching the trolley crossing at this point were instantly killed by the difference of potential created when they rested their front feet on the trolley rail, while their hind feet rested on the earth. This may seem a little peculiar at first thought, but it is well to remember that the ground is not a very good conductor, especially in small areas. If you have ever stood on the ground with ordinary nailed-sole shoes, and touched an electric light socket or live wire of 110 to 220 volts potential, you have undoubtedly found that you will get a very strong current thru the body, and if the ground happens to be damp, the stronger the current received. Also if the shoes are damp, you will get a stronger current than if they were dry. On a *perfectly insulated* electrical distribution system, you should not receive a shock by touching one side or the other of the live circuit, and while in contact with the ground thru your shoes, but if the system is *grounded* on one side (or it may be grounded as in the three-wire system for lightning protection), then, of course, when touching one of the live wires of the proper polarity, you will form a complete circuit thru your body down to earth and thru the soil, back to the grounded conductor connecting to the other side of the circuit.

The problem of electrolysis is a large one and is engaging the attention of all city engineers, for these stray currents play great havoc with the buried metal pipes and conduits forming the water and sewerage system of cities. A stray current will often pass from a poorly bonded railway track to a metal pipe line; where this current leaves the pipe, it carries some of the metal along with it, thus slowly *decomposing* the pipe. Some of these pipes are so riddled with holes as to be veritable sieves, when they are finally located and unearthed. The trolley companies have to keep constant watch on the copper cable or wire bonds joining the ends of their trolley rails, for these reasons.

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RADIO PHOTOS—
New stations, both commercial, government, and private. Owners of private or amateur stations will find a special contest for these photos on another page of this issue.

And don't send us plate or film "negatives"; send unmounted or mounted "prints", preferably a light and dark one. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation.

Address photos to—Editor "Odd Photos", Electrical Experimenter, 233 Fulton Street, New York City.

DYNAMO VOLTAGE QUERY.

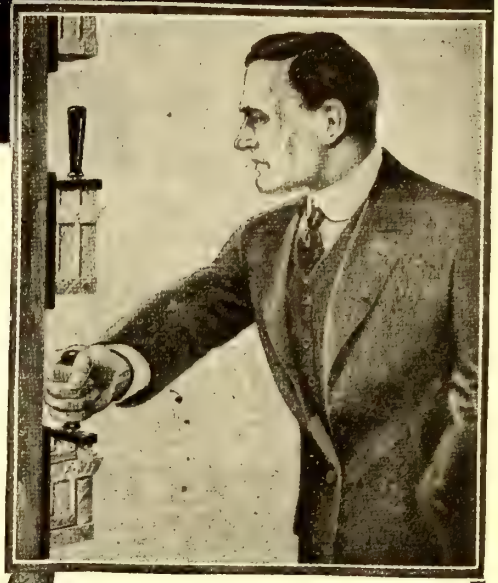
(1035) A. L. Haynes, Clifton, Kansas, writes the Oracle:—

Q. 1. With reference to a transformer for boosting the voltage of a D.C. dynamo while it is accelerating.

A. 1. Concerning data for a small step-up transformer to be used on a direct-current generator, would say that this is impossible, as a transformer must be operated on alternating current in any case.

The best thing you could do in this direction, probably, would be to arrange the field winding on your machine so that the field coils could be connected in *parallel*, while the machine is accelerating, and in *series* after the machine had attained normal speed. This will have the effect of causing the field coils during the acceleration period to take more current, thus producing a stronger field, which in turn would produce a higher voltage in the armature. Later, when the machine had attained normal speed, a specially arranged quick-throw switch could be utilized to throw the field coils in *series*, causing them to take less current and to produce a normal field strength.

Why Electrical Workers Are Needed.



Consider for a moment what part electricity plays in every-day life, in the comfort, convenience, pleasure and even health of the whole civilized world.

Think of having to ride in horse cars again—

of writing a letter every time you now phone—

of waiting days for what the telegraph does in a few minutes—

of no automobiles or moving picture shows—

Electricity takes millions to and from work. Without it the automobile and airplane would be impossible—the telephone and telegraph would be useless. All the civilized world relies on it for light, heat, transportation and communication. In a thousand ways electricity is used in factories, offices and in the homes.

Electricity is almost as essential as the air we breathe. Business would be almost at a standstill if deprived ot its energy.

To say that electricity is still in its infancy is no exaggeration. Every day brings into practical use some new method of controlling it, some new device or appliance for using it. In industrial work there are still scores of operations where electricity will be utilized sooner or later. The day is coming when the railroads will entirely replace steam with electricity. Doctors, dentists and scientists are only beginning to realize the possibilities af electrical energy.

These facts merely touch the high spots, yet they prove beyond a doubt that electricity plays a vital part in business, in our individual lives, and that there is unlimited scope for those who make electricity their life work.

The electrical worker provides other men light to work by, the telephone and telegraph to convey their orders, the power to run their machines and transport their goods. He supplies power in the homes to operate washing machines, vacuum cleaners; for ironing, heating and ventilating. In short, it is the electrical worker who makes it possible for the world to live more comfortably, to enjoy more pleasures and to do a bigger, more profitable business.

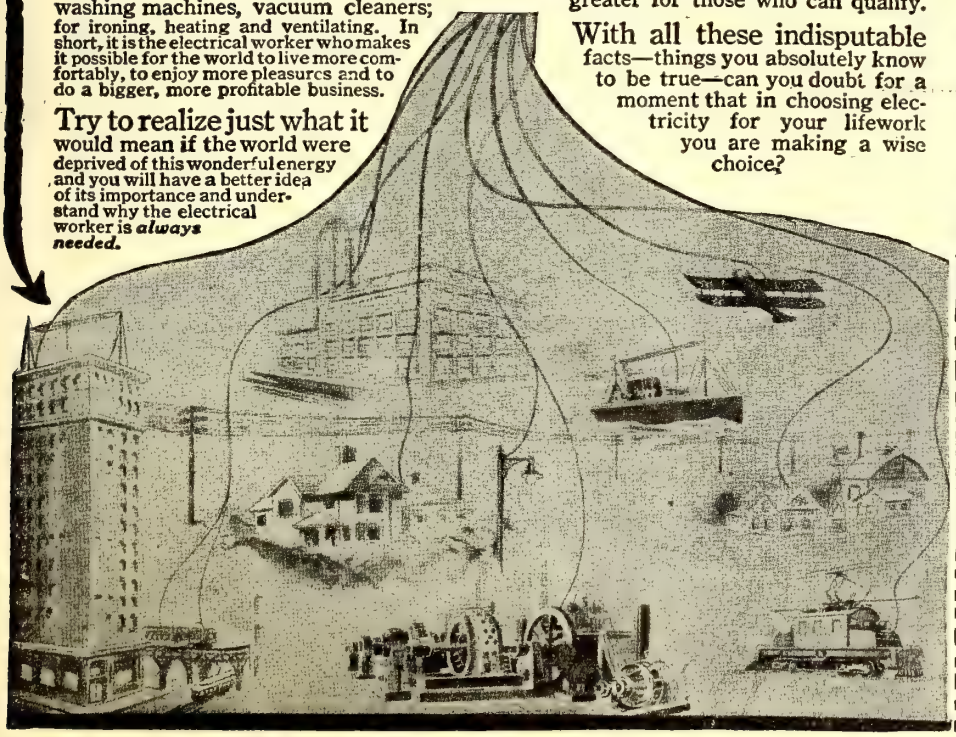
Try to realize just what it would mean if the world were deprived of this wonderful energy and you will have a better idea of its importance and understand why the electrical worker is *always needed.*

What Electricity Offers You

Once you have mastered the A-B-C of electricity you are confronted with unlimited opportunities for advancement. You can specialize in extending and perfecting the wonders already accomplished in the field. You may take up those branches of electrical and mechanical work which cover the design and manufacture of electrical apparatus or start in to qualify for a well-paid position in the designing, construction, operating or consulting branches of the electrical engineering profession, and to fit yourself eventually for a position as Distribution, Operating, Testing, Erecting or Designing Engineer.

In the automobile, airplane, telephone and telegraph lines there is also great scope for the trained electrician. Many wonders of electricity have yet to be unfolded—its uses multiplied—and opportunities still greater for those who can qualify.

With all these indisputable facts—things you absolutely know to be true—can you doubt for a moment that in choosing electricity for your lifework you are making a wise choice?



How You Can Qualify

You don't have to interfere with your present work while qualifying for a good electrical position. The American School can give you just the training you need in your SPARE TIME. Our electrical courses have been specially prepared for home study—are written so you can understand everything quickly—and from your first lesson until you get your Diploma expert instructors coach you. Our training will enable you to get into the game RIGHT.

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..Sanitary Engineer	..Business Manager
..Master Plumber	..Certified Pub. Acc'nt.
..Civil Engineer	..Accountant and Auditor
..Structural Engineer	..Bookkeeper
..Western Union Course	..Gen'l Education Course
..Telephone Engineer	..Com. School Branches
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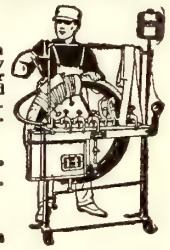
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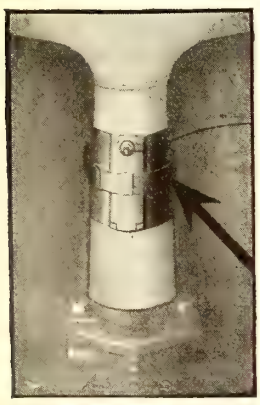
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Popular Astronomy

By Isabel M. Lewis, M. A.

(*Continued from page 887*)

Let the mirror be fixt at equal distances from A and B in the two systems. A and B will agree that AM equals BM^1 for the two lengths can be directly compared by assuming A to come into coincidence with B and M with M^1 as the systems pass. That is, two observers on relatively moving systems will agree in their estimate of the length of a line that lies *perpendicular* to their line of motion.

Now let A thinking himself at rest note how long it takes for a ray of light to pass from A to M and back *in his system.* Say he concludes that it takes *one second* to travel to M and back over the path AMA. Let B thinking *himself* at rest perform the same experiment in *his* system. He also will find that it takes *one second* by *his clock* for light to travel to M^1 and back (since the two observers agree on the velocity of light and the equality of AM and BM^1). B assumes that the path of the ray of light in his system is BM^1B (= to AMA) thinking he is at rest, but A who has been watching B's experiment from S thinks that the path of the ray of light in B's system is BPB^1 where BB^1 represents the motion of B relative to A during the interval in which the ray of light is passing to B's mirror and back. A is surprised that B should report that the experiment takes *one second,* the same time that A found for *his* experiment, since to A the two paths AMA and BPB^1 appear *unequal* in length; so A is forced to conclude that B's time intervals are *longer* than his own; that is, that B's clock is *slower* than his clock and B comes to the same conclusion in regard to A's time intervals. That is, the two observers are in hopeless disagreement as to the actual length of the second. From a reference to Fig. 2 we find that the ratio of B's time interval to A's time interval as it appears to A is $1 : \sqrt{1 - \frac{V^2}{C^2}}$ where C is the velocity of light and V the velocity of B relative to A. That is the amount by which B's clock is slower than A's *depends on the relative velocity of A and B.*

By similar processes of reasoning we can deduce equally startling conclusions as to the length of a given line in B's system *lying parallel to the direction of motion* and find that we must come to the conclusion that a moving yard stick (or other unit of length) is shortened *parallel to its line of motion* in the ratio of $\sqrt{1 - \frac{V}{C^2}} : 1$ as compared with the same rod at rest. That is, the *shape* of a body relative to a stationary observer is changed in proportion to its velocity relative to the observer, all lines in the body parallel to its direction of motion being contracted in the ratio $\sqrt{1 - \frac{V^2}{C^2}} : 1$. There is, therefore, no absolutely rigid body and the shape of a body depends on its velocity relative to the observer and is different for different systems of reference. A body that appears to us to be circular, say when at rest, will appear spheroidal in shape when moving rapidly and its shorter axis will lie parallel to its direction of motion.

Another startling conclusion to which we are forced by similar processes of reasoning is that the mass of a body at rest is less than its mass when in motion in the ratio $\sqrt{1 - \frac{V^2}{C^2}} : 1$ depending on its velocity relative to the observer.

This conclusion of relativity has received striking confirmation in the results of the Kaufman-Bucherer experiments on the mass of electrons shot off from radioactiive substances or in cathode rays.

A still more startling conclusion arrived at is that *mass itself is a manifestation of a certain form of energy* and that "the increase of the kinetic energy of a particle, in ergs, is equal to the increase in mass, in grams, multiplied by the square of the velocity of light," and as a direct result, assuming that matter and energy are different names for the same thing, one gram of matter represents 10^{21} (ten to the twenty-first power) ergs of energy. We must come to the conclusion also that the two laws of the conservation of mass and of the conservation of energy are one and the same thing.

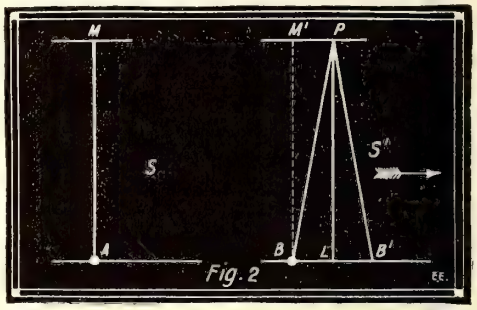


Fig. 2

$(AM)^2 = (BM')^2 = (PL)^2 = (BP)^2 - (BL)^2$

$\frac{(AM)^2}{(BP)^2} = 1 - \frac{(BL)^2}{(BP)^2}$; Now BL is to BP as v is to c, Where v Is the Velocity of B Relative to A, and c Is the Velocity of Light.

Therefore $\frac{AM}{BP} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

and 2 AM Is to 2 BP, or AMA Is to BPB', as $\sqrt{1 - \frac{v^2}{c^2}}$ is to 1. But A and B Both Agree that Light Takes One Second to Travel the Two Paths Unequal in Length, Therefore B's Second Must Appear to A to Be Longer Than A's Second in the Ratio $\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

If the motion of the stars thru space is slightly accelerated instead of being uniform, and if increase of mass and energy due to this fact can be changed into energy of radiation, there is then a source of supply of the radiant energy of the sun and stars that can be drawn upon for infinite ages.

It is also possible to deduce from the form of the factor $\sqrt{1 - \frac{V^2}{C^2}}$ that figures so prominently in the theory of relativity, the fact that *no material body can possess a velocity equal to or greater than the velocity of light,* for if V = C the expression for the mass of a body moving relative to an observer with the velocity of light because *infinite* and its length in the line of motion *vanishes.* Is, then, a ray of light an infinitesimal portion of an infinite mass or energy?

Granted that there can be no velocity equal to or greater than the velocity of light, at what speed, then, does gravitation itself act, which has always been assumed to be instantaneous in its effect?

It can be seen from what we have been able to state, in a more or less detached and incomplete manner, concerning some of the chief deductions to be made from the principle of relativity, that it deprives us of our most cherished ideas concerning the absolute nature of time and space and removes the possibility of the simultaneous happenings of events at different places.

(*Continued on page 918*)



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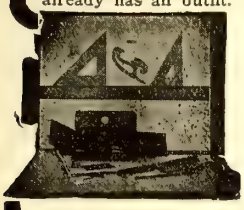
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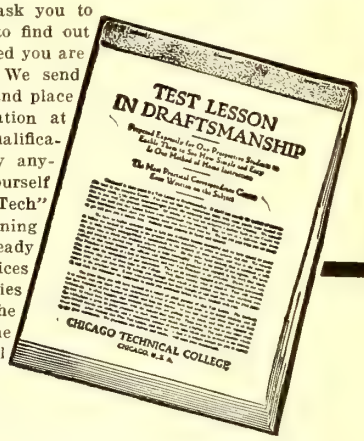
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A. O. LEONARD
Suite 369, 70 5th Avenue -- New York City

Popular Astronomy

(*Continued from page* 916)

The effect of the principle of relativity upon the ordinary affairs of life is negligible so long as we are dealing *with small velocities relative to the velocity of light.*

It does not appear to you or to me that we are changing the rate of a watch merely by picking it up from the table and carrying it on an automobile trip or that a moving foot-rule is any shorter than one lying on the table or that the shape and size of a baseball changes as it speeds thru the air, and for all practical purposes the changes produced by motion in the instances cited are entirely negligible simply for the reason that the velocities to which we are accustomed are in general immeasurably small compared to the velocity of light which is 186,000 miles per second. Even the earth's orbital motion of *eighteen and a half miles per second* produces a contraction of only about two inches in the diameter lying parallel to its direction of motion around the sun, so small is even this velocity compared to the velocity of light.

When we come to the consideration of the electrons shot off from radioactive substances, however, we find velocities comparable to the velocity of light and opportunities are here afforded to test the Einstein theory of relativity, and, in fact, experiments performed in the fields of electrodynamics have been in accord with the Einstein predictions.

A prediction of the Einstein theory that remains to be fulfilled is that of the shifting of the lines in the spectrum of the sun or of the stars toward the red due to the fact that, according to the theory, the rays of light emanating from the stars should be affected by the gravitational fields surrounding them. So far this effect has not been found in the solar spectrum tho it appears to have been noted in certain Orion type stars.

The Newtonian laws of mechanics with which we are familiar are *first approximations* to the Einstein laws and give practically the same results when the velocity in question is small compared to the velocity of light. It is for this reason that the Newtonian laws of motion have remained unquestioned for so long and still remain sufficient for the solution of ordinary problems in mechanics not involving high velocities relative to the velocity of light. It is the satisfactory explanation which the Einstein theory affords of certain facts in the realm of astronomy and electrodynamics *that the Newtonian theory has failed to explain,* such as the large discrepancy existing between fact and Newtonian theory in the case of the motion of the perihelion of Mercury, that has given this theory of relativity such great weight.

It is not an exaggeration to say that this new physical theory is the most valuable contribution that has been made to science since Newton promulgated his immortal laws of motion which are but first approximations to the Einstein laws developed from the Principle of the Relativity of Motion.

EXPLAINING THE EINSTEIN THEORY OF TIME AND SPACE

(Copyright, 1919, by John T. McCutcheon.)



Courtesy Illustrated Daily News



A New Idea that Makes Men Rich

SEVEN men tried out this idea. Each was earning less than $40.00 a week in a routine position. To-day five of these men draw salaries ranging from $8,000 to $40,000 a year, the sixth is wealthy, and the seventh is worth a half-million dollars. How they did it and how you, too, can duplicate their amazing success.

YOU men and women who are eager for success—I wish you could have been with me one memorable evening last week. For then I had spread before me seven of the most remarkable cases of success of which I've ever heard.

It all came about in this way. At a convention in New York I met two old friends who had at one time worked for the same firm. Each of these men had since won remarkable success. As we sat in my room at the hotel, my two friends—Perry and Gordon—got to talking about old times and the men they used to work with.

The talk turned to what their former associates were doing now. "Let's see," said Gordon, "there's Bill Baley—now he's vice-president of a bank at $10,000 a year. Lawrence is general manager of a machinery house at $18,000 a year. Yawman is foreign Sales Manager for an automobile concern and makes $40,000 a year. Stanton is manager of the New York branch and last year made in salary and commission over $28,000. Burton is in the wholesale business for himself and tells me that in the past three years he has cleaned up a fortune. Even old Harry Carter, whom everybody thought a dub, is Secretary of a concern down South and knocks out $8,000 a year. And Zimmerman, our old boss, is director of more concerns than I can think of and is rolling in money."

"FUNNY thing," said Perry, "every man who worked in that department under Zim has made a conspicuous success. In the ordinary course of events you'd naturally expect one or two of the men to win out while the others would plug along and never amount to anything unusual. But every one of these men has since made a name for himself. I wonder if it just happened or if there is a reason."

"I used to think about that a lot myself," cut in Gordon, "and I believe I've found the answer. It's Zim, our old chief. That's who we've all got to thank for our success.

"Remember what a slave driver we used to think him. When he wanted a thing done it had to be done, done quickly and done right. He'd tell us some of the most impossible things, and he *made us do them*. Excuses didn't go. We nicknamed him 'Old Must.' *Must* do this—*must* do that. No excuses. Simply *must* do it. We knew it couldn't be done. Yet *we got it done—always!*

"We couldn't kick because he drove himself as much as he drove us. Remember the line of talk he used to hand us day in and day out. 'It *must* be done. You *can* do it. Get a grip on yourselves, boys. Throw your Will into action. *Drive!* Will-power will carry you through.'

"I never took much stock in that Will talk those days. I thought it was just one of Zim's pet theories. But now I see that Zim was right—wonderfully right.

"The reason why our department always broke records, and why every man in that department has since made a big success is because Zim put the *drive* into us—he taught us how to use our Will-power. That's what put us all where we are—the *winning drive* that comes from Will-power."

WHEN you come right down to it the only real difference between men is not birth nor education nor luck, but Will-power. The successful man is successful because he knows how to use his Will. He *compels* success. The unsuccessful man is unsuccessful because he does not know how to use his Will and is forced to meekly bow down to circumstances. Not one man in a hundred knows how to use his Will. That is why more men are not successes. Nearly every successful man has a highly developed Will—the stronger the Will the greater the success. Natural ability amounts to but little unless backed by a dominant, compelling, driving Will.

The Will is the motive power of the brain. Without a highly-trained, inflexible Will, a man has about as much chance of attaining success in life as a locomotive has of crossing the continent without steam. The biggest ideas have no value without Will-power to "put them over." Yet the will, although heretofore entirely neglected, can be trained into wonderful power like the brain or memory. And by the very same method — intelligent exercise and use.

If you held your arm in a sling for two years it would become powerless to lift a feather, from lack of use. The same is true of the Will — it becomes weak from lack of use. Because we do not use our Wills properly —because we continually bow down to circumstances—we become unable to assert ourselves. What our Wills need is practice.

Develop your Will-power and money will flow in on you. Rich opportunities will open up for you. Driving energy you never dreamed you had will manifest itself. You will thrill with a new power—a power that nothing can resist. You'll have an influence over people that you never thought possible. Success—in whatever form you want it—will come as easily as failure came before. And those are only a few of the things Will-power will do for you. Just how to develop the Will into a mighty, irresistible force—how to make it do all these things for you—is fully explained in that wonderful book "Power of Will."

SOME of the things "Power of Will" has done for people are astounding. I would hardly believe them if I hadn't seen them with my own eyes. Adding ten, twenty, thirty or forty dollars a week to a man's income is a mere nothing. That's merely playing at it. In one case I took a rank failure and in a few weeks had him earning as high as $2,000 a week. Listen to this:

A young man in the East had an article for which there was a nation-wide demand. For twelve years he "puttered around" with it—barely eking out a living. Then he read "Power of Will." Today this young man is worth $200,000. He is building a $25,000 home—and paying cash for it. He has three automobiles. His children go to private schools. He goes hunting, fishing, traveling, whenever the mood strikes him. His income is over a thousand dollars a week.

In a little town in New York lives a man who two years ago was pitied by all who knew him. From the time he was fourteen he had worked and slaved—and at sixty he was looked upon as a failure. Without work, in debt to his charitable friends, with an invalid son to support, the outlook was pitchy black. About this time he ran across a copy of "Power of Will."

In two weeks he was in business for himself. In three years his plant was working night and day to fill orders. During 1916 the profits were $20,000. During 1917 the profits ran close to $40,000. And this genial 64-year-young man is enjoying pleasures and comforts he little dreamed would ever be his.

AMAZING things like these "Power of Will" has done for men and women in all walks of life. There is no sound reason why it will not bring about the same surprising results for you. You at least owe it to yourself to find out. And I'm willing to prove it to you wholly at my expense. You can easily make thousands—you can't lose a cent. Here is my offer:

Send no money—no, not a cent. Merely clip the coupon and mail it to me. By return mail you'll receive not a pamphlet, but the whole "secret" told in this wonderful book, "Power of Will."

Keep it five days. Look it over in your home. Apply some of its simple teachings. If it doesn't show you how you can increase your income many times over—just as it has for thousands of others—mail the book back. You will be out nothing.

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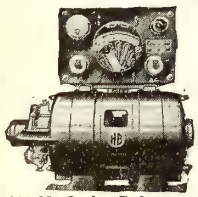
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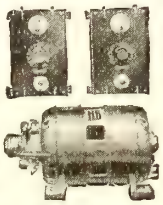
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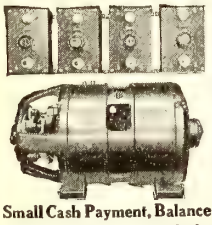
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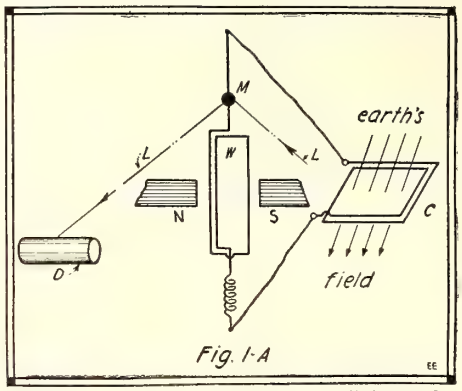
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Magnetic Storms

By Prof. Lindley Pyle

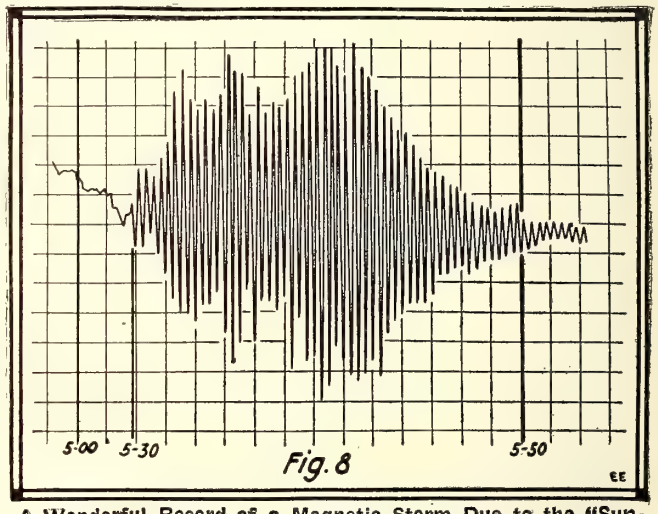
(*Continued from page* 876)

displays. At such times conditions on the sun are no doubt such as to affect either directly or indirectly the magnetic field of the earth. Direct evidence of this was obtained August 3, 1872, when Young, at Sherman, Idaho, observed a solar outburst during an eclipse of the sun. At the same instant magnetic observatories in England recorded magnetic disturbances. On the other hand Professor Francis E. Nipher, the American investigator and scientist, has noted "magnetic effects" arising from purely local weather conditions.

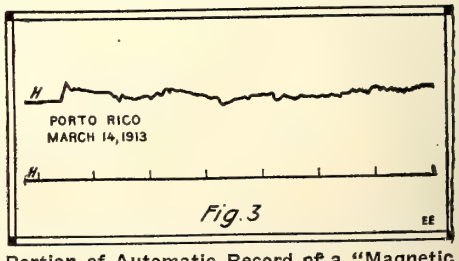


Apparatus Used in Recording "Magnetic Storms." Suspended Coil of Wire, W; Mirror, M, Attached to W.

To obtain an automatic registration of the irregular and continuous changes occurring in the earth's magnetic field, the writer assembled the the apparatus photographed and diagrammed in Figs. 1 and 1-A. A simple coil of wire C, is laid upon a table and its terminals are connected to a sensitive electric indicator, or galvanometer. See Fig. 1-A. That part of the galvanometer that moves when a current traverses the galvanometer is equipt with a small mirror. Within the black box is a strong source of light placed behind a pin-hole. Light pasing thru the pin-hole traverses the lens shown in the photograph, falls upon the galvanometer mirror and is reflected to a revolving cylinder D, driven by clock-work and covered with photographic bromide paper. One has in fact upon the paper the bright image of the illuminated pin-hole. In practise the cylinder with its light-sensitive paper is protected from any stray light by a cover equipt with a narrow slit thru which the light enters to fall upon the moving paper. Subsequent chemical development of the paper yields a permanent record of the behavior of the beam of light, which wags to and fro in accordance with the behavior of the galvanometer mirror. In accordance with Faraday's laws of induced currents there is an electromotive force induced in the coil which is proportoinal at any instant to the *rate* of change of the number of lines of the earth's magnetic field linking with the coil. Consequently every change in the earth's magnetic field is accompanied by a current flow thru the galvanometer and a motion of the spot of light on the moving paper. No doubt the fluctuations recorded in Fig. 2 are in large part due to effects of electric car lines about 700 feet distant from the apparatus. In certain work by the U. S. Government car effects have been noted *at a distance of* 13 *miles from the car lines.* This method of registration of magnetic storms is not new. It was first put into practise in a certain Polar Expedition of 1882-83, when a single insulated wire was laid out upon the polar ice to enclose an area of approximately three square miles. The Einthoven type of galvanometer is the best type to use in con-



A Wonderful Record of a Magnetic Storm Due to the "Sun-Set" Effect.



Portion of Automatic Record of a "Magnetic Storm" of 98 Hours' Duration, Taken at Vieques, Porto Rico.

(*Continued on page* 922)

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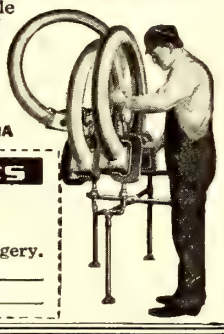
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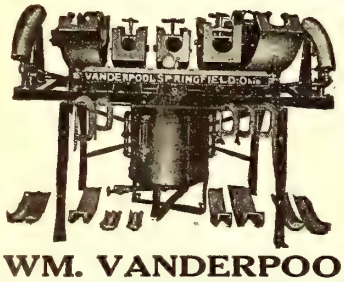
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Magnetic Storms

(*Continued from page 920*)

nection with the test coil, since the moving part consists of but a single, very thin conducting filament stretched across the gap of a powerful magnet. The filament being

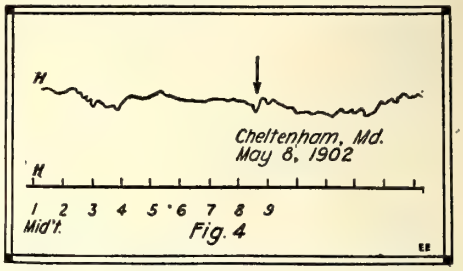


Fig. 4

Record Taken in Maryland of Magnetic Disturbance that Accompanied the Eruption of Mt. Pelée, Martinique, in 1902.

so light follows accurately even extraordinarily rapid variations in the earth's field.

Fig. 3 is a portion of an automatic record of a "Magnetic Storm" of 98 hours' duration taken at the Magnetic Observatory at Vieques, Porto Rico, March 14, 1913. This record differs from that of Fig. 2 in that it is a record obtained from a mirror attached directly to a suspended magnetic needle arranged to move under the varying pull of the earth's field. Also it differs in the rate of motion of the recording paper, being only about one-thousandth the rate used in the case of Fig. 2.

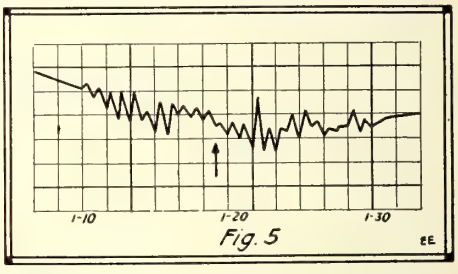


Fig. 5

Record Taken by Prof. Nipher of a Magnetic Disturbance Arising from a Violent Squall of Wind.

VOLCANIC ERUPTION CAUSED MAGNETIC DISTURBANCE

Fig. 4 is a careful copy of an automatic record taken at the U. S. Magnetic Observatory at Cheltenham, Md., May 8, 1902. It records the magnetic disturbance that accompanied the eruption of Mt. Pelée, Martinique (see arrow). This magnetic disturbance was recorded simultaneously at Cheltenham and at Baldwin, Kansas, and occurred as nearly as could be determined simultaneously with the eruption. This disturbance was purely a magnetic one and not a mechanical one due to any transmitted earthquake shock.

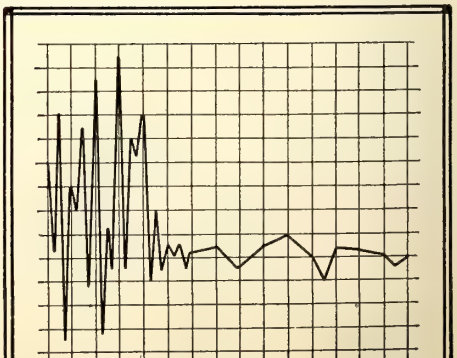
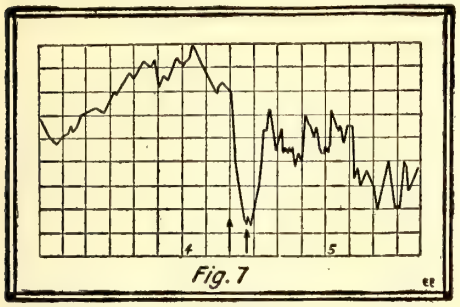


Fig. 6

Magnetic Disturbance Produced by Sunlight Shining Thru Rainfall; After a Record by Prof. Nipher.

The greater part of our magnetic storms come from causes outside the earth's crust. Recent researches by Professor Nipher have extended markedly our knowledge of the origin of disturbances imprest upon the

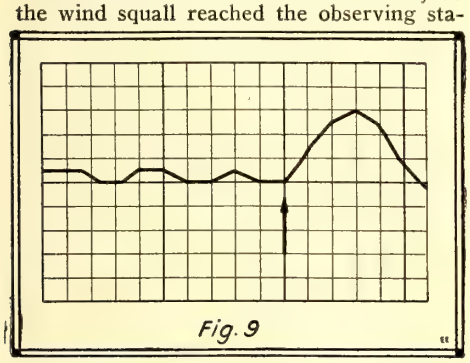


Illustrating the Effect Upon the Strength of the Earth's Magnetic Field of a Large, Dense and Sharply Defined Cloud Passing over the Sun.

earth's magnetic field. In a series of important papers publisht by the Academy of Science of St. Louis, Professor Nipher has shown conclusively *that magnetic storms may arise from wind effects, rain storms, and cloud shadows. He has produced magnetic effects from flames and explosions and has observed magnetic effects due to sounds.*

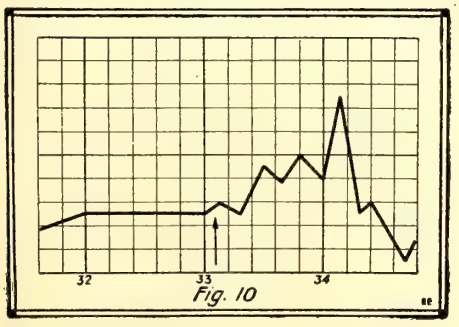
A WIND SQUALL CAUSES "MAGNETIC STORM"

Fig. 5 is one of Prof. Nipher's records of a magnetic disturbance arising from a violent squall of wind. The beginning of disturbances was noted *nine minutes before* the wind squall reached the observing sta-



Record Produced by a Flame Creating a Magnetic Disturbance Close to the Recording Station.

tion (time of arrival indicated by the arrow) and the disturbances continued for *eight minutes after* the squall had past the station. Quoting from one of the original papers,—"When small clouds are scattered over the sky and a local fall of rain occurs at the observing station, the sunlight passing thru the air, thru which the rain drops fall, a very marked magnetic storm is produced." Such a disturbance is reproduced in Fig. 6. Fig. 7 represents the effect upon the strength of the earth's magnetic field of a large, dense, and sharply defined cloud passing over the sun. The sun disappeared at 4:20 and reappeared at 4:28,—indicated



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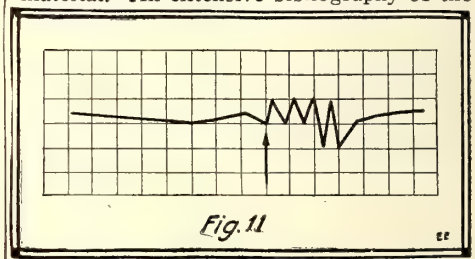
Address .....

City..... State.....

by the arrows. Eclipse shadows produce similar results. Fig. 8 shows the magnetic storm due to the "sun-set" effect. It thus appears that the earth's shadow at night has the same effect upon the earth's magnetic field that a cloud shadow has during the day. Fig. 9 is a record of the *magnetic effect of a flame* produced close to the observing station by the burning of 25 or 30 pounds of black powder, spread uniformly over a platform of 20 square feet area. There is in this case no explosive effect. Fig. 10 records the *Magnetic effect of an explosion* of 21 sticks of dynamite 200 feet north of the observing station. Fig. 11 represents the *magnetic effect of disturbances set up by sound waves,* emitted by a fog-horn several thousand feet distant from the station.

Professor Nipher states that his researches have establisht beyond any question *that local variations in the earth's magnetic field are determined wholly by local weather conditions.* He concludes that the great majority of magnetic disturbances may be traced to variations in the magnetic permeability of the atmosphere, arising from changing conditions in the ionized air.

That the subject of Terrestrial Magnetism is of paramount practical and theoretical interest and importance is evidenced by the large number of magnetic observatories maintained by the leading governments of the world, and by the immense amount of work being carried on in the conduction of magnetic surveys on land and sea. Our own Department of Commerce, thru the United States Coast and Geodetic Survey, continually publishes a large amount of material. An extensive bibliography of the



Magnetic Disturbance Set Up by Sound Waves Emitted by a Fog-horn Several Thousand Feet Distant from the Observing Station.

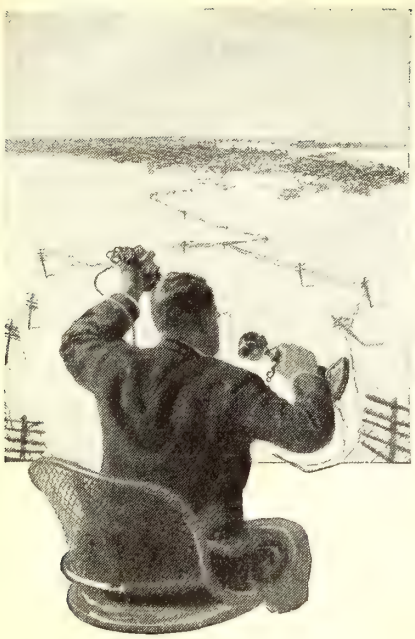
subject may be found in an international quarterly journal publisht under the name "Terrestrial Magnetism and Atmospheric Electricity," by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, D. C.

WHAT ONE RESEARCH LABORATORY DID.

In the research laboratories of a large American electrical manufacturing concern are many scientists working to increase the usefulness of electricity to industry.

In one of these laboratories at Schenectady are nearly 70,000 square feet of floor space, with each room piped for water, gas, compressed air, vacuum, high and low pressure hydrogen, oxygen and high pressure steam, and adjoining are completely manned and equipt machine and forge shops, etc.

In this laboratory research work has been done on paints, oils and varnishes; irons, steels and alloys; copper, zinc, molybdenum and magnesium; kenotrons and pliotrons for radio work; X-ray location of holes in castings; incandescent lamps and searchlights; insulation and brush compounds; turbine blades and boiler feed water; atomic hydrogen; molecular layers in catalyzers; fuse fillers; lithium, boron, uranium and thorium; rubber and platinum substitutes, sherardizing and calorizing, condenser, boiler and pyrometer tubes and powerful X-ray tubes.





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Send check for express shipment. For parcel post add postage and insurance to cover shipping weight of 15 pounds. Ask for bulletin 12 describing this and other F-F charging apparatus of larger capacities including those operating on farm lighting plants, etc.

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$15 AND UP

The Amateur Magician

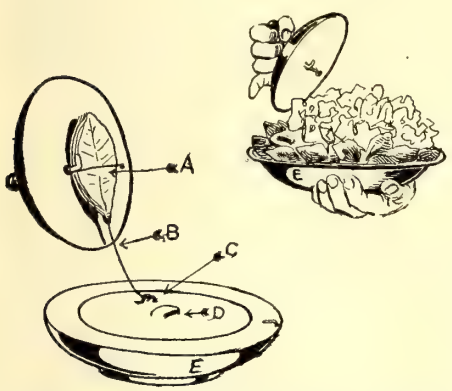
By JOSEPH H. KRAUS

(*Continued from page 896*)

ordinary blank cartridge, mounted on the base, at one end. A steel plunger, which is free to slide between two bearings; has been sharpened at one end (the end which sets off the cartridge), and has a notch filed in the other end. This notch is filed in the rod in such a way that a small, flat piece of brass (also placed in a bearing of its own) will hold the rod back until it is ready to be discharged. In other words it acts as a trigger. Around the rod is coiled a stiff piece of steel or better still, a steel spring. A flat piece of metal is then adjusted to the rod to hold the spring in place; it being held at the other extremity by the bearing. A glance at the accompanying sketch and photos will fix things clearly in your mind.

"To the trigger is attached a piece of strong silk. This is led out thru a tiny hole in the side of the bowl made for that purpose, passing thru two holes in the small one-quarter inch legs. It is then fastened to a button on the other side of the bowl.

"Before commencing the trick, a blank cartridge is prepared by first removing the hard cardboard in the end of the shell.



Detail of the "Fire-Bowl" Trick, Showing How the Flowers Are Concealed in a False Compartment

This is replaced with tissue paper after the powder has been loosened. It is then inserted into the holder, the spring pulled back, and the trigger set. The cotton in the bowl is now saturated with alcohol and sprinkled with ordinary salt (sodium chlorid). This gives a pretty yellowish tint to the flames, after the production of the fire bowl. The bowl is now placed in a vertical position, and the well in the center filled with alcohol so that there will be enough alcohol left to burn for quite some time.

"When the bowl is presented, it is then only necessary to pull on the string which releases the firing pin; this in turn explodes the cartridge, the latter not going off with a report—but burning like a slow flashlight powder. When this occurs, the cotton impregnated with alcohol and salt is set on fire and burns as you have just seen."

"Yes, but how about the flowers?" I intervened.

"We are just coming to that. The top as you will note is made up seemingly of one piece but in reality two. Inside the false top are arranged large quantities of silk flowers, each of which has a spring inside of it so as to insure perfect opening the moment they are released. This effect is obtaind by placing the two tops on the

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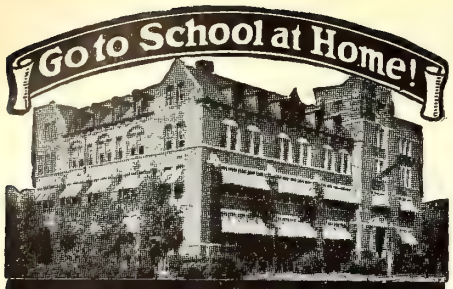
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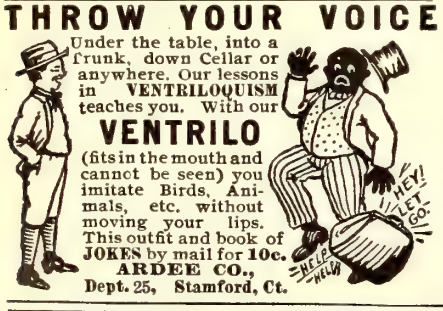
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.....Wireless Operator	.....Sanitary Engineer
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bowl together. (They being held so by a hook-like affair which passes thru the bottom plate in a slot made for it, and held there by giving it a slight turn.) On removing it again only one top is taken away, thus giving rise to the rush of flowers.

"Here are a few photographs which will help make it clear, you may take them if it will help any."

Thus concluded the magician's discourse on his Fire-Bowl mystery.

AN INTERESTING CARD TRICK.

The Universal Pack: A pack of cards similar to that made by any leading magic supply house, which is universal in its use and the fake not easily detected, is made very simply. Take a deck of cards (a straight deck), which has a plain back, in other words, a back which lacks a margin. These are clamped rigidly between two blocks of wood, the latter having been shaved down so as to be quite smooth and the cards and wood all flushed together at one edge. A file is now past over the edge shaving in this way the cards and wood at the same time, thus preventing any marring or turned edges. Some very fine sand paper is now applied to the edge, finishing the job smoothly. The cards may project at one end and be filed off.

It will be noted that all the cards are narrower at one end than at the other, but only *slightly* so, thus making detection almost impossible. The cards are then shuffled and presented to the victim, who draws one, looks at it and replaces it in the pack, whence they are shuffled again. During the operation, however, the performer reverses the deck in his hand and when the card is replaced, it is only necessary to pass the fingers along the edges of the cards, when one card, the card chosen will be withdrawn, due to the fact that it is wider than the rest of the deck, it having been replaced in the reversed position. It is then brought to the top and may be presented in any way thought desirable.

Likewise, all four aces may be inserted into the pack, reversed of course, and completely shuffled, and with one cut may be brought to the top and dealt off. The pack can also be divided into red cards and black cards, with one cut in this case; all the red cards should be reversed before commencing the trick. After shuffling thoroly the performer runs his fingers along the edge of the cards several times to insure perfect separation, and then with one cut he is able to divide the "reds" from the "blacks".

Countless other stunts may be performed in a similar manner, taking advantage of this prepared deck.

(The next paper will appear in an early issue.)

SICKNESS OF THE ADRIATIC.

"Sickness of the Adriatic" is the name given to the phenomenon of luminosity frequently observed in the Adriatic Sea. At times its waters become phosphorescent and give beautiful reflections.

The seas around China and the Indian Ocean offer fascinating spectacles of the same character.

This liquid phosphorescence is truly bioluminescence. It is caused by a tiny protozoa, a species of fire-fly of the sea. These animalcules occasionally occur in such large mucous masses as to interfere with the efficiency of fishermen by clinging to their nets.

But this luminescence is not due to any organic decomposition or exhalations of phosphorescent gases (the vapor of phosphorous trioxide is phosphorescent). It is a sort of phosphorescence of the protozoa.

Contributed by JOHN MARCHETTI.



Gee! Ain't She A Peach?



—that's what your gang'll say if you win the prize.

We'll tell the names of winners in February. The names and addresses of fellows who won prizes for giving the best uses for the

Auto-Wheel Coaster
AND THE
Auto-Wheel Coadster

Maybe your name will be there. Better watch. Thousands of fellows entered the contest and the judges had a hard time picking the winners. They promised to let us know in time to tell you in February.

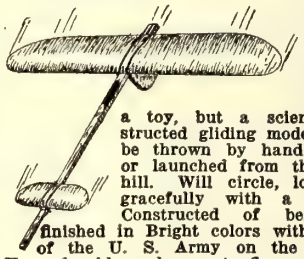
More Prizes Coming

Now, if you or any of your gang did not win you have another chance coming. We're going to have a series of contests this year—just the kind of contests you fellows will like.

And say—the prizes you can win will make the other fellows say—"Ain't She a Peach?" Keep your eyes open for these new contests. Send for our Monthly Magazine. You will like it. It is full of contest news—how to get in on Auto-Wheel contests, with suggestions to help you win. Just give the names of three coaster dealers in your town and state which one handles the Auto-Wheel. Then we'll send the Magazine and a FREE FELT PENNANT. Also the story about organizing an Auto-Wheel Club—with FREE CAPS for all members.

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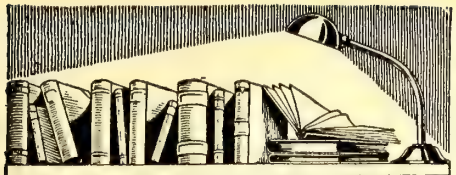
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BOOK REVIEW

THE GAS MOTOR, by Max Kushlan, B.S. 366 pages, 86 illustrations, cloth bound, size 7½ x 5½ inches. Publisht by the Branch Publishing Co., Chicago.

The fundamentals of the gas motor, rather than mere structural details, are covered lucidly in this excellent book, which should find favor among all interested in automobiles, motor boats, and wherever the gas engine may be applied.

The author evidently has thoroughly surveyed his field, and selected for explanation the matters which in his opinion were of the greatest importance in placing the subject fully and clearly before the student as well as the expert.

Among the many virtues possest by the book are the questions placed at the end of each chapter, reviewing the subject matter immediately preceding it. This should prove a welcome feature.

As a practical handbook the volume has few peers. Detailed instructions for the cure of ills common to gas engines are given, as well as an appendix of useful constants and formulas.

THE MODERN MOTOR CAR, by Harold P. Manly, 536 pages, 225 illustrations, flexible leatherette bound. Publisht by Laird & Lee, Chicago. Size 5 x 7¼ inches.

"The Modern Motor Car" is announced by the publishers as a book of simplified upkeep, giving the construction, care and adjustment of motor car units, together with shop and roadside methods of trouble location and repair. There are sections on how to buy, make and use materials and supplies. Among other things, descriptions are given of the operation and repair of electric engine starters, lighting systems, magnetos and ignition parts, electric brakes, gear shifts, etc. Add to the above imposing list of attributes the fact that the book is intended for repairmen, owners, drivers, salesmen and students, and it will be evident that the field has had quite a complete consideration.

Not least interesting in the book is the section on electricity, which explains in simple manner the essential principles of the subject. As Mr. Manly says, "Without electricity, the modern gasoline automobile would be an impossibility. Electricity is used to fire the gas in the cylinders, to start the engine, to light the lamps, and, in some cars, to shift the gears, operate the horn, furnish foot and hand warmers, cigar lighters and all manner of necessities and conveniences."

This section covers 130 pages and would alone make the book a worth-while addition to anyone's technical book-shelf.

LIVING ON $800 A YEAR. Paper cover, size 5½x7¾ inches, 16 pages. Publisht by the author, Leon Miller, Philadelphia, Pa., with an attractive cover showing his home.

The title of this book brings fond memories of a current cartoon running in the daily papers under the heading of "How Do They Do It?" Which is what we are wont to ask after reading over the author's interesting answer to the high cost of living. With the certainty of conviction, he has outlined the program of events for the entire 52 weeks of the year—food, clothes, house expenses, rent, the doctor, the butcher, the baker and candle-stick maker.

Do they have pleasure? You bet they do, and, by the way, we refer to the both halves of this marriage partnership; which is the "better-half" we don't profess to know. Probably they are still trying to settle that eternal problem. Let us not get too far away from the subject of the book, however. Among the principal schedules worked out by the author and his spouse is the "menu." We must eat, you know! Even if we live out-of-doors like the Indians. Here we find a weekly time-table, figured down to the fraction of an ounce as to what we shall have to-day, to-night, etc., etc. Looks good, but, we note that the "left-overs" of the noon meal of Sunday are disguised and used for the evening meal on Monday, and so on and so on, which gives rise to a pertinent question in our minds as to how we originally started, or whether the steak used is elastic and can be stretched to last indefinitely! From past experience we know that our better halves have often served us a "variety" that frequently needed the help of a stone-crusher, but then she's a young, sweet person, and thru our love for her we'll get a regular meal some day, provided the "book" and "our stomachs" hold out that long!

Horrors upon horrors! We overlooked the fact that the "Old Man" will give this the "once over," and if he spies that 800 bucks per annum fairy-tale, good-bye to our 100 per and the struggles of the Review Editor will cease miserably. Maybe

The machinist says:

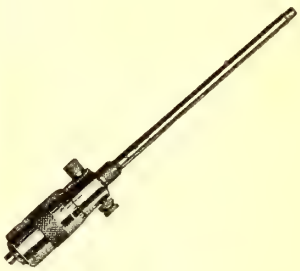
"Sure I'm using them, the same as most of the men in the shop are doing. Some of the Starrett Tools in my kit, I bought when I was an apprentice.

"Y'see, it's like this. We got the habit when we were kids. We saw the older men, the ones that were doing the finer work, preferred Starrett Tools because they knew they were accurate, and we copied after 'em—just like our kids are doing today.

"How's that? No, I wouldn't go so far as to say that Starrett Tools by themselves will make a good machinist, but I'll say this—Starrett Tools will make it a lot easier for any machinist to do good work.

"Yes, I've got one of their 'Starrett Data Books for Machinists,' and believe me, it saves a lot of time and mistakes. If I want to know a decimal equivalent, a taper dimension, the speed of a milling cutter, or something about materials, I don't have to guess or ask — I just look in the book and find out. It set me back seventy-five cents at the hardware store, but it saved me a blame sight more than that in the first week."





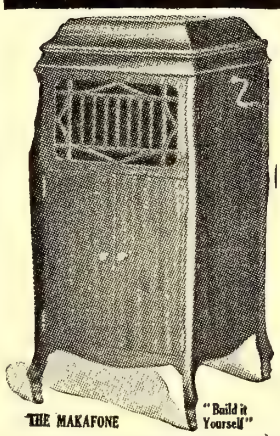
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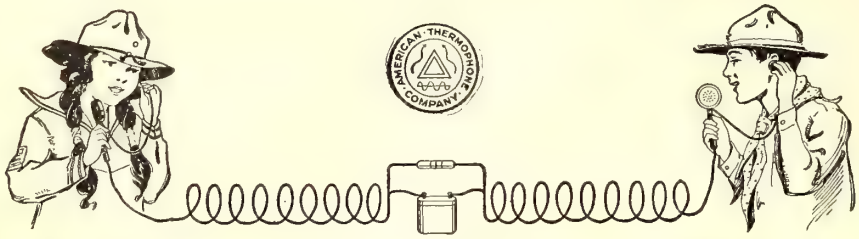
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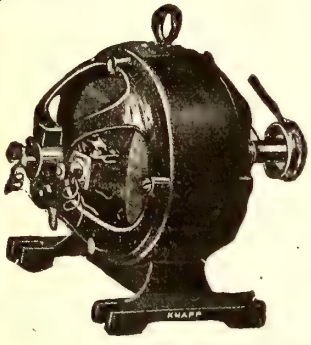
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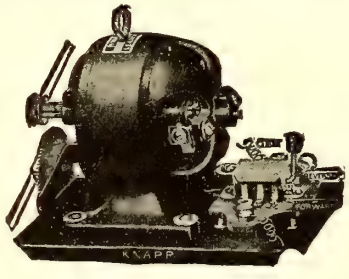
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you would like to try out Mr. Miller's schedule—he and his wife have lived the life, you know—but remember the male gets (2) suits a year, the female gets a few odds and ends every year, whether she needs them or not; the coal? oh! a little; movies? yes; candy???? smokes?—That's inhuman and uncivilized! As for us—but seriously speaking, it can be done on $800 a year. But it requires an iron will, or rather two of them.

SPLENDORS OF THE SKY, by Isabel Martin Lewis, A.M. Cloth bound, 343 pages, 20 illustrations, size 5x7 inches. Duffield and Company, New York.

One feels satisfied and inspired after rising from a few hours spent with what is one of the most refreshing books issued during the last few years. Isabel M. Lewis, the author of that splendid book—"The Splendors of the Sky"—needs no introduction to readers of the ELECTRICAL EXPERIMENTER, who have enjoyed her monthly astronomical articles.

"Splendors of the Sky" is an ideal book for the seeker of astronomical information who does not wish to be encumbered with a treatise on advanced mathematics which is generally added to astronomical texts, as the unrelished seasoning to a tasty subject.

Simplicity and clarity of exposition seems to be Mrs. Lewis' aim thruout. Discoveries of the last few years are explained in such a manner as to make them palatable to every reader; there is a chapter on "Solar Explosions," sudden, but rather infrequent, appearances at the surface of the sun of hydrogen "bombs."

"These 'bombs'," says Mrs. Lewis, "are apparently violent explosions of highly heated hydrogen gas in regions of great solar activity. At times, according to Dr. Ellerman, of the Mount Wilson Observatory, who discovered them, they will follow one another like balls of a Roman candle at intervals of ten or twenty minutes. These "bombs" generally appear at the edge or at one side of active sun spot groups that are developing and are composed of many members. Repeated explosions often occur almost exactly in the same place."

Another interesting recent discovery discust is the existence of a tiny body two or three hundred per cent hotter than the sun, yet with a diameter only one-hundredth as great. Only two or three hundred per cent hotter, in sooth!

Besides these new things, much care is given to the regular astronomical topics. Each planet has a chapter to itself and the other bodies of this vast universe are also given justice.

But what is particularly attractive about the book is its arrangement. The chapters are not lengthy, and they are crowded full of facts more interesting than the most rampant fiction. A chapter every few nights will give anyone a practical knowledge of astronomy as it is today, and a great deal of pleasure besides.

Vertical Lighthouse Beams

(*Continued from page 867*)

the atmosphere is clear enough so that a fairly bright light is discernible for sixty miles or over. In surveying in the mountain regions of this country, the Geological Survey have signaled positions to each other over distances of about a hundred miles with a small electric light operated from eight dry cells.

OLD LIGHTHOUSE HAS RANGE OF ONLY 25 MILES.

"The greatest range of any lighthouse in the world is only about 25 miles! The reason for this is very evident; *the ocean is a curved surface.* This curvature appears to have a remarkably short radius when one observes how quickly lighthouses disappear over the horizon viewed from the deck of a departing ship. The limitation is, therefore, geographical; *it is the curvature of the earth which defines the range of a lighthouse.* The only method of increasing the range is to locate the light as high above sea level as possible. The highest light in the United States is that at Cape Mendocino, California. *This is four hundred and twenty-two feet above sea level, and has a range of about twenty-five miles.* The Navesink Light is two hundred and forty-six feet high and has a range of about *eighteen miles.* In figuring the distance of the horizon from various heights above sea level, there is a simple formula which every seafaring man knows. The square root of

the elevation above sea level in feet is approximately the distance of the horizon in miles.

"With the increasing speed of modern vessels, there is a demand for lighthouses of greater range. It is somewhat surprising to realize that the old Pharos of Alexandria had a range probably just as great as our best lighthouse of today. All of the remarkable improvements have been refinements only. The fundamental requisite of lighthouses, that is, range, has remained the same thru the past two thousand years!

THE VERTICAL SEARCHLIGHT FOR LIGHTHOUSES.

"During the war there was developed a completely new branch of illuminating engineering; this is the *anti-aircraft searchlight service.* This service gave us a great deal of new data and experience in projecting powerful lights upward into the sky. During the latter part of the war and since the war, searchlights have played the part of lighthouses for aviation and have been found to be serviceable over ranges which are unheard of in marine lighthouse practise. *Aviators have picked up the beam from a single searchlight at distances of over a hundred miles* and have been guided by it from this distance up to the searchlight beacon.

"The trans-Atlantic flight has now been accomplished by both airplane and dirigible. It is only a matter of a few years before ocean flights will become regular enough to demand beacons. It will be remembered that the NC-4 made its flight with the aid of the searchlights from the destroyers along the line of flight.

WHAT MAKES THE SKY BLUE?

"A powerful light projected vertically in the form of a narrow beam will illuminate the column of air thru which it passes, making this visible as tho it were a pillar of light. This visible beam is caused by the scattering of the light rays by the myriads of dust particles which fill the air. It is astonishing to learn that the average atmosphere, on clear days, contains about twenty thousand dust particles per cubic centimeter, whereas the air around New York City averages as high as 200,000 dust particles per cubic centimeter! Most of these particles are too minute to be visible, even under a powerful microscope, but they have, however, the property of scattering light. It is this same phenomenon which gives us our blue sky. The sun's rays, in passing thru the hundred miles of our atmosphere, are scattered in all directions by these particles and we thus receive light from all parts of the sky.

"This sky light, however, is noticeably *blue* in color, whereas the sunlight is a yellowish white. *The blueness of the sky is caused by the fact that these minute particles in the atmosphere scatter a larger percentage of the short blue and violet rays than they do of the longer red and yellow rays.*

WHY THE VERTICAL BEACON?

"The new Sperry high intensity electric arc is ideally suited for such vertical beacons. The requisites of a small slender beam of maximum intensity, having a *bluish hue,* are all met by the concentrated beam cast by this arc. Every one who has seen these bluish beams playing in the sky at night can appreciate the value that this projector will have as a beacon. The blue color of the high intensity arc has a double advantage for this service. First, a greater percentage of the rays are scattered by the dust particles in this bluish beam than is possible with any other source of light. This causes the beam to be distinctly visible. The other advantage is that the human eye is more sensitive to the blue light than to any other color when the intensities are very low. Hence, at great distances from the beacon a faint bluish color may be distinguished more easily than any other hue. Therefore, the high inten-

The Man Who *Wouldn't* Stay Down



He was putting in long hours at monotonous unskilled work. His small pay scarcely lasted from one week to the next. Pleasures were few and far between and he couldn't save a cent.

He was down—but he *wouldn't stay there!* He saw other men promoted, and he made up his mind that what they could do *he* could do. Then he found the *reason* they were promoted was because they had special training—an expert knowledge of some one line. So he made up his mind that *he* would get that kind of training.

He marked and mailed to Scranton a coupon like the one below. That was his first step upward. It brought him just the information he was looking for. He found he could get the training he needed right at home in the hours after supper. From that time on he spent part of his spare time studying.

The first reward was not long in coming—an increase in salary. Then came another. Then he was made Foreman. Now he is Superintendent with an income that means independence and all the comforts and pleasures that make life worth living.

It just shows what a man with ambition can do. And this man is only one out of hundreds of thousands who have climbed the same steps to success with the help of the International Correspondence Schools.

What about *you?*

Are you satisfied merely to hang on where you are or would you, too, like to have a real job and real money? It's entirely up to you. You don't *have* to stay down. You *can* climb to the position you want in the work you like best. Yes, you can! The I. C. S. are ready and anxious to come to you, wherever you are, with the very help you need.

Surely when you have an opportunity that means so much, you can't afford to let another priceless hour pass without at least finding out about it. And the way to do that is easy—without cost, without obligating yourself in any way, mark and mail this coupon.

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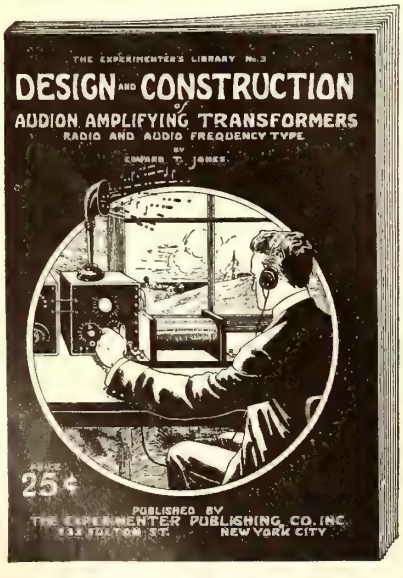
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sity arc has the advantage at each end. It produces the most visible beam at the sending end and makes the most easily discernible beam from the distant receiving end.

"In lighthouse work the varying conditions of the weather are all important. The light that is visible thru the greatest variety of atmospheric conditions is most desirable. We have *clear weather, cloudy weather, hazy and foggy weather,* with which to deal.

EFFECT OF CLEAR WEATHER.

"On a perfectly clear, cloudless night the vertical beacon is somewhat faint, due to the decreased number of dust particles, but it reaches to great heights and is visible from great distances because of the clearness of the atmosphere between the beam and the observer.

"As the weather becomes a little more misty or hazy a remarkable advantage of this system is evident. The increase in particles in the beam increases its intensity and makes it more visible almost in the same proportion that the haziness decreases visibility. The pillar of light is automatic, the lower the visibility the brighter the pillar. We therefore take advantage of the very thing which tends to decrease the range and maintain the range with it.

THE VERTICAL BEACON IN FOGGY WEATHER.

"When we consider fog, the problem differs. Fog consists of small water droplets over a thousand times as large as the ever-present dust particles. When fog is heavy *no light will penetrate it to any great distance, and one scheme is as futile as another.* But a sea fog is not always deep; many of the fogs are low-lying blankets of mist, and it is not unusual to see the stars above on nights when lighthouses are almost useless. *Under such conditions the vertical beacon has the advantage of being visible by showing its pillar above the fog where the navigators may discern it.*

"Lastly, the very usual condition of cloudy weather is perhaps the most advantageous condition of all for demonstrating the efficacy of the vertical beam.

"Night clouds vary in height from half a mile to seven miles. The vertical beam produces on any cloud within ten miles above it a patch of light that is surprisingly brilliant and is visible from great distances. If the clouds were low-lying and not more than half a mile in height the brilliant patch would be visible approximately *fifty miles away.* When the clouds are high and dense, *one hundred miles' range of visibility of the spot has been obtained.*

EACH VERTICAL BEACON HAS OWN SIGNAL.

"The problem of making various beacons distinctive is much simpler than in present lighthouse practise, since any combination of dots and dashes may be mechanically signaled continually by means of a *light shutter.*

"The use of a shutter is impossible in present lighthouses, since only one portion of the azimuth is illuminated at one time, therefore the optical system has to rotate and the flashes are produced by the rotation of the beams in azimuth. The vertical beacon is *visible in all azimuths* at all times, a very great advantage.

"We have spoken mainly of the application of the beacons to sea navigation. It is almost unnecessary to enlarge upon their advantages for air travel. Inland as well as shore beacons will be required for this field to make night flying possible. Inland guide-posts of light will probably be instituted for airplanes even before the present shore lighthouses are supplemented with similar apparatus for the mariners. But the ultimate adoption of this system is more than a possibility; it is the next logical step in this period of rapid and revolutionary progress."

Electric Locos Cross Mountains

(*Continued from page* 874)

turns electrical energy to sub-stations to be utilized by other trains—*from 25 to 52 per cent of power is recovered by regenerative braking!*

MORE EFFICIENT OPERATION

The electric locomotive can be operated for a thousand miles or more with only casual inspection, whereas the steam locomotive on mountain work requires considerable attention at every division point. This has made it possible to operate the electric locomotive over several old steam divisions, and practically eliminates roundhouses and yards at intermediate points.

By contrasting its workings with the steam locomotive in cold weather, as this railroad points out, the superiority of the electric locomotive is notably demonstrated. In cold weather a steam locomotive, losing much of its power thru heat radiation, draws lighter loads, makes less speed, and has greater difficulty in climbing grades and penetrating snow-drifts;—while the electric locomotive, aided by the cold in keeping its motors cool, is able to draw maximum loads, maintain its regular speed, and, by its immense power, to drive thru snow-drifts with comparative ease.

Abolishing Smoke Electrically

(*Continued from page* 880)

ing fine powders as in the manufacture of lamp black, zinc oxid, desiccated food, etc.

The process is generally applicable to collecting suspended solids and liquids carried in a gas. It has not yet been developed to the point where it can be used to separate gases of different constituency.

One of the interesting features of this process is that, tho originally designed simply to suppress a nuisance, it has in practise almost invariably proved a highly profitable investment, because of the value of the otherwise wasted material it recovers.

RECLAIMING COPPER FROM FLUE GASES, AT A PROFIT.

For example, a copper smelting company installed an electrical precipitation equipment at the cost of $113,900. The operating expenses (power, labor, supplies, etc.) were $14,600. But the value of the copper dust collected (at 12 cents a pound) was $180,018 a year. Thus, this installation paid for itself before the year was up and thereafter operated at a magnificent profit.

Again, a cement plant has an equipment, which cost $180,000 to install and $10,395 a year in operating expenses. Tho the material recovered is worth much less than copper dust, its value per annum at pre-war prices was $74,325, of which about one-third is cement dust at $1.00 a ton and two-thirds is potash at 70 cents a unit. This also represents a highly satisfactory profit.

These examples are of large plants. However, small plants may be installed at approximately proportional cost with practically proportional recoveries, since the efficiency is not dependent upon the size of the plant, but more particularly upon the operation of it.

The ability of this process to obtain potash in commercial quantities out of the vapors from cement kilns was a genuine



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By the addition of a loud talking telephone he is able to hear the messages many feet away from the instrument.

The super-sensitive DETECTAGRAPH-TRANSMITTER herewith shown is two and three-eighths inches in diameter, five-eighths of an inch thick and weighs less than three ounces. It is the most sensitive sound detecting device ever brought before the public.

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Not only is this instrument applicable for amplifying radio signals, but it can be used with equal satisfaction for magnifying other sounds. Phonograph music can be transmitted from one place to another by means of this instrument, and those who are afflicted with deafness will find enormous benefit by using this transmitter. It is the greatest device for building your own loud talking telephone, detectagraph and other devices. Can be used for any purpose where a sensitive detecting instrument is required.

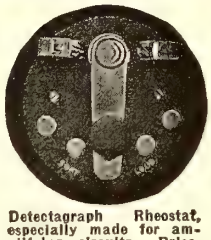
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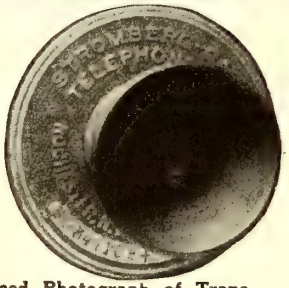


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surprise to the world and will undoubtedly have economic consequence of the greatest importance.

PRINCIPLES OF ELECTRICAL PRECIPITATION.

A treater for electrical precipitation is a comparatively simple structure. The accompanying schematic diagram illustrates a typical pipe treater. In general it consists of two large horizontal flues connected together by a number of small vertical pipes. Gases enter thru one flue, pass thru the vertical pipes and are discharged thru the other flue to a stack, exhaust fan, or other draft producer. The gas is then exhausted into the atmosphere. Some treaters are operated with an up-draft, some with a down-draft, according to the particular local conditions to be met. Some treaters employ rectangular passages instead of pipes to connect the two flues. These are generally referred to as plate or box type treaters. The principles of operation for all these types of treaters is the same.

The actual precipitation of the dust or fume occurs in the vertical pipes referred to above. Carefully centered in each, is suspended a small wire or a small chain. These constitute the *negative electrode* of the treater system. The inside surface of the pipes constitute the *positive electrode.* Each wire or chain is carefully insulated from its pipe and from the ground, and is charged to a high potential, usually at from 25,000 to 65,000 volts *direct current.* The tubes themselves are grounded. Thus, within each pipe is created an intense electrostatic field. The gases passing thru this field become ionized, and the ions travel with high velocity in a direction at right angles to the electrodes causing the field. These highly charged ions are continually colliding with the suspended solid and liquid particles in the gas, and the ions impart a charge of like potential to such particles, which in turn begin to travel toward the electrode of opposite polarity. Since the negative suspended electrode is of much smaller area than the electrode formed by the inside surface of the pipe, there is much greater electrostatic stresses per unit of area in the neighborhood of the wire, and as a result far greater ionization about the wire. Thus the gas receives a static charge of the same polarity as the wire, and the solid or liquid particles in the gas receive charges of this same polarity, which causes them to be projected against the inner surface of the pipes, where they tend to stick and accumulate until the electric power is turned off; after which the accumulation of dust is usually collected from the pipes by loosening it by rapping the sides of the pipes, and collecting the dust in hoppers at the bottom.

The treater tubes are usually arranged in a series of units. Each unit or section is independent of the rest and is supplied with dampers and electrical disconnecting switches, so that it can be shut down for cleaning or repairs, without interfering with the operation of the other sections.

To produce the high static charge on the suspended electrodes a *uni-directional current* of high voltage is used. While it is possible to generate *direct current* of a potential in the neighborhood of 100,000 volts, it is at present better practise to obtain this uni-directional high voltage current by *rectifying a high voltage alternating current.* Alternating current at low voltage is stept-up to the desired high voltage by means of a transformer and then changed into uni-directional current by means of a mechanically driven rectifier. Accordingly, the usual equipment for electrical precipitation involves the following:—A source of low voltage alternating current; a step-up transformer; a high voltage rectifier; means for driving the rectifier, also a switchboard and accessories.—*Photos courtesy Westinghouse Electric & Mfg. Co.*



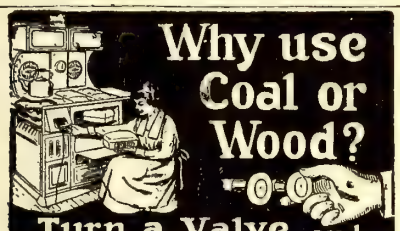
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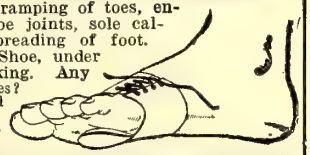
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Science In Slang

By EMERSON EASTERLING

(*Continued from page* 913)

or aunty's knitting thread or pop's fishing pole. Next we hear of some wise guy springing on the g.p. the tantalum. But not until we had the carbon type improved by metalization. Next, seeing that the tantalum filament was not the very best thing for Ford headlights, as it broke by looking at it too hard—and we all couldn't hold our mouth right when in its presence all the time—so the high priced metal that we extract from shelite was stuck into the vacuated glass shell—the famous tungsten. You could use the old hammer on it and still not have to bring out the oil lamp.

"Next some enterprising gink finds out that nitrogen gas works better than the absence of everything in the globe, and we get the nitrogen gas lights. By coiling the wires and thereby concentrating the light unit in the nitrogen environment, we get a glim that you can't look at and see whether she had green or just pale blue stockings until you give your headlights time to recuperate from the shock—of the light.

"That Nernst light we hear about is just oxide of Mother Earth in a few of her forms and when said earth is heated to the right temperature it becomes conductive and the juice makes it glow, like the other kind. It is a queer thing, the stuff is non-conductor when cool. Glass is the same way, only not so much so.

"The big idea in the arc lights is this: the current passing from one pole of carbon to the other particle seizes the stuff and passes it from one pole to the other. The current causes the carbon to become incandescent by way of the resistance given to the current. Some of the carbon is consumed in flame and the rest is deposited on the negative pole. In alternating current the carbon is going each way, intermittently.

"In the incandescent—so called—type the wire is heated by the juice that passes thru it, by way of the resistance in the wire, to an incandescent state. We have light.

"Is that plain?"

"Plain as broad day light," Punk returned.

"You see, in some cases, electricity flowing thru a conductor sets up resulting surrounding vibrations, sometimes in the form of light, sometimes in the form of magnetism, sometimes both. The energy that is impeded in the electrical form is converted into heat, a form of potential energy, or something else—the converting of the forces is what really impedes the current. It is the cause, not the result."

"But lissen," spoke up Punk with a dreaming, far away look in his left uppermost eye, "why has no one thot to take out a patent on a light-bulb with the vacuum on the *outside!*"

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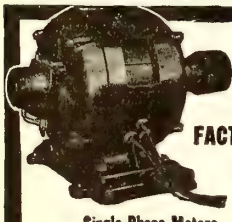
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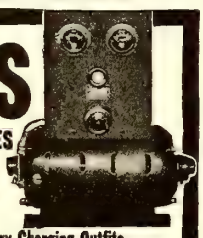
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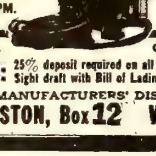
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What Atomic Forces Could Do.

(*Continued from page 872*)

pound of coal burned in the locomotive develops 13,500 British Thermal Units. Each pound of coal thus yields 3,402,000 gram calories and for 60 tons of coal, we arrive at a total gram calorie output of 408,240,000,000. Divide this by the number of gram calories or 2,900,000,000 produced by one gram of radium disintegrating, we find that approximately five ounces of radium would be required instead of 60 tons, or 120,000 pounds of coal. This considers, of course, that we could disintegrate the radium during the trip between the two cities, so as to release all of the caloric energy in the five ounces of the stuff (based on 2,500-year decay period). The difference in weight between the coal required and the radium is almost inconceivable, so startling is the ratio between the two. Radium, of course, is very expensive at present, and this amount of radium would cost a prodigious amount of money, but presently we will undoubtedly see the cost of radium drop to a figure several thousand per cent below what it now is.

And this is not all, for we have merely used radium in this case to base our computation on for the sake of convenience. When our scientific investigators have at last solved the method for us whereby to unlock this marvelous store of energy in the atoms of any substance, then we can use an ounce of any material and not particularly radium, for as many of the world's best-known thinkers in this philosophical field have declared many times, one ounce of a certain metal, in this respect, is the same as any other substance; but the great secret, so far unsolved, is—how to overcome and control the overwhelming force with which these electrons are held in their orbits about their central nuclei.

A very small amount of coal and also a lesser amount of radium would be required to drive a railroad train from New York to Chicago, or vice versa, providing some genius will show us how to use coal, for example, to produce power in a steam locomotive without wasting about 93 per cent of it in heating and other losses. It is a well-known fact that the efficiency of the average steam locomotive is about 7 per cent. This lowly figure of 7 per cent then means that that is all of the energy put to actual work on the trip, while out of 100 per cent of the energy in the coal, when we place it in the tender car of the engine, 93 per cent is thrown away. Suppose that to-morrow an engineer produced a steam locomotive which would burn coal with an efficiency of 90 per cent; then we would only have to use approximately 1/12 of 60 tons, or 5 tons of coal! Likewise with the radium—instead of using five ounces to drive a train between the two cities, we would only require practically 5/12 of an ounce! It might be said at this juncture that, practically speaking, but a very small fraction of an ounce of radium would be required to do the work necessary to haul such a train at this rate, for undoubtedly when we once learn how to disintegrate matter after such a fashion as this, we should have available much more efficient motors, turbines and engines, etc., than we now dream of. In computing the amount of radium required, or five ounces in the present case, the amount of heat assumed as required, was that produced by the coal burning under the boiler. It will therefore be seen at once that this is really a very poor comparison so far as showing the real effectiveness of radium (or atomic energy); but as we do not have any other means of showing this ratio in a practical sense, we have to content ourselves with this illustration.



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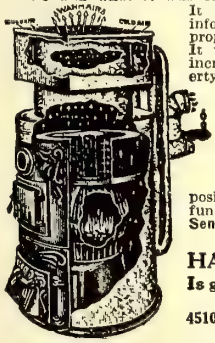


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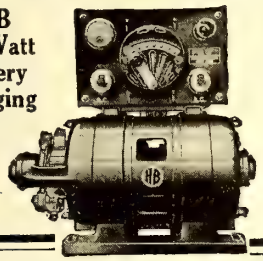


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4,000-MILE EARTH RADIO SIGNALS.

Radiography is being revolutionized by transmission through the earth and water instead of the air, and recently gave remarkable results at a little experiment station on a barge in San Diego Bay, said Lieut, R. A. Morton, of the navy radio laboratory at Mare Island, who conducted the experiments.

First proof of the success of the new method of radio transmission thru the earth, Lieut. Morton said, was made when the Navy Department sent a message from the Annapolis station to the British admiralty that the dirigible R-34 had been sighted off the American coast.

Lieut. Morton was at his instruments, heard the messages and copied them in their entirety, he said.

A Model Helicopter

By William J. Beach, M. E.

(*Continued from page* 883)

would be attempting to rise vertically at the forward speed of an airplane and to dream of going up around 100 m.p.h. is rather visionary. What I claim is necessary, however, is sufficient supporting surface revolving in a circular direction at a sufficient number of miles per hour; as the aerofoil or aerofoils of an ordinary plane are taken in a forward direction at a sufficient number of miles per hour for example.

Having now described the advantages and explained the principal requirements in a *vertical rising aeroplane*, I will proceed to offer my suggestions as to how they may be successfully carried out and at the same time explain the principle of my invention.

As already stated I consider that there is a practicable way other than from the *center axis* of a motor by which a sufficient amount of surface may be rotated to rise vertically and lift into the air a useful load. This, I suggest, may be done from the outer perifery or at a sufficient distance from the center axis or axes of the motor or motors.

A simple illustration may be had from the fact that if a large wheel were mounted on a suitable axis and in suitable bearings, human strength could not turn the wheel if the energy were exerted at the axis; but once we allow the energy to be exerted at the outer perifery, then the feat becomes an easy accomplishment for human strength. The reader immediately says "Obvious"—and in saying so, agrees with me that large things are learned from small details. Having agreed that a body may be rotated from its outer perifery with a power that would be incapable of turning it from its axis, it now becomes necessary to apply that simple principle for the purposes already outlined.

According to the illustrations it will be seen that a central nacelle has a bridge-work extending transversally from it; the outer extremities of the bridge-work is provided with circular structures. Extending rearwards from the nacelle or fuselage are spars or booms which carry or support a horizontal stabilizer and a vertical fin and steering rudder.

Immediately above the two circular structures are the *uplifting surfaces* secured to central vertical shafts. The lower parts of the circular structures are provided with a track extending from the vertical shafts, on which the supporting surfaces are secured. There are also beams or the like which carry at their extreme ends suitable motors, there being two in or on each track; the motors are preferably of the rotary type and placed in an inverted manner for purposes mentioned later.



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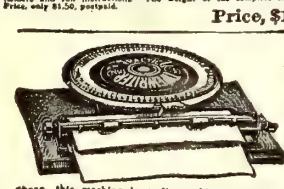
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It will be observed that a circular part has been cut out of the horizontal stabilizer, beneath which is located a continuously revolving stabilizer, the blades of which may be reversed at the will of the operator, but normally the blades revolve in a neutral position.

The two uplifting surfaces revolve in *opposite directions,* and since it is most desirable that they both revolve at uniform speed, or that they shall be perfectly synchronized, they are positively coupled together, so that should the one on the left attempt to revolve at a higher rate of speed than the right hand one, extra power or speed developed is immediately transferred to the one on the right or vice versa.

The continuously revolving stabilizer is driven from this coupling and likewise the forward propeller if need be.

Describing the invention in operation, the motors are provided with traction wheels which engage with the tracks and race around same as already explained, transmitting their energy at a sufficient distance from the central axis of the surfaces to enable them to take the surfaces around at a sufficient number of miles per hour to create a sufficient number of pounds per square foot "lift" to create an elevating force more than equal to the weight of the entire flying machine. The advantages of placing the motors in an inverted position is primarily for lubrication purposes, as an oil reservoir may be provided in the bottom of the crank case which is not practicable in a rotary motor revolving in the present airplane; however, the principal reason is to take advantage of the gyroscopic action of the motors which provide for a maximum of inherent stability, as it will be seen that with each revolution of the motor the gyroscopic action changes its position in the plane and changes many times thruout one complete circuit of the track.

The lateral stability of the machine is taken care of by flaps or ailerons, which are pivotly secured under each main surface and normally are neutral and maintained so by air pressure, but are free to be deflected at the will of the pilot.

While ascending vertically, should the machine have a tendency to fall out of balance longitudinally, the blades of the continuously revolving stabilizer are either elevated or deflected as the circumstances may require.

If any of my readers are of a mathematical nature, a very few minutes with a pencil will show what may be accomplished according to these suggestions with a comparatively small horse-power.

If the operation of the machine is followed out carefully it will be seen that a perfect demonstration of the solar system is in evidence, in which case let us accept the center axis of the uplifting surfaces as the Sun, the revolving motors as the Sattelites, and the tracks around which they travel as their Orbit around the Sun.

In testing a model of this particular character the procedure is different to testing a model of the present type of machine. In the latter case a wind tunnel is used or a blast of air driven thru the tunnel which enables the lift and drift, etc., to be readily determined. In the case of a model of a vertical rising plane such as a *Helicopter,* the model is secured to the end of a light boom which is pivotally and rotatably mounted on a pedestal; in the case of the model herein shown a copper pipe was led along the boom to the model, which copper pipe conveyed comprest air to the four 3-cylinder motors which have a ½" bore and ½" stroke.

All experiments were carried out on 50 pounds air pressure; the model measured 36" across the surfaces and has performed all the evolutions desirable for "safe and sane flying."

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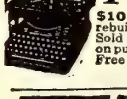
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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

Receiver.

(365) Merle Nantz, Battle Creek, Mich., hereby presents to us a scheme and diagram for an amplifying telephone receiver. It employs a small transformer which acts upon the diafram (D) simultaneously with the polarized magnets (E M), which are energized by the current from the secondary of the transformer. In the diagram P is the primary of the transformer, S is the secondary of the transformer, P M a permanent magnet which may or may not be used. The greatest doubt is that the transformer will not be efficient enough to magnetize the electro-magnets properly.

A. We do not think that the scheme is feasible, altho theoretically there are grounds for your contention. The reason is that a telephone receiver diafram is pulled down in the exact ratio of the current supplied. Other things being equal, it will not help you to transmit the current as shown in your illustration. As long as you get a sufficient number of ampere-turns the diafram will be pulled down in a certain ratio to the current past thru the windings. Using a transformer would therefore not help you. On the contrary, due to the losses inherent in every transformer, the efficiency of the receiver would not be increased, but rather reduced.

Patents to Minors.

(366) Robert W. Ashworth, Houston, Texas, says: "I am fifteen years old and have an invention which I would like to have patented. Please let me know, if not too much trouble, how old a person has to be to apply for a patent in the United States."

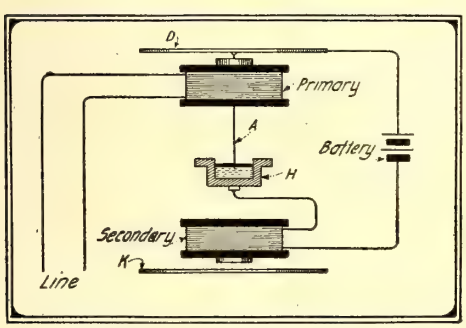
A. As far as we can ascertain there is nothing in the patent laws in the United States that prevents anyone from obtaining a patent. As long as a person is the inventor of a certain device the age will make no difference and a patent will be granted, even to a minor.

This is as far as the Patent Office is concerned. It should, however, be understood that a minor would have difficulty in selling a patent until he was of age, or unless he had a guardian appointed.

Telephone Receiver.

(367) Weldon Hampton, Chicago, Ill., submits several elaborate drawings of a telephone receiver, the principle of which is shown in the illustration herewith. The inventor calls it a secondary receiver or a combination of a transmitter and receiver. It may be used for reproducing the feeble vibrations in the receiver to stronger ones. From the illustration it will be seen that two diaframs are used and that the receiver has a so-called primary and secondary. The core of the primary is hollow and a fine wire A passes thru it and forms one electrode of the microphone H. The incoming line current operates the diafram D, which in turn vibrates rod A of the microphone. This operates microphone H, which in turn acts upon the secondary and the diafram K. An amplification thereby results.

A. A very clever idea, and we think that a patent can be obtained upon it. We are certain that the device works and it would come in useful for many purposes.

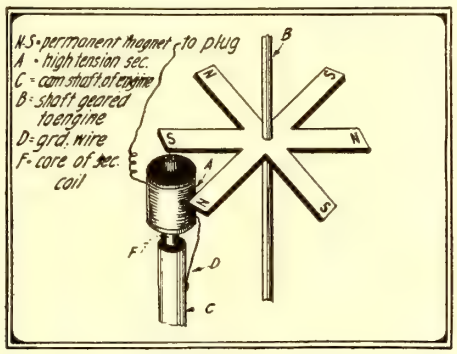


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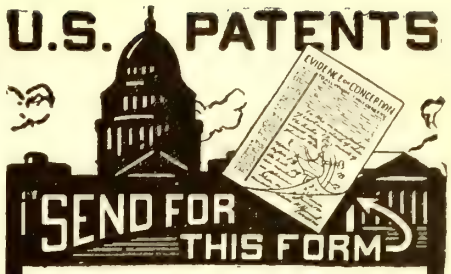
(368) Clyde Stewart, Beldenville, Wis., says: "I submit herewith a drawing of a proposed ignition outfit. The drawing is almost self-explanatory. The secondary coil, which could be similar to the one used on wireless spark coils is fastened firmly to the cam shaft C. The magnets N S are, of course, rotating all the time the engine is in operation. When the engine is on the compression stroke the cam shaft moves up, carrying the coil with it. On account of the magnetic field set up by the rotating magnets a high tension current would be set up in the coil. I am rather in doubt as to how much current could be produced, but I should think if the secondary were larger than most secondaries on gas engine coils enough current could be induced. The device could also be applied to automobile engines by means of a special device, which I have. The question of timing the discharge could be solved by moving either the coil or magnets.

A. This seems to us a good idea, altho it should be tried out first in practise. We are also afraid that more magnets than shown will have to be used in order to get a sufficiently strong spark. We also are afraid that unless the magnets are very powerful little current will be realized. When it is considered that even a small spark coil takes as much as five or six amperes it will be realized that in order to get sufficient electro-magnetic flux the permanent magnet would have to be exceedingly powerful.



This Patent Advice Inquiry is Repeated This Month, as no Diagram was Publisht with It in the December Issue.

U.S. PATENTS



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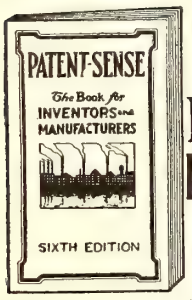
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Rotary Spark Gap.

(369) J. Russell Franty, Du Bois, Pa., sends in to us for patent advice on the following and says: "I submit herewith a plan drawing of a rotary spark gap which embodies a new idea in the manner of connection. The object of this is to increase the number of discharges across the gap per second with the use of a smaller number of electrodes.

Referring to the drawing:

R = rotating member. Made of bakelite or other insulating material.

B = a ring of copper or brass surrounding R.

C, D, E, F, G, H, I, J, K = electrodes mounted on B.

S S' S" = stationary electrodes. S and S' are similar to the revolving electrodes C, D, E, etc. S" is of a rectangular form and is slidably mounted on a stud so that it can be moved closer to or farther away from the revolving member.

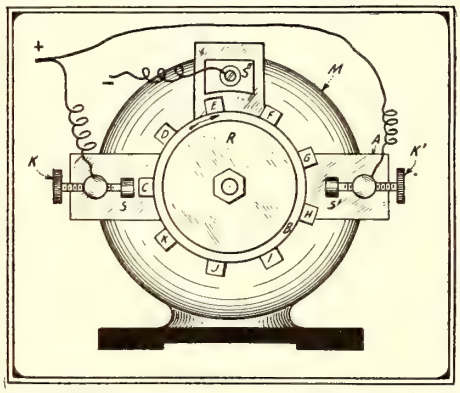
K, K' = adjusting knobs of bakelite or hard rubber.

A = stationary electrode support. It is a T-shaped member and supports the electrodes S S' S".

The stationary electrodes S S' are connected together and thence to one side of the high tension circuit. The electrode S" is connected to the other side of the circuit.

When the high tension current flows into S it jumps across the gap into C, then passes thru B into E and then jumps across a gap into S". The rotor R moves in a clockwise direction, and when it has made 1/18 revolution the electrode G will have come opposite the electrode S', which being connected to the electrode S, will pass a current into G, thru the ring B to E and then across the gap into S". The next spark will pass between S and K and D and S." The same cycle of operation is repeated 18 times per second.

The advantage is due to the fact that each revolving electrode is used four times per revolution, whereas in the ordinary gap they are only



The Object of This Rotary Spark Gap is to Increase the Number of Discharges Across the Gap per Second with the Use of a Smaller Number of Electrodes than Usual.

utilized twice. Hence the discharges are twice as frequent as in the common gap.

Thus the number of revolving electrodes may be reduced and the pitch of the omitted wave still remain high.

If the number of revolutions per minute is 3600 and there are 9 electrodes on the rotating member, there will be 64,800 discharges across the gap per minute, or 1080 per second. The ordinary gap with 9 electrodes would only produce 540 discharges under the same speed.

In practice the number of revolving electrodes could be 5 or 7 and the pitch of the emitted wave will be above 600.

Please advise thru the patent advice columns of the ELECTRICAL EXPERIMENTER whether this idea would be of any practical value. Could a patent be obtained?

A. This seems to us as a very good idea and quite original to our mind. We are almost certain that a patent can be obtained on this design. At least we have never seen a gap just like this described before. As a precautionary measure, however, we would advise to have your patent attorney make a search for patentability.

FRANCE TO EXPERIMENT WITH TIDAL POWER.

Experiments to determine the practicality of the use of tidal power to offset the coal shortage under which France is expected to suffer for a long time will be carried out under government auspices in St. Briac Bay, on the north coast of Brittany.

Experiments are also being conducted to determine the possibility of replacing coal wholly or in part on the railways, in gas, water and power plants, and for domestic purposes. The *Petit Parisien* states that the use of gasoline in the chief gas, water and power plants of the public service is contemplated, and that a daily saving of 4,000 tons of coal for domestic use may result. This would require 60,000 tons of gasoline a month, possibly imported from the United States.

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By a Former Examining Official of the U. S. Patent Office

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Lawyer and Engineer

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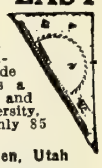
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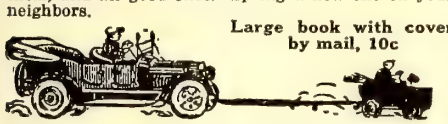
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By JOSEPH H. KRAUS

(*Continued from page* 877)

A person is instantly imprest by the bright blue glow at the far end of the pool and going over to investigate, sees the sterilizer. Looking into the pool he can see the bottom thru eight feet of water as clearly as tho he were looking into a finely polished glass, and ah! what confidence he has in "taking a duck" in the inviting waters glittering and sparkling in their purity.

The device is constructed very simply. It consists of a tank of non-ponderous proportion, which tank contains three compartments. Between the vanes which divide the compartments is an opening, allowing for the insertion of the ultra-violet ray lamp,—the water in order to flow from one of the compartments to the other, must pass two of these lamps. The drain pipe successfully prevents the overflow of the water above the compartment vanes. In this way all of the water must pass over or under the sterilizer at least twice. The water constantly going in, forces the rest of the water along, and inasmuch as the last compartment has a low vane or partition, a miniature water fall is produced. The water then passes into the pool thru the supply outlet pipe. The tank can sterilize about 300 gallons of water per hour, and perhaps even more may be obtained from it.

Astern! With Engine Running Ahead.

(*Continued from page* 885)

How easily this maneuver is executed is proven by the remarkable triple exposure photograph here reproduced. This picture shows three exposures on one plate depicting the Landreth Motor-boat *turning in approximately its own length while traveling "full speed" ahead!* The exposures were made a few seconds apart and the boat made a complete turn in approximately twenty seconds!

With a few turns of the wheels the rudder plates are set in V-shape, as illustrated in the chart and with the propeller running *full speed ahead,* the boat almost instantly stops and starts to run backward. The boat was brought from full speed forward to backing in 9 seconds. With the reversing gear originally installed on this boat it took 26 seconds to back. The reversing speed can be controlled to any degree by increasing or decreasing the angular positions of the rudders. The reversing motion is imparted by a stream of water thrown back against the rudder by the propeller and projected thereby forward along the sides of the boat toward the bow. The speed of this water is sufficient to propel the boat backward at about 30 per cent of the full speed ahead. Just how this is accomplished is shown in the accompanying detail drawing. It will be noted that there is a steel plate, or fin, above the rudder which prevents the water thrown back by the propeller to escape over the top of the rudder. This fin assists in directing the water forward along the sides of the boat.

The manner in which this experimental boat was equipt with the new rudder is shown in the photos herewith. It was discovered in these experiments that the angle of the supporting rod must be 90 degrees, or more, with the propeller shaft.—*Photos courtesy of General Electric Co.*



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DR. J. H. ROGERS URGED FOR NOBEL PRIZE.

A cablegram sent recently to Stockholm, Sweden, may secure for Dr. James Harris Rogers of "Underground Radio" fame, an honor which he well deserves and a reward that he has spent a lifetime in earning. The cablegram follows:

Committee on Award of Nobel Prize in Physics,
Royal Academy of Science,
Stockholm, Sweden.

We ask consideration in award of prize in physics for Dr. James Harris Rogers, Hyattsville, Md., discoverer of underground and undersea wireless. Details obtainable from *Baltimore Sun*, Southern Commercial Congress, United States Senator France, Georgetown University.
[Signed.]
MARYLAND ACADEMY OF SCIENCES,
FRANCIS C. NICHOLAS, Director.

While all the scientific world concedes that Dr. Rogers discovered, revealed and put to immediate practical use a secret that Nature had hitherto concealed, no one happened to think, before *The Baltimore Sun* suggested it, of the Nobel prize in physics as a reward for his achievement.

The Nobel Prize Fund is administered by a board of trustees at Stockholm, and the income from it is divided into five equal sums, of about $40,000 each, to be awarded annually December 10, the anniversary of the donor's death, and to be known as the Nobel Prizes. The prizes are conferred for what is considered the greatest work of the year in chemistry, in physics, in medicine or physiology, in idealistic literature and in the furtherance of the world's peace. The trustees do not make the awards, but have designated various educational institutions of Sweden to make them. The Royal Academy of Science, Stockholm, is chosen to award the prize in *chemistry* and that in *physics*.

Thus far only three persons in America have won Nobel prizes. The late President Theodore Roosevelt was chosen for his share in bringing about peace between Russia and Japan in 1906; Dr. Albert A. Michelson, of Chicago, a German by birth but a resident of the United States and a graduate of the Naval Academy, won the physics prize in 1908, and Senator Elihu Root received the Nobel Peace Prize for 1912 because of his work in the pacification of Cuba and the Philippines.

No Nobel prize has been awarded in physics since 1915 owing to the war.

Dr. James Harris Rogers, of Hyattsville, inventor of the underground and undersea wireless system of telegraphy, regarded as one of America's greatest war inventions, has made a discovery in physics and perfected a practical invention that makes him today a central figure in the scientific world. It is a discovery that gave the United States opportunity successfully to transport American troops to the Continent and to continue to receive, continuously, telegraph messages from Europe after Atlantic cables had been cut.

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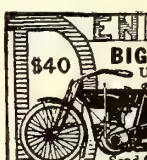
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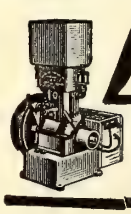


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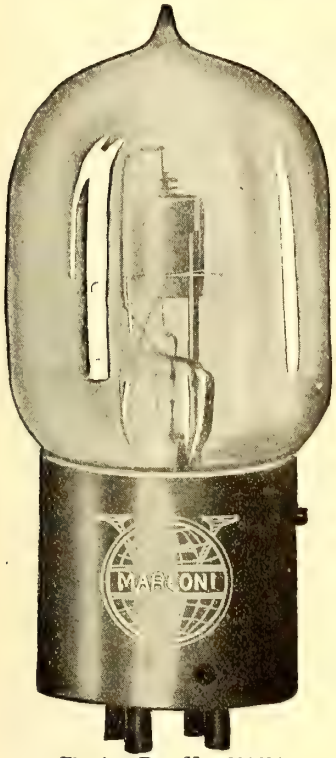
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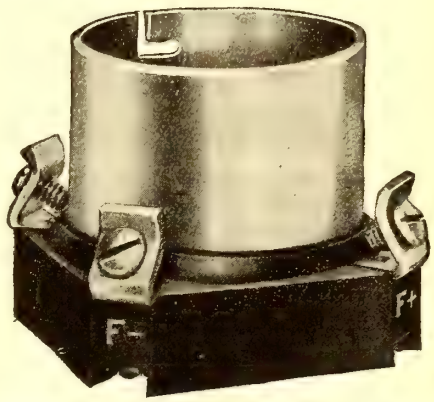
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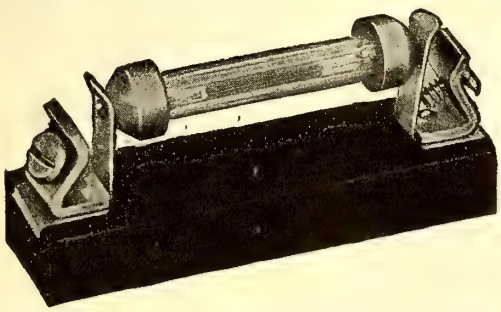
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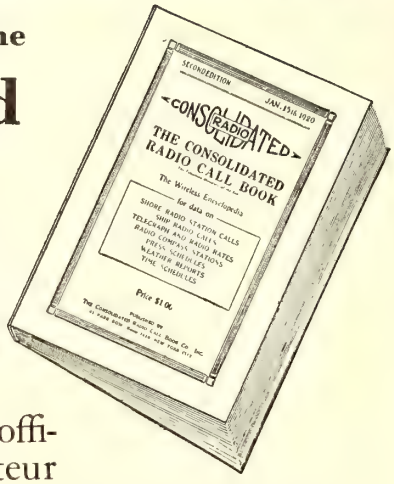
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This book also contains the advertisements of practically every leading company in the radio field.

The Mt. Wilson 100-Inch Reflecting Telescope

(*Continued from page* 889)

effect it, however, and even the heat from the friction of grinding made it necessary each day to discontinue work after a couple of hours. Another most elaborate series of tests was made each day to determine the effect of the previous day's grinding on the optical qualities of the glass. To carry out these tests a 60-inch plane mirror was required, the grinding of which took nearly a year in itself.

HUGE LENS MIRROR WEIGHS 9,000 LBS., OR 4½ TONS.

When the polishing was complete the huge mirror was 12¾ inches thick at the edge, 101 inches in diameter and weighed 9,000 pounds. The surface is slightly parabolic and yet at its center differs from a true spherical form by only .001 of an inch. A deviation of more than .000,004 of an inch from the theoretical form calculated by the mathematician was positively not permissible. Imperfections so minute are discovered by exploring the surface of the disc with a ray of light and it was for this purpose that the 60-inch plane mirror was required. And thru the center of this wonderful mirror a hole, several inches in diameter, is drilled. This is used for viewing the image thru, as explained later on.

In the spring of 1917, eleven years after the order was given for the casting of the glass, and seven years after the grinding began the mirror was pronounced fit for use and it was therefore silvered. The area of its surface is 8,012 square inches and the operation of silvering required 150 gallons of distilled water and 32 ounces of silver nitrat. In 15 minutes the deposition of silver was complete.

For use in conjunction with the larger mirror two convex mirrors also had to be ground. These mirrors were of 29 and 25 inches aperture respectively and when combined with the larger mirror increase its focal length from 42 feet 3½ inches to 150 and 251 feet.

In the meantime other and equally important operations were in progress, for telescope mirrors are useless without proper mounting and housing. The dome of the observatory built contemporaneously with the grinding of the mirror is 100 feet in diameter and 100 feet high. In its construction 650 tons of steel were used, all of which had to be transported to the summit of Mount Wilson, 6,000 feet high. To permit this it was necessary to widen the mountain road from 3 to 8 feet. Motor trucks having extra water supply to prevent overheating on the steep grades were found necessary and 6 months were required to get the materials to the top. The larger parts of the telescope mounting were made in the Fore River Ship-yard at Quincy, Mass., and the dome was built by the Morava Construction Works of Chicago.

The dome is made of metal and is double-walled to insure more uniform temperature. The greater portion of the dome rotates, only the lower 28 feet being stationary. A huge central pier, surrounded by 40 others, comprises the foundation for the telescope mounting. Underneath the main pier is a 6-foot depth of sand. This pier is of solid concrete and hollow. At the level of the ground it is 20 feet by 45 feet and rises to a height of 33 feet. In it are three heavy floors, the uppermost of which at a level of 25 feet houses the driving clock and other parts of the mechanism. The pier is surmounted by a circular floor 52 feet in diameter. To exclude

(*Continued on page* 944)

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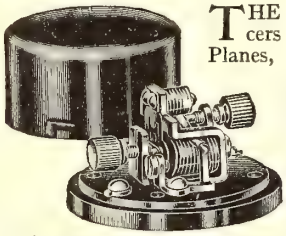


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THE Radio Officers of the NC Planes, after testing all other buzzers, decided to use the "Mesco" on their radio equipment. The R-34 was equipped with two Mesco Radio Buzzers.

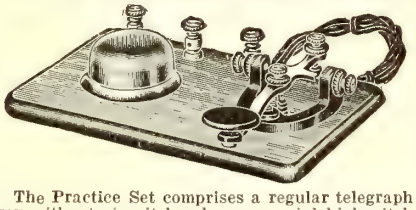
Why? Because of its reliability and constancy in operation; greater output efficiency; ease of adjustment; unaffected by extreme variations in weather conditions; exposed wires eliminated.

Sparking is almost entirely eliminated, so that the energy lost in light and heat in the operation of other buzzers is here conserved and radiated in the form of oscillating energy.

This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

List No. 55, Mesco Radio Buzzer
Price $2.05

MESCO WIRELESS PRACTICE SET



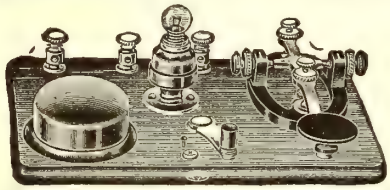
The Practice Set comprises a regular telegraph key without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

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Weighs 4 lbs. packed.
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MESCO Combination Practice Set for Learning the Mo. and Cont. Visual and Audible Codes



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The Mt. Wilson 100-Inch Reflecting Telescope

(*Continued from page* 942)

drafts this floor is surrounded with a metal wall 9 feet high.

MOVING PARTS WEIGH 100 TONS.

The telescope tube is 11 feet in diameter and consists of 4 sections. The moving parts of the telescope weigh 100 tons and this immense mass is supported by a unique system of *mercury flotation.* Two cylindrical pedestals rest in cast iron tanks with ⅛ inch clearance between pedestal and tank which is filled with mercury. A plunger device adjusts the mercury to any desired level. For driving this huge mechanism the lower end of the polar axis carries a worm wheel having 1,440 teeth cut with the utmost accuracy and meshing with the driving train of the clock.

The driving clock, a marvel of scientific accuracy and mechanical perfection, is 6 feet high and covers a floor space of 5½ feet by 4 feet. The clock is operated by a weight of 1½ tons whose falling is governed by a pendulum. Every 12 minutes the clock is automatically wound.

The telescope and dome are operated from a desk at the 42-foot level by means of a system of electric controls. Without leaving his chair the observer may point his telescope to any portion of the heavens and rotate the dome and platform at will. In all there are 40 electric motors ranging from 1/20 to 7½ horsepower and making a total of 50 horsepower with 13 miles of wiring.

To prevent temperature changes an insulating chamber with walls of cork one inch thick is built about the mirror cell. In addition fans circulate the air about the mirror and keep its temperature even.

The telescope carries photographic attachments and a spectrograph of great refinement. Much of its work will be done by aid of these instruments.

At last when both mirror and mounting were complete came the very delicate task of transporting to the top of the mountain the precious disc of glass, without which all these years of patient toil and outpouring of genius would be in vain. It was a Herculean undertaking. Most carefully the glass was lifted from the grinding table and lowered into an octagonal box lined with paraffin paper. Inside the paper carded wool and Brussels carpet were packed to lessen the danger from shock and heat. The cover of the box was likewise padded with carpet and wool and securely fastened in place. The box itself was wrapt in paraffin paper clampt between heavy timbers and provided with a ring for lifting. The motor car which transported it was lined with cushions in which were strong springs, and heavy timbers were bolted to the bed of the car. Then the ascent began and as all the world knows it was crowned with success.

HOW A CONCAVE MIRROR PRODUCES AN IMAGE.

To understand the operation of a reflecting telescope it is necessary to know how a concave mirror produces an image. Unlike a plane mirror the reflected rays of light actually come to focus at some distance in front of the mirror and produce a real image. A real image may be caught on a screen and it is not upright, as that of a plane mirror, but inverted. The production of such an image is shown in the accompanying figure. A line drawn to the middle point of the mirror and perpendicular to it is called the principal axis. Now all rays of light coming to the mirror parallel to the principal axis will

(*Continued on page* 946)

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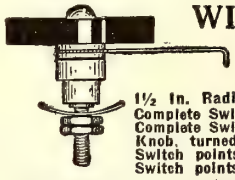
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Complete Switch, polished brass finish	50c
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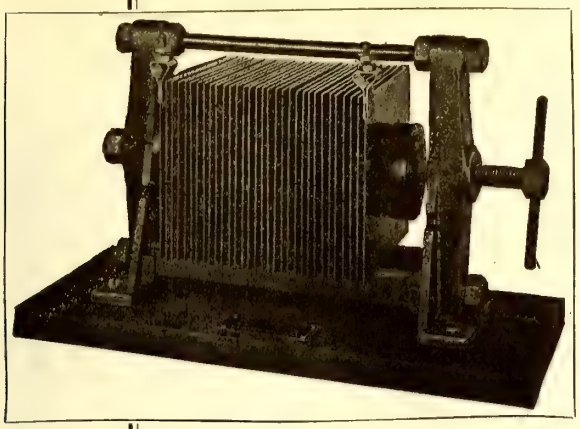
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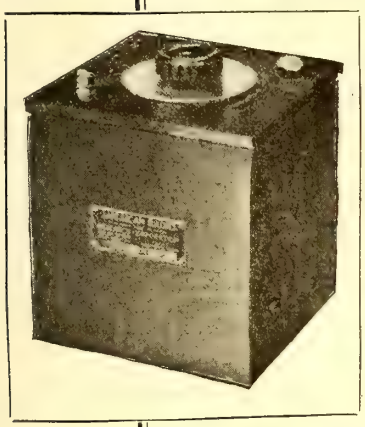
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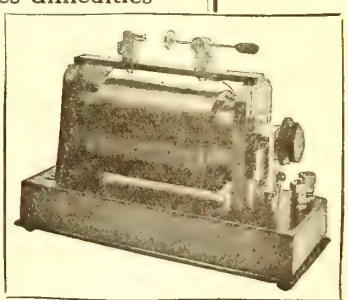
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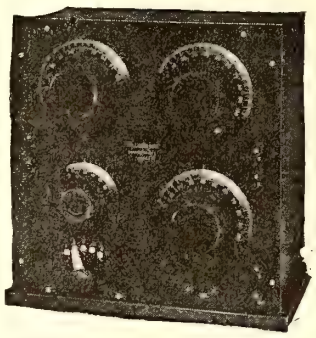
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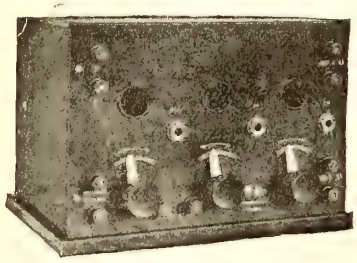
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Short-Wave Regenerative Receiver, Type CR-4 is characteristic of our line of apparatus. It comprises a highly developed circuit of the continuously variable inductance type with an antenna series condenser. Range, 170 to 580 meters. It is an embodiment of the latest achievements in electrical and mechanical design; capacity effects and other losses reduced to an absolute minimum. If you want results,—real long-distance signals—investigate this receiver, it will pay you.

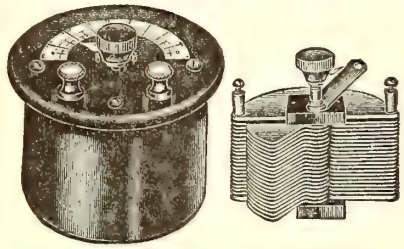


Vacuum-Tube Detector and Two-Stage Audio-Frequency Amplifier Type RORD

Vacuum-Tube Detector and Two-Stage Audio-Frequency Amplifier, Type RORD is another proof of Grebe pre-eminence. The latest development in Amplifier construction—The Grebe Automatic Control is found exclusively in this model. A telephone jack and plug system controls both the filament and telephone circuits automatically. The RORD Amplifier is equipped with two sets of binding posts for B batteries—one for the Detector, the other for the Amplifier tubes.

FREE bulletins R-103 and R-110 describe these models—Why not write for them now? Or send ten cents for complete Catalogue.

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BEEKO VARIABLE CONDENSER
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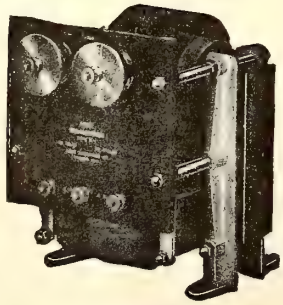
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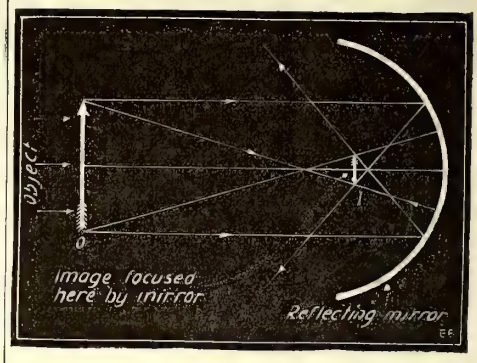
GET WHAT YOU PAY FOR!



An "ACME" will do it!

The Mt. Wilson 100-inch Reflecting Telescope

(*Continued from page* 944)



Illustrating How a Concave Mirror Produces An Optical Image. The Reflected Rays of Light Actually Come to Focus at Some Distance in Front of the Mirror and Produce a Real Image. Rays of Light Coming From Distant Objects, Such as Stars, Are Brought to Focus in This Focal Plane, and It Is at This Focusing Point That a Screen or Mirror Must Be Placed to Catch the Image. This Image Is Always Smaller Than the Object, No Matter How Large the Mirror. An Eye-piece Must Be Used to Magnify the Image.

come to focus at some point on the axis, depending upon the curvature of the mirror. This point is called the *principal focus* and a plane passing thru it at right angles to the axis is called the *focal plane* of the mirror. Rays of light coming from distant objects are brought to focus in this focal plane and it is there that a screen must be placed to catch the image. *This image, too, will always be smaller than the object, no matter how large the mirror may be. But the larger the mirror the more light will be gathered and the brighter will be the image.*

THE NEWTONIAN TELESCOPE.

In order to observe this image the rays of light producing it must be thrown into an eye-piece. This is done in either of two principal ways. In the Newtonian telescope a plane mirror or total reflecting prism is so adjusted at the focal plane of the big concave mirror as to throw the light into the eye-piece placed at the side of the telescope tube. The observer stands on a platform at that level and views the image.

THE CASSEGRAIN TELESCOPE.

In the Cassegrain type, which is the more usual method of using a telescope, a *convex* mirror is placed at about the position of the focal plane and *reflects the light back thru a small hole in the center of the big mirror* and into the eye-piece. Such a combination greatly increases the equivalent focal length of the telescope.

The eye-piece is really a high-power compound microscope *and any magnification that there may be is done with the eye-piece.* The purpose of the large reflecting mirror is to gather light and to increase the number of rays brought upon the retina. Since the area of the big 100-inch mirror is 250,000 times that of the pupil of the eye, it is theoretically able to make a star appear 250,000 times brighter than when seen with the unaided eye! Practically, however, there is some light lost in reflection. But only the planets and their satellites is it able to magnify. So distant are the fixt stars that even the nearest are entirely beyond the magnifying power of our largest telescopes.

The 100-inch reflector may be used either

(*Continued on page* 948)

SKINDERVIKEN TRANSMITTER BUTTON

Most Sensitive Microphone For $1.00

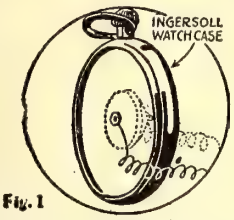


Fig. 1



Fig. 2

THE SKINDERVIKEN TRANSMITTER BUTTON presents the latest advance in microphones and marks a revolution in transmitter construction. It works on an entirely new principle, takes up practically no room, and marks the end of all telephone transmitter troubles.

The **SKINDERVIKEN TRANSMITTER BUTTON** can be placed in any position and it will talk loudly and distinctly and is at the same time extraordinarily sensitive. It was primarily designed to replace the old damaged or burnt out transmitter. Simply unscrew and remove the telephone transmitter front, disconnect the two inside wires, unscrew and remove the bridge and the old electrode. There remains only the diafram. These wires are then connected with the Skinderviken button, the latter screwed to the diafram, and after screwing the old transmitter housing together again, the telephone is ready for work.

ELECTRICAL EXPERIMENTER readers will be particularly interested in all the different experiments that can be performed with the Skinderviken Button. Fig. 1 shows the Skinderviken button attached to the back of an Ingersoll watch case. When speaking towards the inside of the case, it will be found that the voice is reproduced clearly and loudly. Fig. 2 shows another interesting stunt. By attaching the button to a tin diafram about the size of half a dollar, and by holding the diafram at the side of the throat, as shown, speech can be transmitted with surprising clarity. Fig. 3 illustrates the same arrangement placed on the chest as shown. In this position the transmitter will talk clearly and loudly. Fig. 4 shows how to transmit phonograph music at a distance merely by drilling a small hole in the phonograph arm and attaching the Skinderviken button; a very favorite experiment with all experimenters.

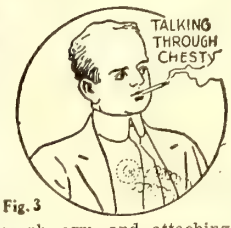


Fig. 3



Fig. 4



Actual Size

Fig. 5 shows an interesting stunt, whereby a hole is drilled in the side of a thin glass water-tumbler; the sides of the glass thus acting as a diafram, the voice is clearly transmitted. Fig. 6 shows a simple match box Detectophone. The Skinderviken button is concealed inside of the box, only the small brass nut showing on the outside. This can be camouflaged as well.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

We have the utmost faith in this transmitter button. We guarantee satisfactory service or we will refund the purchase price. Boys—Young and old send in a dollar bill RIGHT NOW! You can't lose. If you're not satisfied, you receive your dollar back. Isn't that fair?

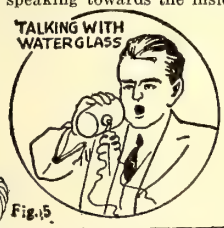


Fig. 5

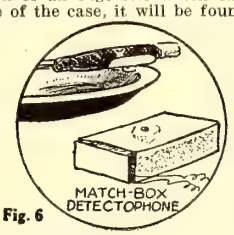


Fig. 6

JOHNSON SMITH & CO., Dept. E-12, 3224 N. Halsted St., Chicago

Johnson Smith & Co.,
Dept. E-12, 3224 N. Halsted Street, Chicago

Gentlemen:—Please ship at once to address below.....Skinderviken Transmitter Buttons for which I enclose $.....

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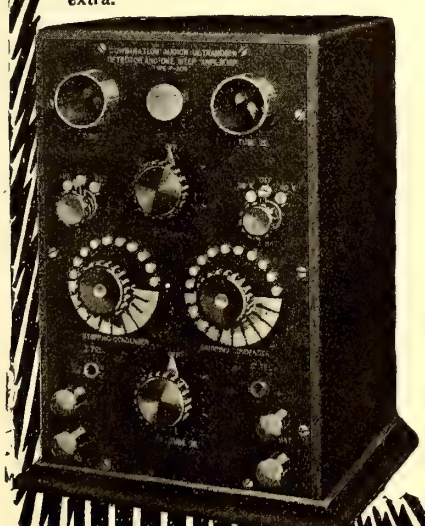
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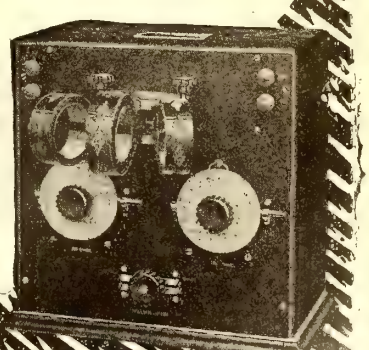
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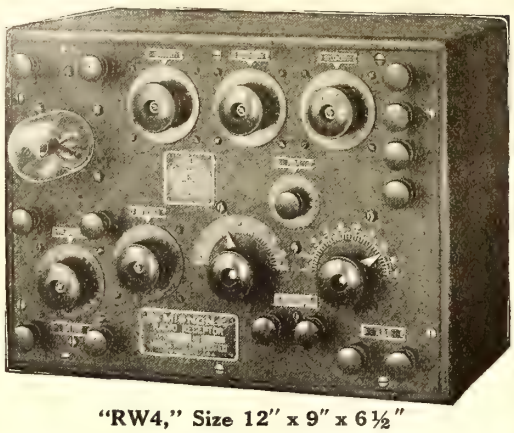
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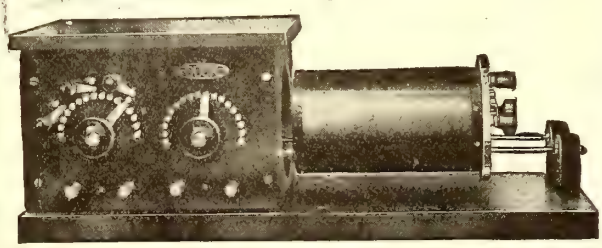
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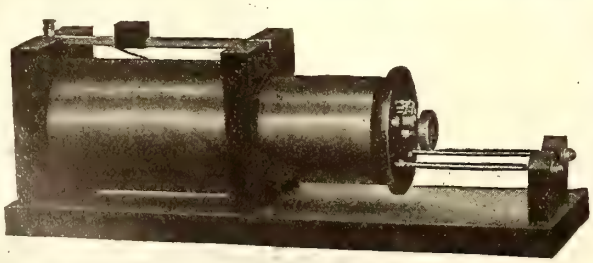
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The Mt. Wilson 100-inch Reflecting Telescope

(*Continued from page* 946)

as a Newtonian or Cassegrain telescope, but it is in the latter form that it will be most frequently employed. As already stated two convex mirrors have been ground for use in this combination. For putting these mirrors into position a special crane is provided.

The actual mounting of the telescope on its axes follows the English type and is somewhat unusual in this country. In any telescope there are two axes—the polar axis and the declination axis. By rotating the telescope on these two axes it may be turned to any point of the heavens. The polar axis, as shown in the figure, consists of a heavy rectangular yoke parallel to the earth's axis and supported by two pedestals, the north one bearing 40 tons and the south one 60 tons. At the top of these pedestals are the cylindrical tanks and the mercury system of flotation. Mounted on trunions inside this yoke is the telescope tube. The trunions constitute the declination axis and this is at right angles to the polar axis. By rotating the telescope tube about these two axes any heavenly body desired may be brought into view. When this has been done, the large toothed-wheel at the lower end of the polar axis is thrown into gear with the driving mechanism of the clock and the object may be kept constantly in the field as long as the observer cares to look. Stars of course rise and set, just as the sun does, and since the clock turns on the polar axis of the telescope at the same rate that the earth rotates, this must just compensate for the apparent motion of the star. The dome is also made to rotate at the same speed. The observing floor, too, may be raised and lowered to any level with the changing position of the telescope.

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HARVARD DISCOVERS NEW STAR

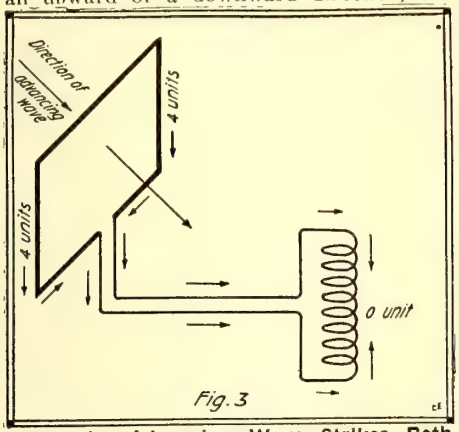
Another star has been discovered by the Harvard College Observatory. It was announced on January 8th that Miss Joanna C. S. Mackie of the observatory staff, in the course of her examination of photographs of the milky way taken recently at Cambridge, had detected the new comet. Its position is Right Ascension 18 hours 49 minutes 30 seconds, declination plus 29 degrees 6.3 minutes (1900).

The Radio Compass

By PIERRE H. BOUCHERON

(*Continued from page* 907)

(or magnetic field) the wave will strike both sides of the loop at the same time and an equal amount of energy will be induced in both sides of the loop circuit, either in an upward or a downward direction, de-



When the Advancing Wave Strikes Both Sides of the Loop Antenna Simultaneously, the Resultant Current in the Receiving Set Is Zero. This Is the Action Employed in Practise.

pending upon which side of the sine wave first strikes the loop windings. Since the currents induced in both sides of the loop are of equal field strength, they will meet and neutralize when the circuit is completed in the receiver, with the result that the detecting apparatus will not respond. Fig. 3 illustrates this action, where the flat front of the advancing wave, having reached the loop and induced currents on each side having an arbitrary current strength of, let us say 4 units, travel to the receiver, reach there simultaneously and neutralize; thereby reducing the current intensity to 0. However, if the loop is swung 90 degrees so that its plane points in the direction of the transmitter, it is evident that the advancing wave, which as explained before is either rising or falling, will strike the front side of the loop either at a higher or at a lower point than the other side, so that the amount of current induced in one side of the loop will be *either greater or smaller* than the current induced in the opposite side.

The result of all this is that when the two currents meet in the receiver, the stronger will overcome the weaker and the *resultant current* will actuate the receiver. Fig. 4 illustrates this condition where the advancing wave has induced an arbitrary current intensity of 8 units in the front side of the loop and 6 units in the other side, the resultant being 2 units, which latter is used to actuate the receiver. Of course, in actual practise the difference between the two currents is not very great for the comparatively small loop presents a very small surface to the advancing wave of 600 meters. It will therefore, readily been seen that the farther apart the two sides of the loop are spaced, the greater will be the difference of potential between the two currents, and this difference must be of sufficient intensity to properly respond in the receiver, for that is the one made use of in reading the bearings.

The reason that the *minimum* current is the one used to read bearings is because there is too broad a variation of the current intensity at the point of maximum, which fact makes it difficult to secure the ideal intensity. On the other hand the current strength variations are very sharply defined at the point of minimum and therefore, a selective reading is more readily obtained. This condition can be better understood by referring to Fig. 5, which is known as the "bilateral" characteristic curve of the loop. The heavy line in the

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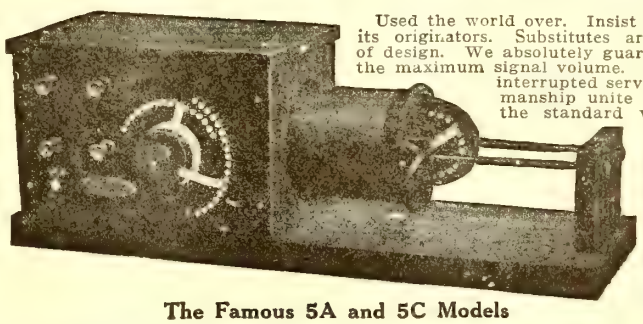
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center of the two circles represents the loop, which, while at that angle, is receiving the advancing wave at maximum strength where the undesirable broad intensity lies. As the loop is gradually swung, however, from 300 degrees to 270, the wave strength gradually decreases to a sharper degree, until when the loop has reached 180 degrees, the current is practically zero. The reading is therefore secured just before reaching zero intensity and at a point where it is very sharply defined; *i. e.,* at the minimum current strength. This minimum reading, of course, is taken into account on the compass dial and the compass pointer is set accordingly.

The Radio Compass as explained thus far is known as bi-directional; that is, it gives general east-and-west, or north-and-south direction and therefore is subject to an error of 180 degrees. This error is not serious in land radio compass stations as the geographical position of the station always enables the operator to determine the proper direction in respect to sea and land. For instance, if the *Montauk* station gave a bearing of 330 degrees, which points directly inland, the operator would know quite well that the ship's position would be directly opposite, in other words at 150 degrees, as will be evident by studying the scale of the *Montauk* station in Fig. 1. On board ship, however, it is quite another matter and to be effective a radio compass must be *uni-directional.*

HOW BEARINGS ARE OBTAINED.

Radio compass stations as controlled by the U. S. Navy usually operate in units of three, and sometimes four and five, as in the case of the New York harbor approaches and are operated by remote control; that is, all compasses are connected by *telegraph wires* to a *control center,* which supervises the activities of all outlying stations. In the case of New York, this central point is situated in an office

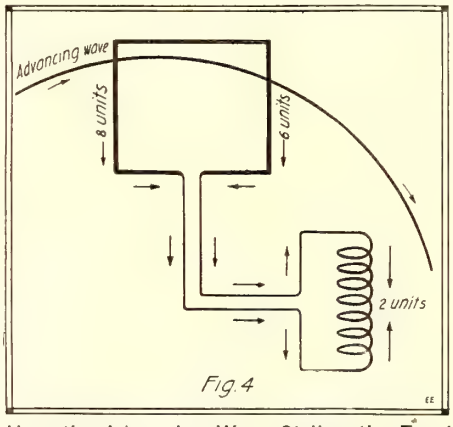


Fig. 4

Here the Advancing Wave Strikes the Front and Rear of the Loop at Diffierent Levels and Induces Currents of Different Strengths. Hence the Resultant Current Will Have a Measurable Difference of Potential.

building near the Battery, where not only radio compass operation is supervised but all radio traffic as well. The procedure for furnishing or obtaining bearings to or from incoming or outgoing vessels is as follows:

The ship calls "NAH" (call letters of N. Y. Radio) in the regular commercial manner and transmits the special radio compass signal "QTE?" (meaning "what is my true bearing?"). The radio compass supervisor at the control station, by making use of one of the local transmitters, then instructs the ship to "send MO for two minutes"; the signal "MO" being a special one recognized by radio compass stations. After this the supervisor simultaneously informs all outlying compass operators by means of direct telegraph wires controlled by a master key, to secure bearings or directions from which the ship is sending "MO" signals, usually on a wave length of either 600 or 800 meters—800 meters to be used exclusively after April 1, 1920.

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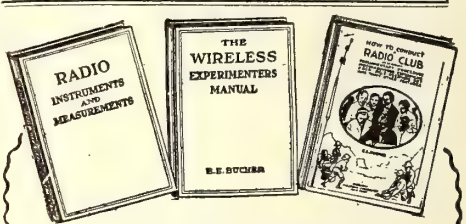
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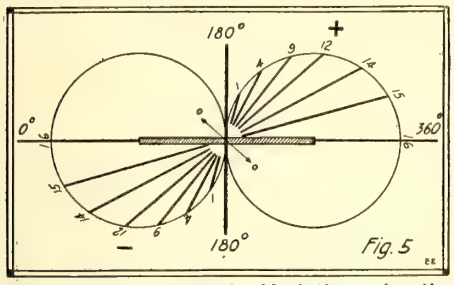
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When the ship has concluded transmission of the "MO" signal it is then instructed to "QRX" (stand by), after which the supervisor obtains the respective bearings secured by the compass operators; *i. e.*, Mantoloking, N. J., Sandy Hook, N. J., Fire Island, L. I., and Montauk, L. I. All individual bearings are then plotted on a specially prepared chart similar to Fig. 1,



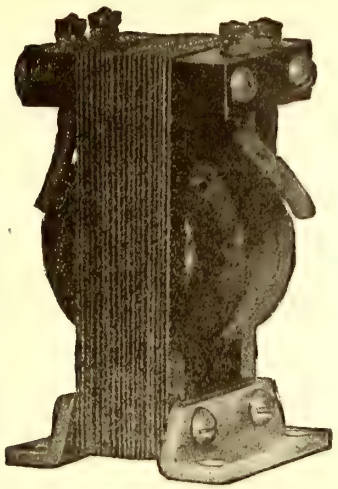
The Current Strength Variations in the Radio Compass are More Sharply Defined at the Point of Minimum and Therefore a More Selective Reading is Obtainable Than if the Maximum Strength of Signal Were Used.

and the resultant position will be the point of intersection of all combined bearings. An example of this is shown in Fig. 1. The bearings are then transmitted to the vessel in the following form: "QTE (your true bearing is) at ———— (whatever time the observation is made) 186 degrees from Montauk; 132 degrees from Fire Island; 112 degrees from Sandy Hook; 96 degrees from Mantoloking (signed) NAH". *It is then an easy matter for the navigator of the vessel to plot the bearings on his own chart and thus secure his exact position!*

The complete operation from the time of call to the transmission of result is usually accomplisht *within five minutes.* Not only is this information valuable to the navigator but is also made use of extensively by various agencies on land concerned with the movements of naval vessels, transports, revenue cutters, cargo vessels, etc. In the case of incoming passenger vessels, their positions are telephoned to Customs, Post Office, Immigration and Ship News officials in order that steps be taken to meet these vessels at the proper time and make other necessary preparations.

FUTURE OF THE RADIO COMPASS.

The radio compass has come to stay. Every day news comes that one or more stations have been erected at various points of American and foreign coasts. Canadian, French, English and Italian governments have erected radio compasses at important shipping sections and are co-operating with the United States in order to make the service uniform and popular with skippers of merchantmen. In fact, an international radio compass conference will probably be held very shortly where standard wave lengths, methods of furnishing and securing bearings, special abbreviations and other details of procedure will be adopted for international marine use. Masters of vessels are gradually learning of the safety and advantage gained by the use of the radio compass during bad weather or fog, when other means of ascertaining positions are unavailable, and judging from past performances, it is estimated that fully 50,000 requests for assistance will be made by vessels during the coming year. This service is open gratis to any vessel equipt with radio apparatus, no matter of what nationality or tonnage. Modern nautical schools have included the radio compass as part of their curriculum for navigators. Great sums of money are being expended yearly by various governments to develop this new art and make it 100 per cent efficient, and there is no doubt that in a very short time it will be as indispensable a part of the world's merchant marine, as the lighthouse service has been for centuries past.



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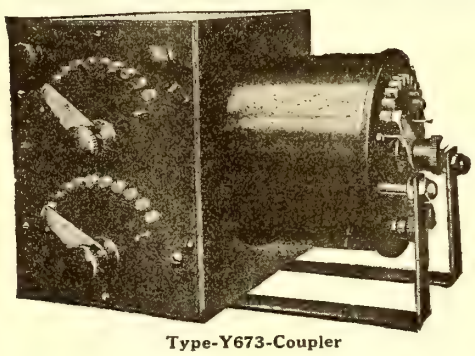
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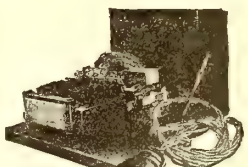
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The Electrical Machinist

By H.WINFIELD SECOR

(*Continued from page* 903)

ture core are good and tight on the shaft, so that some of them will not move when being turned or filed and thus cut into the winding and short-circuit it, "the operation is usually successful," as the doctor would say.

REBABBITTING OF WORN BEARINGS.

The usual practise in repair shop work and also in the manufacture of some motors and dynamos is to babbitt the bearings. Babbitt metal is a mixture of several metals in the following proportions:—Tin—50 parts; copper—1 part; antimony—5 parts. Phosphor bronze contains:—Copper—79.17; tin—10.22; lead—9.61, and phosphorus—.94. A mixture for an antifriction metal is:—Lead—88.32; antimony—11.93.

The pouring temperature of the molten babbitt metal should not be allowed to exceed 470° Centigrade. The simplest shop test to determine when the babbitt metal is hot enough for pouring, is to stick a piece of paper or a splint of wood into the babbitt metal for a second, and if it bursts into flame, the metal is at the correct temperature for pouring. For first class work of course, some form of electrical or other regulator is necessary to keep the temperature of the molten babbitt metal at an even degree or between the limits of 460 to 470° Centigrade. The metal should be stirred thoroly by means of a ladle at frequent intervals, or otherwise the heavy metals will settle at the bottom of the pot, also the skum which gathers at the top of the molten metal should be removed from time to time and to prevent oxidation the molten metal should be kept covered with a light layer of charcoal or grafite.

One of the accompanying illustrations shows a clever self-skimming ladle which is provided with inside bridges which predetermine the size of the metal stream in pouring, and for preventing skum from the top of the ladle getting into the bearing. Leather holders to protect the hands in holding the ladle are shown at the right of the figure. In pouring babbitt metal into the bearing, the bearing being invariably stood upright for the purpose, as shown in Fig. 3, you should pour from the ladle in a steady stream, directly down along the mandrel or shaft, to avoid splashing or pocketing of air. The lip of the ladle should be kept free from burrs or other surface irregularities in order to pour a smooth, round stream. If the hot metal is splashed against the shaft, it will cause blow-holes and give a "mushy" bearing.

Referring to Fig. 3-A, this shows a common type of bearing in which the inner lining is formed solely of babbitt metal. If such a bearing has to be relined with this metal, it is placed in a gas stove flame or that from a gas blowpipe, until all the old babbitt metal is melted out. It should be thoroly cleaned and scraped inside and several small holes are drilled thru the brass shell, as at C, into which some of the molten metal will run and help to lock the new babbitt lining into place. Over these openings a piece of asbestos can be tied tightly and into the set screw and oil holes at the top and bottom a piece of wood can be tightly threaded. The bearing is then usually set upright on a piece of asbestos and packed around with wet fire clay or putty, as shown at Fig. 3-A. For small bearings that is all that's necessary, and no shaft or mandrel is placed in the center; when the newly poured bearing is cooled, it is then "chucked" in the lathe and bored

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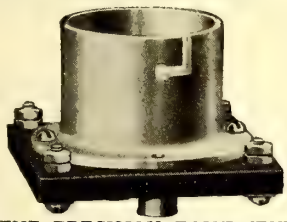
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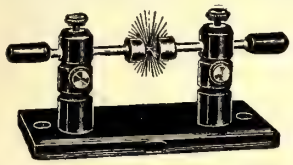


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and reamed out to fit the shaft. When a bearing is of good size, however, two methods of procedure are followed:

In an emergency, as for instance where the bearing is sometimes to be rebabbitted right on the machine, without removing the shaft or housing, the molten babbitt metal is poured into the properly prepared bearing housing and allowed to cool against the shaft, which is to turn in it, without giving excessive play when it is cooled. Where a first class bearing is desired, with regard to a close fit, so that the shaft just turns freely in it when it is finished, the procedure is then to use a mandrel slightly smaller than the shaft, and this is accurately placed in the center of the bearing. When the molten babbitt metal is poured in there will be a hole thus left in the center of the bearing, somewhat smaller than the proper size to fit the journal which is to run in it. The bearing is then placed in the lathe, carefully centered as regards the *outside supporting surface of the bearing,* drilled or bored out with a boring tool to nearly the required diameter, and then if a first class finish is desired, *reamed out with the proper size reamer.*

Fig. 3-B shows a bearing set up ready for pouring, and in which there has to be secured by the babbitt metal filling, a *bearing sleeve* which is often of phosphor bronze, brass, steel, or even iron pipe. This sleeve is held accurately in place by means of a shaft or mandrel carefully centered and held by jigs or clamps, together with the bearing, onto the base plate of asbestos or else a metal plate on which rests a piece of asbestos. In this case the sleeve should have its outer surface, which is to be in contact with the babbitt metal, thoroly tinned, and it should also be heated before being placed into the bearing ready for pouring. One clever make of electric motor utilizes a cast iron sleeve for a bearing, which the manufacturers claim they have found very satisfactory for cool running and even wear.

The Westinghouse concern recommends the following procedure for bronze, pipe, or steel shells (tinned):—"Remove the old lining by heating, preferably in a pot of scrap babbitt, and be sure not to heat above 375° Centigrade. Just as soon as the old lining is melted out, swab the tinned surface with zinc chlorid (a saturated solution of zinc in hydrochloric acid), then dip into a pot of "half and half" solder, which should be kept at a temperature not less than 340° C. and not more than 375° C. If shells are to be babbitted immediately, do not touch tinned surface after removing from the solder pot. If the shells are to be allowed to cool, brush off the tinned surfaces with a piece of clean waste."

GROOVING REBABBITTED BEARINGS.

Fig. 4 shows how oil glands or grooves are tooled in babbitt lined bearings and also one form of hand grooving tool. The grooving tool is made of tool steel forged out to the shape shown, either from square, round or hexagon stock, and it is usually curved slightly upward along the length of the tool. For small bearings the tool is about five inches long, while for large bearings the tool is sometimes provided with or else forged onto a long, low grade piece of steel one foot or more in length. The bottom edge of the tool is rounded to a semi-circle and the sides taper towards the top so as to give the appearance as shown in tool drawing at Fig. 4. The grooves in small bearings are cut to semi-circular shape from the *oil ring slots,* so that the oil as it falls on the shaft from the revolving oil rings or oil chains, will be spread

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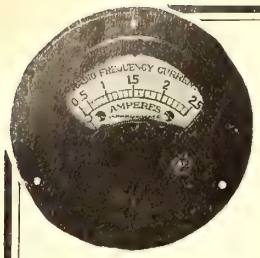
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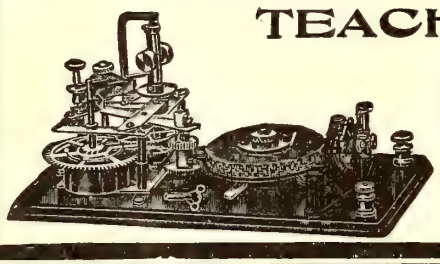
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along the shaft by means of these grooves or glands. The position of the oil rings or chains are shown at Fig. 4, and when the shaft is placed in the bearing and slowly turned, the rings should rest on it and be revolved by it. They dip into the oil in the lower part of the bearing housing in the manner shown, and keep a continuous supply of oil on the shaft. Any superfluous oil runs out of the ends of the bearings and drops back into the oil well below.

At the right of Fig. 4 is shown a more elaborate *tree design* of grooving in a babbitt bearing from a single oil ring slot. These slots are usually cut in the top of the bearing, as becomes evident. These grooves are cut in babbitt metal bearings and sometimes in bronze or other bearings by means of a tool of the shape shown and described, hitting the tool lightly with a hammer and taking pains to keep the groove of approximately even depth. It takes quite a little practise to make a good job of the grooving but the experience, once gained, is always valuable.

(*To be continued*)

An Oscillion Radio TELEPHONE AND TELEGRAPH

(*Continued from page* 908)

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By H. Winfield Secor

(*Continued from page* 881)

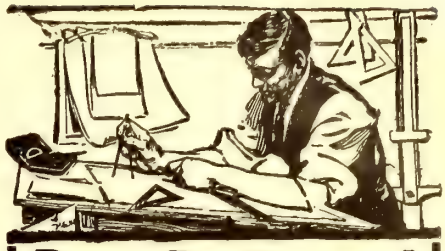
who is invariably a real dyed-in-the-wool engineer-draftsman, has to contend with. The writer has been thru just such work as he now speaks of, and can thus give a clear idea of how this work runs under general conditions. Of course, it all depends on the personnel naturally, and every person works in a slightly different way. For instance, one engineer's sketches from which you may have to work and prepare your initial drawing and layout with the full details on them which you have gleaned during several hours study of a dozen catalogs or so and your ever-ready slide-rule and pocket text-book, may be a very complete and respectable diagram made out on cross-section paper with at least legible figures and letters on them. On the other hand, possibly due to the personal traits of the expert who made these sketches, or perhaps due to his being under great pressure of work, the engineer-draftsman may have to work from sketches which are more or less difficult to understand.

Drafting students, and also engineering students, but particularly the former, should therefore study the fundamentals of engineering calculations and design very thoroly, for they will find that unless they intend to remain as draftsmen, they will have to educate themselves so as to be able to grasp the lower rungs of the engineering ladder, so to speak. As an example, the engineer-draftsman may be called upon to make an initial or preliminary drawing or layout of a new piece of engineering work or apparatus in which he would have to do considerable calculating in order to properly proportionate the various parts. He should be thoroly schooled of course in arithmetic, plane and solid geometry and trigonometry, and he will find it valuable indeed to know something of algebra thru to quadratics. In the designing of dynamos and motors, electromagnets and solenoids, rheostats and various other electrical machinery involving coils or windings, which have to be very carefully designed so as not to heat up unduly, besides many other considerations, the Consulting Engineer or the Chief Engineer will invariably specify the data for all such windings, for it is of course, unreasonable to expect a draftsman, especially a beginner, to know anything about [illegible] details of electro-physics. [illegible] draftsman progresses in his [illegible]ion, and after a period of several [illegible] will in most cases master a sufficient amount of engineering technique and mathematics to come under the general class of engineer-draftsmen, and depending upon how valuable he has made himself in his progression up the ladder, just so much more responsibility and also the greater the remuneration will be accorded him.

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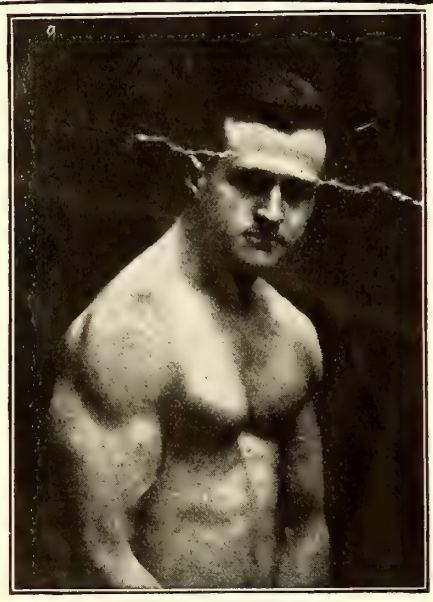
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is a specially prepared oiled linen, and from which blue prints are later made by passing sunlight, or light from an electric arc thru them. The tracing is made with regular black drawing ink with the usual drafting pens and instruments, the tracer simply having to follow the lines on the original drawing as laid out by the engineer-draftsman, whose drawings are usually made on some strong quality drawing paper. Tracings are often made of drawings in books or catalogs, photographs, maps and innumerable other illustrations and drawings met with in the thousand and one details of engineering work.

The young men of today are of course interested in all these things, for in this great field of engineering, which is ever expanding and growing at tremendous strides, the students today will become the draftsmen and engineers of tomorrow. Generally speaking, a tracer, presuming he is a young man of possibly sixteen to twenty years of age, will not remain as a tracer very long. Possibly in six months to a year, he may be given a position as junior draftsman, and in another year or so he may, if he is a conscientious student and a careful draftsman, be advanced to the position of a full-fledged draftsman or engineer-draftsman. In this connection it may be said that many young college men, graduates of the various engineering courses, first make their acquaintance with the commercial world via the drafting room. It is a very good way in which to learn the rudiments of their profession in a first-hand way, so that they are familiar with all details and work to be done by each department of a modern engineering organization.

BLUE PRINTING

Blue prints are not total strangers to any one today as everyone has seen blue prints at some time or other, even if they were nothing else than those of their own homes. There are vartous kinds of prints now in use, such as black prints and brown prints, but the time-honored blue print still holds its own to a very large extent, and millions of them are turned out every day, carrying with them masses of detail and calculations which serve as the connecting link between the engineering staff and the producing or manufacturing staff. The engineer talks with his drawings and the production expert and machinist interpret these drawings and construct the machine from them. Good drawings are not only necessary, but are demanded in the best engineering circles everywhere, and it has been said, and rightly so, that a good drawing or blue print should contain all the necessary views of the machine, and each part thereof as well as all necessary dimensions, such that this blue print can be given to a model maker or machinist, and the complete machine constructed accurately, without one word of explanation from the designer.

The old solar printing frame, which is pushed out an upper window on rails, with its glass face turned toward the sun, is still in use in many small drafting departments all over the world. There has been a new era in blue printing—thanks to the powerful electric arc light, and blue prints are made today a hundred times faster than they ever were before. One of these machines has a vertical glass cylinder while another type shown in one of the accompanying illustrations, has a horizontal glass cylinder,—the arc is turned on and the paper exposed. The light passes readily thru the uninked portions of the tracing cloth, but does not pass thru the inked lines and sections.

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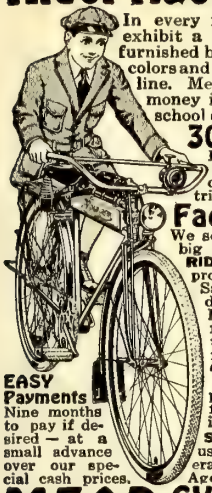
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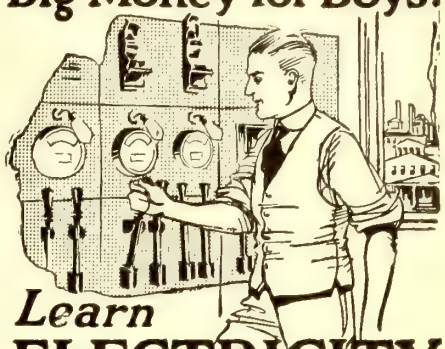
The blue print paper is then removed from the machine. In the earliest model of the electric blue printer, the paper had to be removed from the machine and past thru a developing and fixing bath, and then washed. In the later model of the horizontal drum type, the developing is done right in the machine itself, and the finished blue prints are reeled out in a continuous roll at the other side of the machine, in a very short space of time.

THE TRIUMPH OF THE ENGINEER—THE FINISHED MACHINE

The happiest day of an engineer's life occurs when his first machine or device has been finished and proven successful under test. When the machine, installation or device is finally finished by the workman then the engineer, and frequently the consulting engineer, if there is one on the staff, is invited to witness the test of the apparatus. These tests are of the utmost importance, and in all well-regulated engineering establishments having an engineering department, it is seen to that both the eventual customer for the machine, who is to use the device, as well as the designer, are satisfied that everything is right and as it should be. Electrical machinery is tested by voltmeters, ammeters, watt-meters, and in the case of motors and dynamos, the speed is carefully checked. Frequently, during the test by speed indicators or tachometers, many other electrical and mechanical qualities are carefully measured under the direction of the designer. Several of the large electrical manufacturing companies in America, including the General Electric and the Westinghouse Electric and Manufacturing Companies, operate very elaborate testing laboratories, for their electrical, steam and other machinery, and here it is that many of our engineers just out of college gain their first practical experience in the commercial application of their studies. The work is intensely interesting, and if the student takes up this work, or enters one of the testing engineering courses, conducted by these large electrical companies, and if he has the real making of an engineer in him, then he will never regret his experience in this work. From this experience as a basis, the conscientious engineering aspirant will build his future career, and we know of no better foundation to start from.

In closing, it should be mentioned that naturally every machine design does not fulfill its performance, as was theoretically intended and, of course, there are a myriad of reasons why it may not do so. Perhaps the iron, for instance, used in constructing the core of a magnet, dynamo or motor, is not of the quality which the engineer who designed it originally conceived it to be, and therefore his calculations are upset in spite of himself, no matter how elaborate they may have been. Here an interesting example of electrical engineering is brought to light. The layman might reasonably ask at this juncture, how could the electrical engineer know how many lines of magnetic force per square inch of cross-sectional area that the iron in his finished dynamo or magnet is going to carry and what magnetizing force in ampere-turns will be required to produce this magnetic strength of field in the grade of iron specified to be used. As a matter of fact, every grade of iron varies in its magnetic qualities, and the only sure way to ascertain before designing the machine, just what performance one may expect of it, is to procure samples of the actual iron, or "run of iron," and have a permeability test made in the electrical testing laboratory. From these tests he will then know the magnetizing force required to produce the desired magnetic flux in lines per square inch of cross-section in the iron or steel.

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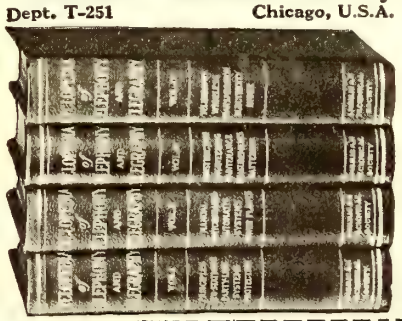
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Calibrating Electrical Measuring Instruments

By THOMAS W. BENSON

(*Continued from page* 900)

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For convenience the temperature of the gas and weight of the solution in the burette have been disregarded, these factors nearly balancing out at ordinary temperatures in this type of instrument.

Having an accurate ammeter, it becomes an easy matter to check a voltameter. Knowing the relation between the voltage, amperage and resistance, as stated in Ohm's law, we can arrange the apparatus as shown in Fig. 4. A known resistance is put in the circuit at R; by passing currents of different strengths we can check the voltameter with the formula:

$$I = \frac{E}{R}$$

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A correction chart can also be made for the voltameter if necessary in the same manner as shown for the ammeter, plotting actual voltage against the meter readings.

A Small Rectifier for Charging Storage Batteries

By Elliott A. White

(*Continued from page* 899)

they are likely to slip past each other and thus overlap. The joints in each layer are covered up by the next layer above, the L-shaped pieces being put alternately on opposite sides. This makes a solid mass of iron in even layers. In Fig. 1 the solid lines across the face of the core indicate the joints in the top layer, the dotted lines the joints in the layer underneath; the joints in the third layer will again be in the position shown by the solid lines, and so on down thru the core. It will be noted that the L pieces are not symmetrical, one side being longer than the other. The purpose of this is to bring the joints out to the ends and away from the ends of the coils, where the core is likely to build up ragged. Of course symmetrical stampings may be used instead, in which case the joints will come at the ends of the window.

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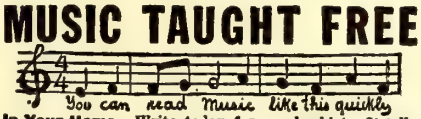
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thru. As many pieces as possible should be forced in. The core should then be squeezed together in a large vise, after which it will be found that still more can be forced thru. When no more pieces will go in, the transformer is stood up on end on a flat surface and the core knocked into even shape by pounding it sharply but carefully with a hammer on all edges and on the bevelled corners. This will close all the open joints. To keep the core from humming under load, thin wedges of hard wood 1⅛" wide by 2¼" long may be driven into the coils on top of the iron on both top and bottom sides of the transformer (4 pieces required). The ends may also be wound tightly with friction tape.

As the outside dimensions of the completed transformer are about 5" by 5⅛" by 2¾", it can be enclosed in a box of these inside dimensions. The transformer shown in the photograph is contained in a cigar box with outside measurements of 5½" by 6½" by 5", but would go into one still smaller, as there is considerable spare room, especially as to depth. In placing it in the box, the ends of the core should rest on blocks of wood about ⅝" thick and long enough to fit tightly against the sides of the box, so that the surfaces of the coils just touch the bottom. Other similar blocks should be placed on top of the ends of the core, and the core clamped tightly between the two sets of blocks by means of bolts or screws. Screws or nails may then be put from the outside into the ends of the blocks to secure the transformer in place. It should then be wholly silent. The five leads are soldered to binding posts on the top of the box; or the two for the filament, kept as short as possible, are run thru holes drilled in the top and then to the terminal screws of the tube socket which is screwed to the top also, the other three leads being connected to binding posts as shown in the wiring diagram, Fig. 3.

The leads from the 110-volt winding go to two binding posts (1 and 2, Fig. 3) and thence to a cord and plug, or thru a fused switch, to a lamp socket or feed wires. One end of the 15-volt winding goes to a binding post (3) marked "positive", to which the *positive* side of the storage battery is connected for charging. The other end of the 15-volt winding and both ends of the 2-volt winding go to the socket and filament (an ordinary porcelain receptacle is used, as the Tungar tube has a standard Edison base). The negative side of the storage battery goes to a binding post (4) marked "negative", and thence to the anode of the tube, to which it is fastened by means of a Fahnestock or Eureka spring clip on the single wire projecting from the top of the tube. Care should be taken not to handle this wire roughly, as the seal is easily broken where the wire comes thru the glass, in which case the tube becomes useless.

In operation the current from the 2-volt winding of the transformer keeps the filament incandescent. Current from the 15-volt winding passes thru the battery and then thru the tube, from the anode back to the filament, thru the ionized gas. The Tungar tube is a rectifier or check-valve which allows current to pass in only the one direction. The alternating current is thus rectified into pulsating direct current for charging the battery, as only one-half of each wave is allowed to pass. This single tube outfit is known as a "half-wave" rectifier. Figure 4 shows how a "full wave" rectifier may be made with two tubes, furnishing 4 amperes of charging current. This rectifies both halves of the wave, but requires two 2-volt and two 15-volt windings instead of one of each, tho with no appreciable increase in the size of the transformer coils, and the same dimensions can be used. In this case the rectifier

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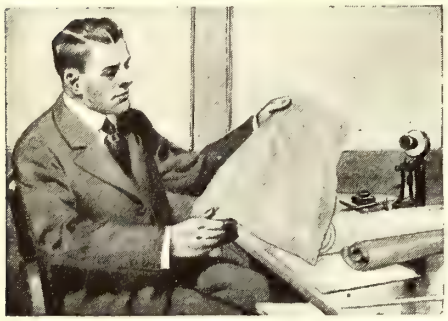
terminals are connected to two binding posts, to which the battery is also connected with the polarity indicated by the signs as shown in the figure.

When the tube is operating a blue glow will be seen in the space between the anode cone and the filament and also between the filament supporting wires inside the tube. Under normal operating conditions this glow soon spreads and fills the bulb with a pink glow, particularly in the space above the anode. Considerable heat is developed, and for this reason the tube should *not* be mounted inside the box. The tube will not safely carry more than 2 amperes. This may be determined with a direct current ammeter in the battery leads, or, after some experience, can be judged with fair accuracy by the behavior of the tube itself. Since the life of the Tungar rectifier depends on the brightness of the filament, the latter should not receive more than the voltage specified. Too low a filament current will prevent rectification. Rectification will also be absent with too low a charging voltage. If the blue glow fails to appear or is too faint, or the charging current is less than 2 amperes, the inner end of the 15-volt winding should be tried on the other terminal of the filament, that is, connected to the other terminal screw of the socket. Failure of rectification will then mean increasing the number of turns on the charging winding, or on the filament winding, if one of these is at fault, or on the power winding if the voltage of both the others is too low.

Again, in case the current in the tube is excessive, a resistance may be inserted between binding post 4 and the anode—either an adjustable battery rheostat with a carrying capacity of 2 amperes, or a fixt resistance of nickel silver or alloy resistance wire wound in notches around a small fiber or Bakelite card (see photograph). Usually an ohm is enough to cut the current down to a proper value. Or a few turns may be removed from one or more of the windings, from the charging, power, or filament windings, in the order given. However, if the transformer is constructed as here described, and the supply voltage is 110, no resistance (and consequent waste of energy in heat) is required. The resistance card shown in the photograph is not used. The extra binding posts which appear in the photograph are the terminals of extra windings added during construction so that other tubes might be added to give full wave rectification with greater current carrying capacity, and also to furnish various voltages for other purposes, such as the operation of vacuum tubes for radio, as described by the author in the July, 1919, issue of this magazine.

The rectifier, if built as directed, consumes about the same power as an ordinary lamp, 50 watts—losses 20, filament 20, charging 10 or more. Altho the efficiency is therefore not very high—about 20%—at the same time the convenience of charging a battery where it stands by merely plugging into the commercial power circuit, more than makes up for its lack of efficiency. After charging it is sufficient to disconnect both sides of the power winding from the 110-volt supply, for except when the filament is lighted the Tungar tube forms an open circuit and the rectifier may be left permanently connected to the storage battery. To start charging, connect the 110-volt side of the transformer to the supply circuit. At ordinary rates for power, a 6-volt 40-ampere-hour battery may be fully charged for about 10c for current, a 60-hour for about 13c. To this should be added depreciation of the tube, which may be given roughly as 5c per charge, up, depending on filament temperature and rectified current. The total cost of operation is therefore approximately 15c and 20c per charge.

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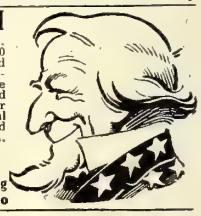
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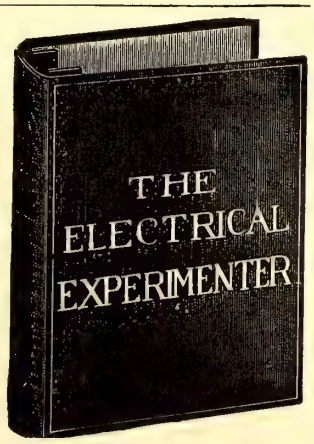
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Is There a Sub-Electron?

By Rogers D. Rusk, M.A.

(*Continued from page 894*)

TABLE I

Early values of charge of electron.

Thomson	$e=6.5$	$\times 10^{-10}$
Wilson	$e=3.1$	$\times 10^{-10}$
Townsend	$e=2.4$	$\times 10^{-10}$

Later values.

Regener	$e=4.79$	$\times 10^{-10}$
Rutherford and Geiger	$e=4.65$	$\times 10^{-10}$
Millikan	$e=4.744$	$\times 10^{-10}$

TABLE II

Prof. Millikan's

Remarkable Agreement of Multiple Charges.

No.	Calculated	Observed
4x4.917	19.66	19.66
5x —	24.59	24.60
6x —	29.50	29.62
7x —	34.42	34.47
8x —	39.34	39.38

Science in Latest Movies

(*Continued from page 884*)

of course, foreign Secret Service agents try to battle with the wits and brawn of the American Secret Service agents and the heirs to the property. The scene at the left shows episode 4 of this mystery. Its story consists of the battle of wits, muscles and mechanisms. The "still," here reproduced shows the hero of this photoplay in a torture machine in which he is being slowly punctured by the iron spikes, which are gradually being closed upon him. Electric lights indicate the amount of pressure being applied which is readily regulated by a push button

In the lower left picture is depicted a foreign agent in the act of demonstrating a machine which will destroy by its terrific discharge the American agent. An immense Oudin transformer is used, excited by a large transformer having a rotary gap of ponderous proportions connected to it.

The Structur of Electricity

By Dr. Alfred Gradenwinotz

(*Continued from page 892*)

can be derived from the color of the light given out by each individual particle: Gold particles about 8.5 millionth parts of a centimeter in radius thus will give out an orange light; gold particles 4/5 millionth parts of a centimeter in radius green, and mercury particles 3/4 millionth of a centimeter in radius, blue light. The figures found by these two methods respectively show a surprising agreement. There is, however, a third method by means of the Brownian movements just referred to.

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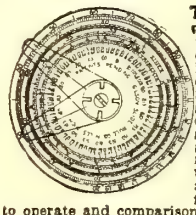
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Famous Violet Ray Treatment

for Health, Vitality and Beauty

Now Possible in Your Own Home

A new machine has been perfected by scientists which enables anyone to enjoy the benefits of the Violet Ray treatment at home. The tonic effect of Violet Rays upon the system—how they are used to increase health and strength and to overcome specific disorders of the body.

FOR many years the wonderful results to be obtained through the application of electricity to the body have been known to scientists. Early investigation and experimentation opened up amazing possibilities for the future development of electricity as a curative agent and a vital source of health. Probably we all recall the first crude contrivance of a storage battery in a box from which a mild current of electricity could be passed through the body. Then came electric vibrating machines which, however, simply made use of the principle of mechanical massage and did not apply the action of electricity itself to the organs of the body.

The Discovery of Violet Rays

It was Nikola Tesla, one of the most brilliant of modern scientists, who mystified the world with the discovery of the peculiar Violet Ray. Tesla had found a way to convert a current of electricity into high frequency discharges. This can be described in simple terms as the diffusion of a solid current into a mist-like discharge. It is similar to a light, invigorating spray of water as compared to the force of a solid stream.

One of the most remarkable properties of the Violet Ray is its ability to penetrate solid objects, even including glass which acts as an insulator for electricity in its ordinary forms. We are all familiar with this phenomenon in the use of the X-Ray.

The Violet Ray Treatment

It was in the discovery of Violet Rays that the ideal way was found of applying electricity to the human body and obtaining all its wonderful, beneficial effects without any of the dangers that might attend its use in its more violent forms.

It is just like the refreshing, invigorating effects of a shower bath upon the system as compared to the shock of a solid torrent of water.

The Violet Ray, as used in the treatment of the body, sends a spray of mild, tiny currents through every part and organ, flowing through each infinitesimal cell, massaging it, invigorating it and vitalizing it. That is why after a Violet Ray treatment one is left with such a delightful feeling of health and buoyant energy. You have only a suggestion of this feeling in the effects of the ordinary massage. You know how restful and refreshing it is—how it brings a glow of health to your skin.

Now imagine this massage applied not only to the surface of the body, but to every part, every organ, every single cell, internal as well as external. No wonder that a Violet Ray treatment makes one feel "completely made over" and has such a delightful tonic effect upon the system. It acts upon the brain cells just as upon the other cells of the body, and that is why it is so often used by business men to overcome brain fag and mental sluggishness.

Wonderful New Machine Now Brings Violet Ray Treatments to Your Own Home

The Violet Ray treatment has long since passed its experimental stage. As its remarkable results were demonstrated, it received the endorsement of eminent physicians and scientists. Violet Ray machines became a part of the equipment of hospitals and sanitariums in the treatment of specific diseases and then were adopted by famous beauty specialists because of their effectiveness in eliminating skin diseases and blemishes such as eczema, blackheads, pimples, etc., and bringing the glow of healthful color to the complexion.



This illustration shows the wonderful new machine which enables anyone to enjoy the remarkable Violet Ray treatment at home.



Because of its effectivenss in clearing the skin of blemishes and beautifying the complexion, the Violet Ray machine is used for beauty as well as for health.

What Physicians and Users Say:

Trixie Friganza, well known actress, says: "Cheerfully will I add my praise for Violetta. It's the best 'pain chaser' and 'soother' I've had the good fortune to find. It's WONDERFUL. It cured my brother of neuritis. As for myself, I use it for facial treatments and general massage. I cannot say too much for it."

Dr. Bert H. Rice of Vinton, Iowa, says: "I have good results with the Violetta High-Frequency Instrument in all cases of neuralgia. Almost instant relief in Facial Neuralgia."

K. L. Allen, D. C., 205 Boone National Building, Boone, Iowa, says: "I have had very good results with the application of High-Frequency Current in cases of Paralysis, Rheumatism and Neuritis, and think it is a great help in drugless healing."

Dr. Daniels, Lisbon, North Dakota, says: "Have used the Violetta in such cases as Goitre, Bronchitis, Pleurisy, Neuritis, Neuralgia and Lumbago, and find it very beneficial. In fact, I would not be without it in my office."

It is almost impossible to list all the various disorders for which Violet Rays are used, for, by restoring normal activity and life to every part of the body, they eliminate the abnormal conditions whose presence is generally responsible for any local ailment. For example, as the free circulation of blood through the body is established, congestion is removed, eliminating the *cause* of headaches, catarrh, nervousness and insomnia. The same principle applies to the treatment of neuritis, rheumatism, lumbago, indigestion and neuralgia.

Hitherto, however, the costly apparatus necessary for giving Violet Ray treatments has limited them only to the well-to-do who could afford the time and money to go to establishments equipped with the Violet Ray machine.

But now scientists have perfected a new Violet Ray machine, operating on the same principle, but smaller in size, more convenient to use and infinitely less expensive in cost. This little machine is adapted to home use and requires no special electrical equipment. The wire which supplies the current simply fits into any electric light socket and the machine is ready for use. Where no current is available, special equipment is furnished at small extra cost.

Now, anyone can enjoy all the benefits of the famous Violet Ray treatment. Those who are suffering from some particular ailment will appreciate the wonderful help this handy new instrument brings to them. And others will be delighted to avail themselves of its wonderful tonic effects in creating health and strength, vitalizing the nerves, energizing the cells of the brain and body.

Already users of the machine have written enthusiastic letters to the manufacturers, telling of the results obtained through it—how it enables them to sleep better—how it has soothed their nervous troubles—how it has cleared and beautified the complexion. And even those who thought they were well before say that Violet Rays have brought them an entirely new feeling of health, strength and energy.

Try the Violet Ray Treatment Without Cost

In order that everyone may know what Violet Rays will do in his or her own particular case, the distributors of this new machine are willing to send it to anyone interested for free examination and trial. This liberal offer enables you to enjoy the delightful sensation of the Violet Ray treatment without any cost or obligation to buy unless you decide that you want to keep and own the machine. It is only necessary to mail the coupon below and you will receive full details of this special free trial offer.

Interesting Book Sent Free

It is impossible to tell in this small space all about the Violet Ray—what it is and how it acts and all the disorders and diseases it is used to treat successfully. But an interesting book has been prepared, fully illustrated, which describes in full the Violet Ray treatment and explains the new Violet Ray machine for home use. It tells just how to use the machine to get the same results as are obtained by physicians, drugless healers, sanitariums and beauty specialists. A copy of this book will be sent free upon receipt of your request on a postal card or the coupon below.



This man is using the Violet Ray machine for a local trouble—in this case rheumatism. Clothing offers no obstruction to the passage of the Violet Rays.

As the special Ten-Day Trial Offer is made for a limited time only, in order to introduce this demarkable machine and to enable you to see for yourself just what it is and how it operates, you are urged to send for particulars at once. Just write your request on a postal or fill in the coupon and send it to the manufacturers. There is absolutely no cost or obligation in doing this. Address

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326 West Madison St., Chicago, Ills.

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Wanted—Good live selling agents for our garage testing instruments and publications. Write for catalogue and particulars. H. E. Phillips & Company, Service Division, Union City, Ind.

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100 Model Aeroplanes. Good flyers. 15c brings working Drawings and Prices. F. Bruland, Redford, Mich.

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(Continued on page 964)

(Continued from page 963)

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Wanted. Phones, audion, other receiving apparatus. A. Walmsley, Star Route, Florence, Ala.

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Sell inch spark coil $1.00. New Phones, 2,000 ohm., $3.00. Send stamp for list. Earle Burns, 93 Union St., Athol, Mass.

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For Sale—1 horsepower steam engine $10.00. Chemical laboratory $10; other junk. Send for list. Carroll Fisher, 42 Putnam St., Somerville, Mass.

For Sale—1½ H. P. 110-volt, 60-cycle induction motor, $30.00; 1¼ KW. 500-volt DC. generator, $30.00; 1 hot wire meter, 0-5 amps., $2.00; 1 hot wire meter, 0-5 amp.; 2 pair 2000-ohm phones, each $4.00; 2 telephone microphones, each $1.00; motors, switches, sockets, rheostats, insulators, etc. Write for prices at once. J. E. Law, Sycamore Street, Clarksburg, W. Va.

Sell complete receiving set at bargain. P. Leary, 65 Kenwood Park, Springfield, Mass.

For Sale—Robbins & Myers ¼-horse motor. Brand new, $17. George Marx, Le Mars, Iowa.

Exchange—32 Winchester auto rifle for wireless apparatus. Geran Read, La Grange, Ind.

Sell. Loose Coupler, condenser, etc. Quick. Mariel Scharer, 110 West 89th St., New York.

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Sell 1 K. W. 220-volt primary 60-cycle Thordarson Transformer, brand new, $18. Starrett, 2615 N. Fourth St., Columbus, Ohio.

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(Continued on page 966)

ALSOP-ALL-SPARK

Address Reply in Duplicate to
DIRECTOR OF MILITARY AERONAUTICS
Washington, D. C.

IN REPLY PLEASE QUOTE
FILE NO. _____

WAR DEPARTMENT
OFFICE OF THE DIRECTOR OF MILITARY AERONAUTICS
WASHINGTON
January 13, 1919

From: Engineering Officer, Camp Morrison, Va.

To: Commanding Officer, Air Service Depot.

Subject: Supplemental Report on Test of Alsop Ignition Device.

1. In order to ascertain whether the device would insure ignition through plugs that were carbonized, cracked or rendered inoperative from other causes, one quart of oil above high level was placed in unit #9, the car was run until the motor died and could not be again started. The spark-plugs were then inspected and found to be heavily carbonized.

2. The Alsop Device was then attached, and within a short time all plugs were firing perfectly. The plugs were immediately removed and found to be clean - free from oil and carbon.

3. Then the Alsop was removed entirely from the car, motor was started again and ran for about four hours, then due to the excess oil still in crank-case, the plugs again became fouled and motor stopped. The heavily carbonized plugs were examined and replaced without cleaning.

4. The following day, Jan. 20th, the Alsop device was reinstalled with same results as before.

5. Later, a mixture of 50% kerosene and 50% gasoline was placed in the tank, no changes were made in the motor, carburettor or ignition device. The engine started as easily as with straight gasoline, developed greater power and continued to operate as above. No carbon formations were found on the plugs after using up the tank full of the above mixture.

Floyd A. Taylor
1st Lieut., A.S.M.A.

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Saves fuel and spark plugs.

Fires dead carbon-choked plugs.

Causes perfect combustion.

Fortifies any ignition system.

Guarantees increase of gasoline mileage.



Does away with changing spark plugs.

Prevents running engine with a misfire.

Gives a more powerful spark.

Eliminates carbon and vibration.

Increases speed and power.

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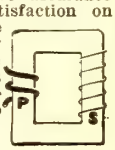
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(Continued from page 964)

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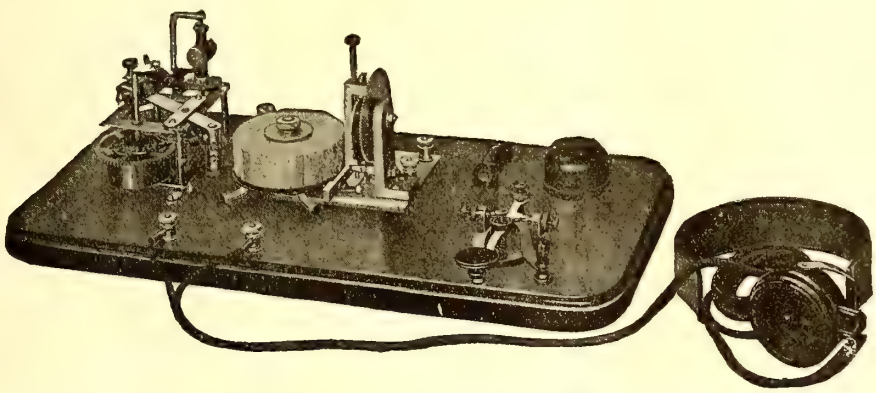
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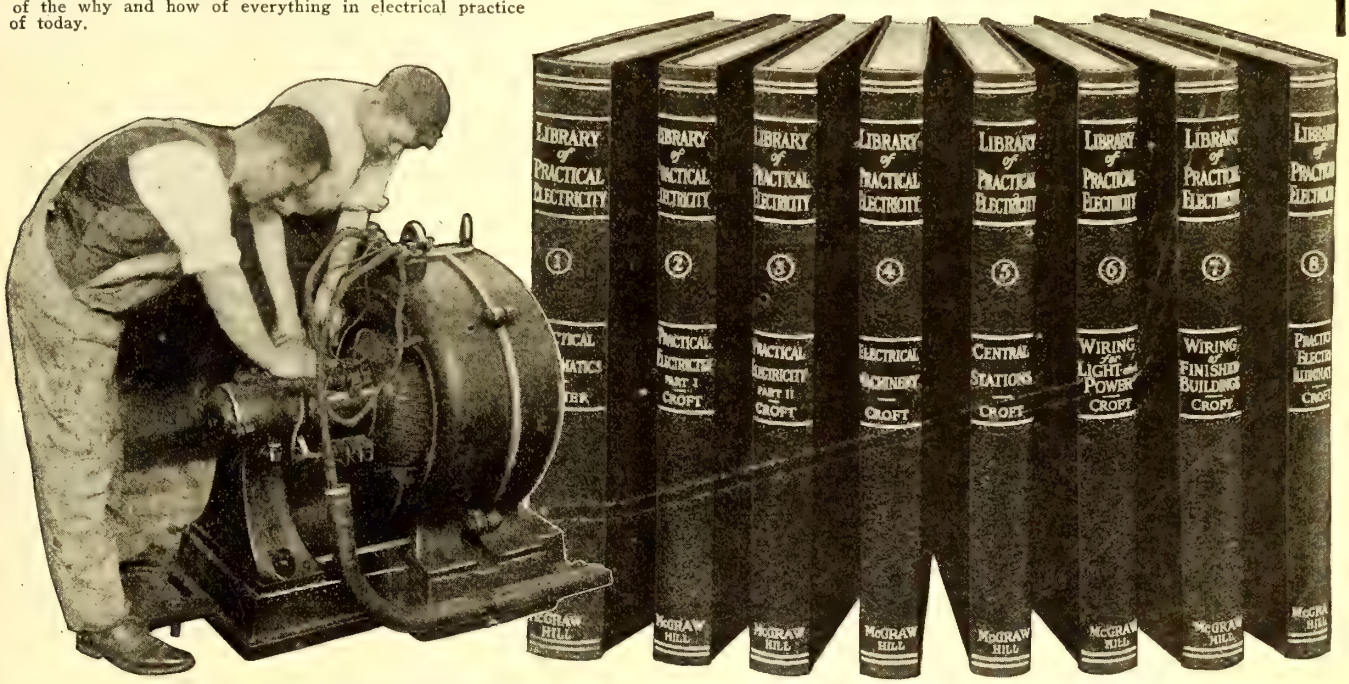
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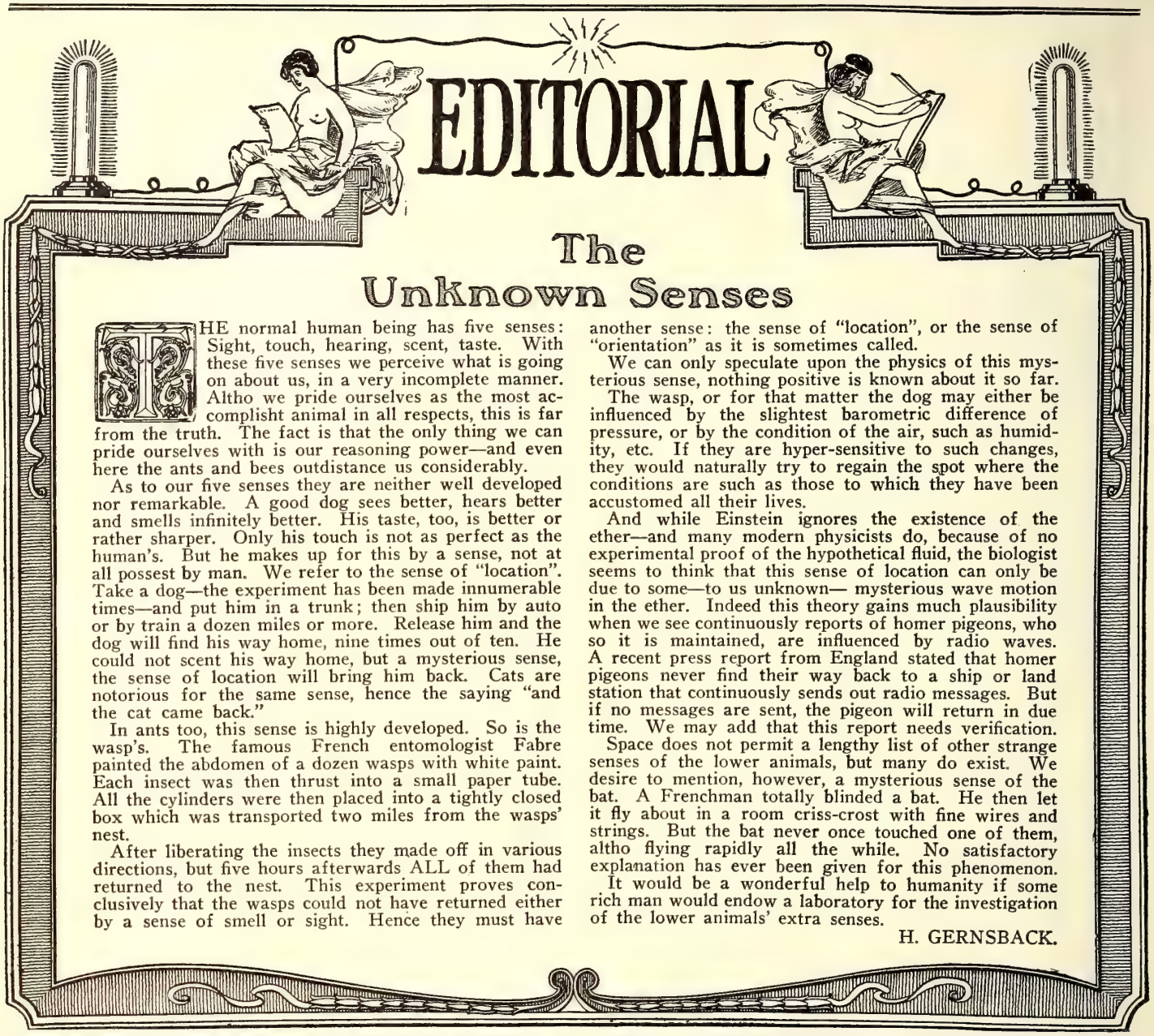
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EDITORIAL

The Unknown Senses

THE normal human being has five senses: Sight, touch, hearing, scent, taste. With these five senses we perceive what is going on about us, in a very incomplete manner. Altho we pride ourselves as the most accomplisht animal in all respects, this is far from the truth. The fact is that the only thing we can pride ourselves with is our reasoning power—and even here the ants and bees outdistance us considerably.

As to our five senses they are neither well developed nor remarkable. A good dog sees better, hears better and smells infinitely better. His taste, too, is better or rather sharper. Only his touch is not as perfect as the human's. But he makes up for this by a sense, not at all possest by man. We refer to the sense of "location". Take a dog—the experiment has been made innumerable times—and put him in a trunk; then ship him by auto or by train a dozen miles or more. Release him and the dog will find his way home, nine times out of ten. He could not scent his way home, but a mysterious sense, the sense of location will bring him back. Cats are notorious for the same sense, hence the saying "and the cat came back."

In ants too, this sense is highly developed. So is the wasp's. The famous French entomologist Fabre painted the abdomen of a dozen wasps with white paint. Each insect was then thrust into a small paper tube. All the cylinders were then placed into a tightly closed box which was transported two miles from the wasps' nest.

After liberating the insects they made off in various directions, but five hours afterwards ALL of them had returned to the nest. This experiment proves conclusively that the wasps could not have returned either by a sense of smell or sight. Hence they must have another sense: the sense of "location", or the sense of "orientation" as it is sometimes called.

We can only speculate upon the physics of this mysterious sense, nothing positive is known about it so far.

The wasp, or for that matter the dog may either be influenced by the slightest barometric difference of pressure, or by the condition of the air, such as humidity, etc. If they are hyper-sensitive to such changes, they would naturally try to regain the spot where the conditions are such as those to which they have been accustomed all their lives.

And while Einstein ignores the existence of the ether—and many modern physicists do, because of no experimental proof of the hypothetical fluid, the biologist seems to think that this sense of location can only be due to some—to us unknown— mysterious wave motion in the ether. Indeed this theory gains much plausibility when we see continuously reports of homer pigeons, who so it is maintained, are influenced by radio waves. A recent press report from England stated that homer pigeons never find their way back to a ship or land station that continuously sends out radio messages. But if no messages are sent, the pigeon will return in due time. We may add that this report needs verification.

Space does not permit a lengthy list of other strange senses of the lower animals, but many do exist. We desire to mention, however, a mysterious sense of the bat. A Frenchman totally blinded a bat. He then let it fly about in a room criss-crost with fine wires and strings. But the bat never once touched one of them, altho flying rapidly all the while. No satisfactory explanation has ever been given for this phenomenon.

It would be a wonderful help to humanity if some rich man would endow a laboratory for the investigation of the lower animals' extra senses.

H. GERNSBACK.

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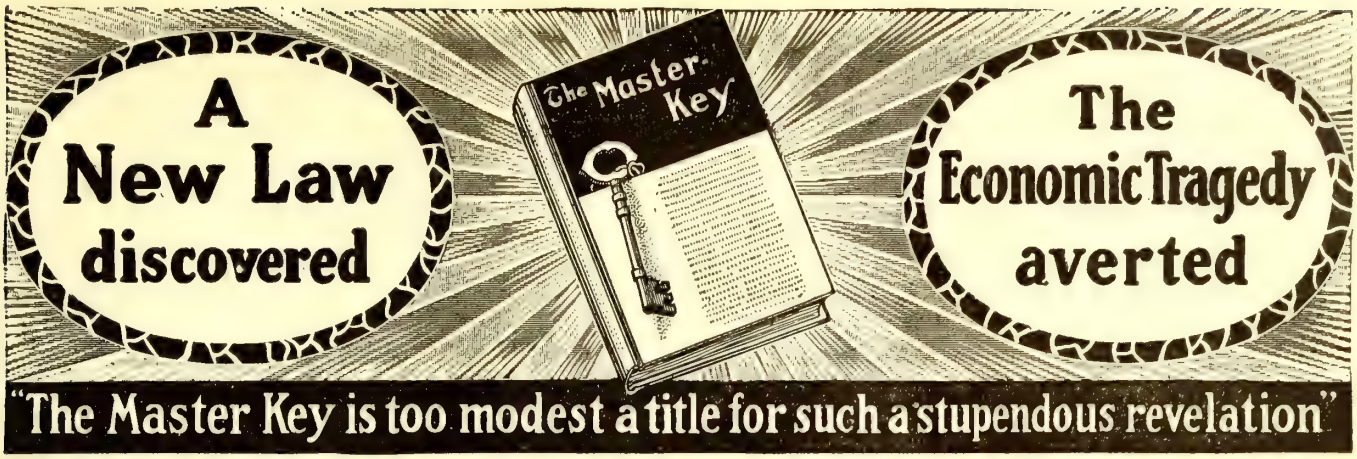
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The apparent impossibilities are the very things that help us to realize the possible. We must go over the unbeaten "trail of thought across the mountain of ignorance," wade through the "swamp of superstition" and cross the canyons of "rites and ceremonies" if we ever expect to come into the "promised land of revelation."
JOHN A. BOSTIC.

You have synthesized the wisdom of the East and the West and given it in a manner so logical and penetrating, that by its aid one is able to distinguish wisdom from sophistry, truth from delusion, spiritual expression from psychic vagaries, and the sublime operations of spiritual insight and intuition from deceptive visions and false revelations. You have successfully taken the mystery out of mysticism and placed all propositions in the clear light, so that "He who runs may read." I consider you a true benefactor to the world.
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The Master-Key System is taught in no school, in no college, in no university, or in no text-book. There is one way only to get it—just one—an easy and simple way—yet many neglect it. They would not be so careless if they realized the joy, the inspiration, the courage, the independence which is coming into the lives of those who are more thoughtful.

Creative power is the ability to bring into manifestation things which did not heretofore exist in the objective world. It is therefore the greatest power there is, because it means an actual contribution to the wealth of the world. If you develop this kind of power, you can hold a certified check on the bank of civilization for a fortune.

In contradistinction to this system of constructive thinking, note what a director of one of our largest universities says: "My students can neither think nor speak. They have in general a low degree of power to seize the organizing thought of chapter or book—reckless thought—aviation without steering apparatus and little experience in starting a train of thought and conducting it on a straight track to some terminus; paralyzing embarrassment on being left alone with a problem; lack of resourcefulness for new uses of old knowledge; no resourceful command of mental business method."

(A simple knowledge of the ability of the individual to create conditions for himself will unerringly and inevitably change this negative thought to a positive, dominant, creative thought, which will open up a wonderful vista of possibilities, broaden the outlook on life, and show how effort to accomplish may be rewarded with certainty. A wonderful promise, is it not?)

But do not be deceived. Reading books, magazines, attending lectures, taking home study courses will never put you in possession of the "Master-Key." It is only by a conscious co-operation with natural laws that we are enabled to "enter and partake." The Master-Key System teaches the method whereby this may be accomplished. In this it is DISTINCTIVE, ORIGINAL, UNUSUAL and AUTHORITATIVE.

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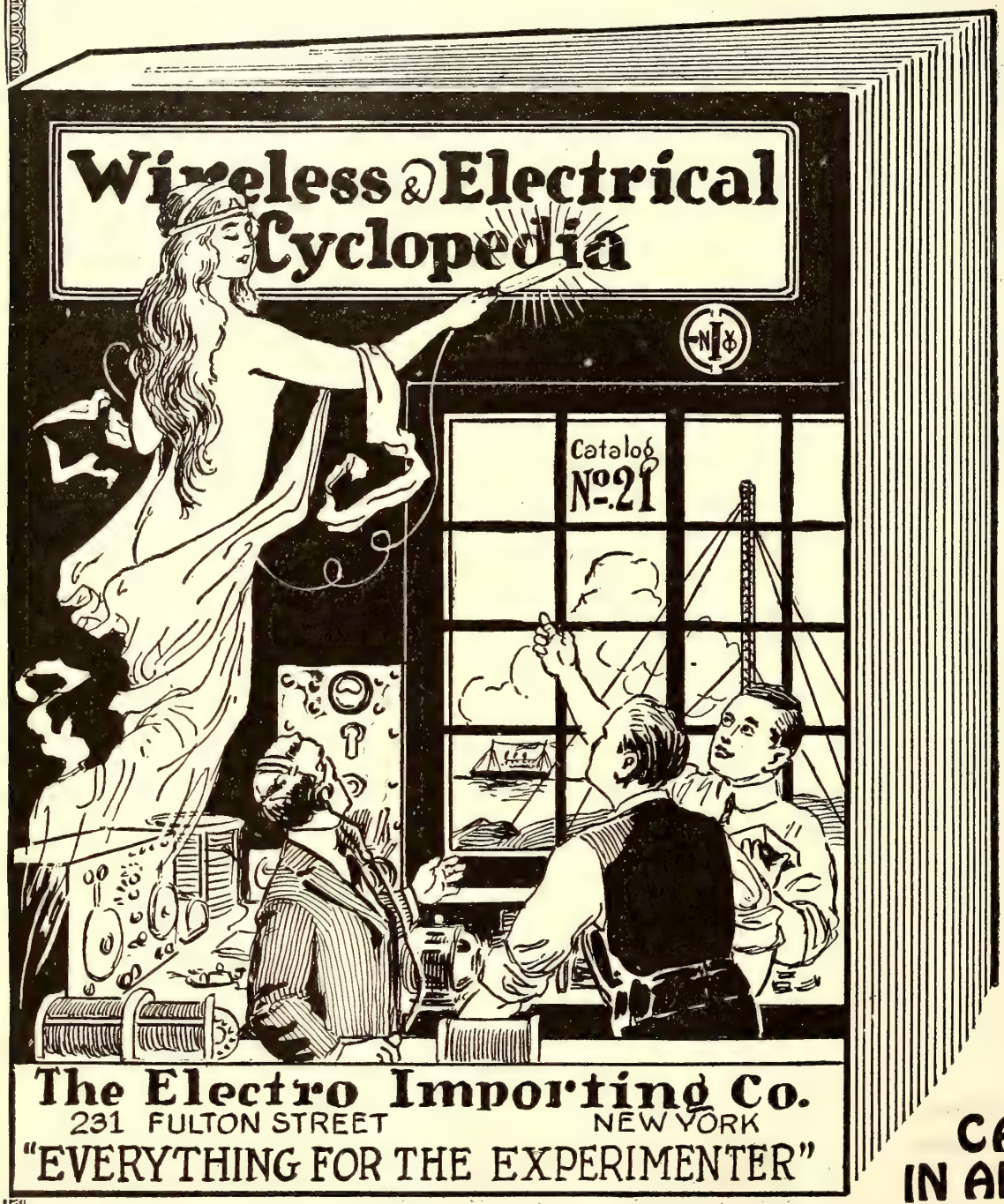
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WHAT I THINK OF PELMANISM—By George Creel

PELMANISM is the biggest thing that has come to the United States in many a year. With a record of 400,000 successes in England, this famous course in mind training has been Americanized, and is now operated by Americans in America for American men and women. Pelmanism is neither an experiment nor a theory. For twenty years it has been teaching people how to think; how to use fully the powers of which they are conscious; how to discover and to train the powers of which they have been unconscious. Pelmanism is merely the science of thinking; the science of putting right thought into successful action; the science of that mental team play that is the one true source of efficiency, the one master key that opens all doors to advancement.

I heard first of Pelmanism during a recent visit in London. Its matter filled pages in every paper and magazine and wherever one went there was talk of Pelmanism. "Are you a Pelmanist?" was a common question.

It was T. P. O'Connor who satisfied my curiosity and gave me facts. By 1918 there were 400,000 Pelmanists, figuring in every walk and condition of life. Lords and ladies of high degree, clerks and cooks, members of Parliament, laborers, clergymen and actors, farmers, lawyers, doctors, coal miners, soldiers and sailors, even generals and admirals, were all Pelmanizing and heads of great business houses were actually enrolling their entire staffs in the interest of larger efficiency.

Not a Mere Memory System

THE famous General Sir F. Maurice, describing it as a "system of mind drill based on scientific principles," urged its adoption by the army. General Sir Robert Baden-Powell and Admiral Lord Beresford indorsed it. In France, Flanders and Italy over 100,000 soldiers of the empire were taking Pelmanism in order to fit themselves for return to civil life, and many members of the American Expeditionary Force were following this example.

Well-known writers like Jerome K. Jerome, Sir Arthur Quiller-Couch, Max Pemberton, the Baroness Orczy and E. F. Benson were writing columns in interpretation of Pelmanism. Great editors like Sir William Robertson Nicoll and educators such as Sir James Yoxall were going so far as to suggest its inclusion in the British educational system.

As a matter of fact, the thing had all the force and sweep of a religion. It went deep into life, far down beneath all surface emotions, and bedded its roots in the very centers of individual being. A growing enthusiasm led me to study the plan in detail, and it is out of the deepest conviction that I make these flat statements:

Pelmanism *can*, and *does*, develop and strengthen such qualities as will-power, concentration, ambition, self-reliance, judgment and memory.

Pelmanism *can*, and *does*, substitute "I will" for "I wish" by curing mind-wandering and wool-gathering.

It is, and I say it advisedly, an important and necessary addition to American education, for it takes fundamental truths out of the back water and brings them back into real life and every-day use.

Pelmanism to-day is the *one* known course in applied psychology, the *one* course that builds mind as a physical instructor builds muscle. There is nothing really new in it. All of its truths are as old as the hills. But it reduces these truths to practical use. It puts them into harness for the doing of the day's work.

It teaches how to develop *personality*, how to build *character*, how to strengthen *individuality*. Instead of training memory alone, or will-power alone, or reasoning power alone, it recognizes the absolute interdependency of these powers and trains them *together*.

It is not, however, an educational machine for grinding out standardized brains, for it realizes that there are wide differences in the minds and problems of men. It develops *individual* mentality to its highest power.



GEORGE CREEL

There is nothing arduous about the course, and it offers no great difficulties, but it does require *application*. *Pelmanism has got to be worked at.*

There is no "magic" or "mystery" about it. It is not "learned in an evening." Brains are not evolved by miracles. Just as the arms stay weak, or grow flabby, when not used, so does an unexercised mind stay weak or grow flabby.

You can take a pill for a sluggish liver but all the patent medicines in the world can't help a sluggish mind. Pelmanism is not a "pill" system. It proceeds upon the scientific theory that there is no law in nature that condemns the human mind to permanent limitations. It develops the mental faculties by regular exercise, just as the athlete develops his muscles. It gives the mind a gymnasium to work in; it prescribes the work scientifically and skilled educators superintend the work. The "Little Gray Books" are intellectual dumbbells.

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IT is the science of Get There—getting there quickly, surely, finely! Not for men alone, but for women as well. Women in commercial pursuits have the same problems to overcome as men. Women in the home are operating a business, a highly specialized, complex business, requiring every ounce of judgment, energy, self-reliance and quick decision that it is possible to develop.

I say deliberately, and with the deepest conviction, that Pelmanism *will* do what it promises to do. Followed honestly, it *will* give greater power of self-realization and self-expression in word, thought and action. It *will* stop wool-gathering and mind-wandering. It will develop mind, character, personality, giving ambition, energy, concentration and self-reliance.

There are too many men who are "old at forty"; too many people who complain about their "luck" when they fail; too many people without ambition or who have "lost their nerve"; too many "job cowards" living under the daily fear of being "fired."

Original thinking is almost a lost art. We look at games instead of playing them. The less the mental demand the more popular the play. There is music in restaurants because it is too much trouble to talk intelligently. Life is cut to pieces by deep ruts, with the people in them never looking over the sides. Greater driving force and higher powers of concentration will add to the nation's assets.

There is nothing more true than that success and failure are next-door neighbors. The success of today may be the failure of tomorrow, and the inefficient can rise to efficiency when he *wills* it. No one can mark time in modern life, much less stand still. We *go forward or drop back.*

Increased Incomes

TALK of quick and large salary raises suggests quackery, but I saw bundles of letters telling how Pelmanism had increased earning capacities from 20 to 200 per cent. With my own ears I heard the testimony of employers to this effect. Why not? Increased efficiency is *worth* more money. Aroused ambition, heightened energies refuse to let a man rest content with "well enough." Business demands ever-increasing efficiency and employers are quick to recognize it and reward it.

But Pelmanism is bigger than that. There's more to it than the making of money. It makes for a richer and more wholesome and more interesting life.

Too many people are mentally *lopsided*, knowing just the one thing or taking interest in only one thing. Of all living creatures they are the most deadly. I have seen eminent scholars who were the dullest of talkers; successful business men who knew nothing of literature, art or music; people of achievement sitting tongue-tied in a crowd while some fool held the floor; masters of industry ignorant of every social value; workers whose lives were drab because they did not know how to put color in them, and I have heard men and women of real intelligence forced to rely on anecdotes to keep up a conversation.

The emphasis of Pelmanism is on a *complete* personality. It does away with lopsided developments. *It points the way to cultural values as well as to material success.* It opens the windows of the mind to the voices of the world; it puts the stored wealth of memory at the service of the tongue; it burns away stupid diffidences by developing self-realization and self-expression; it makes unnecessary the stereotyped in speech and thought and action.

GEORGE CREEL

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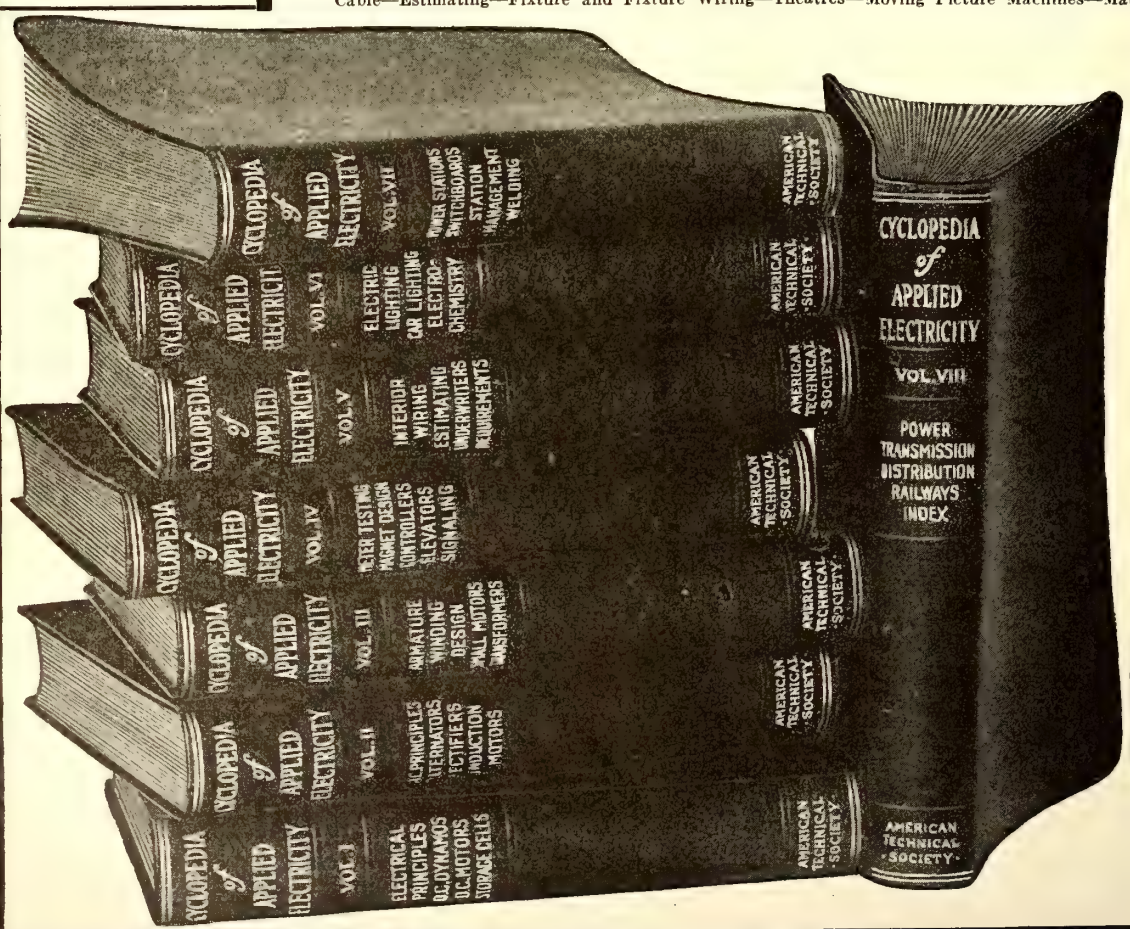
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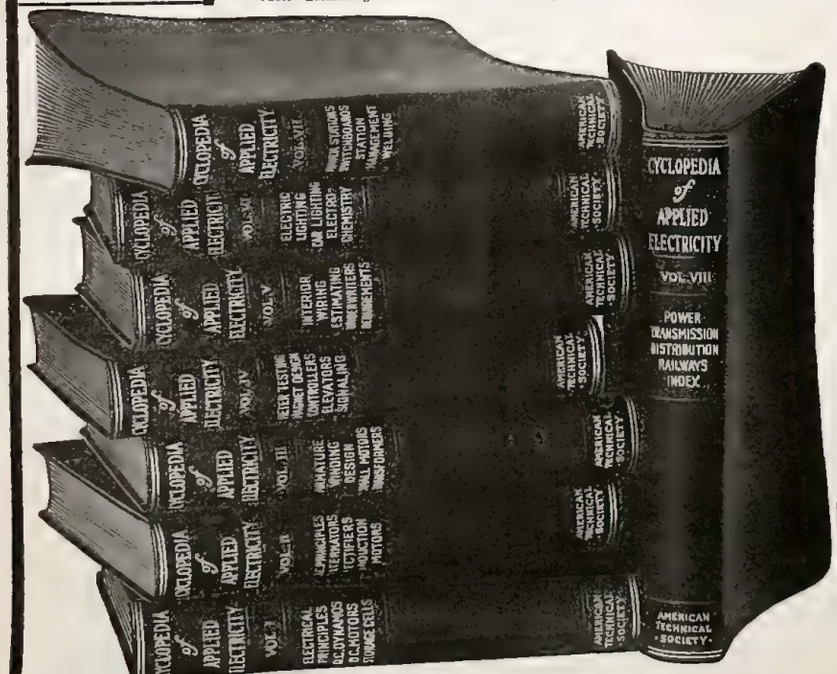
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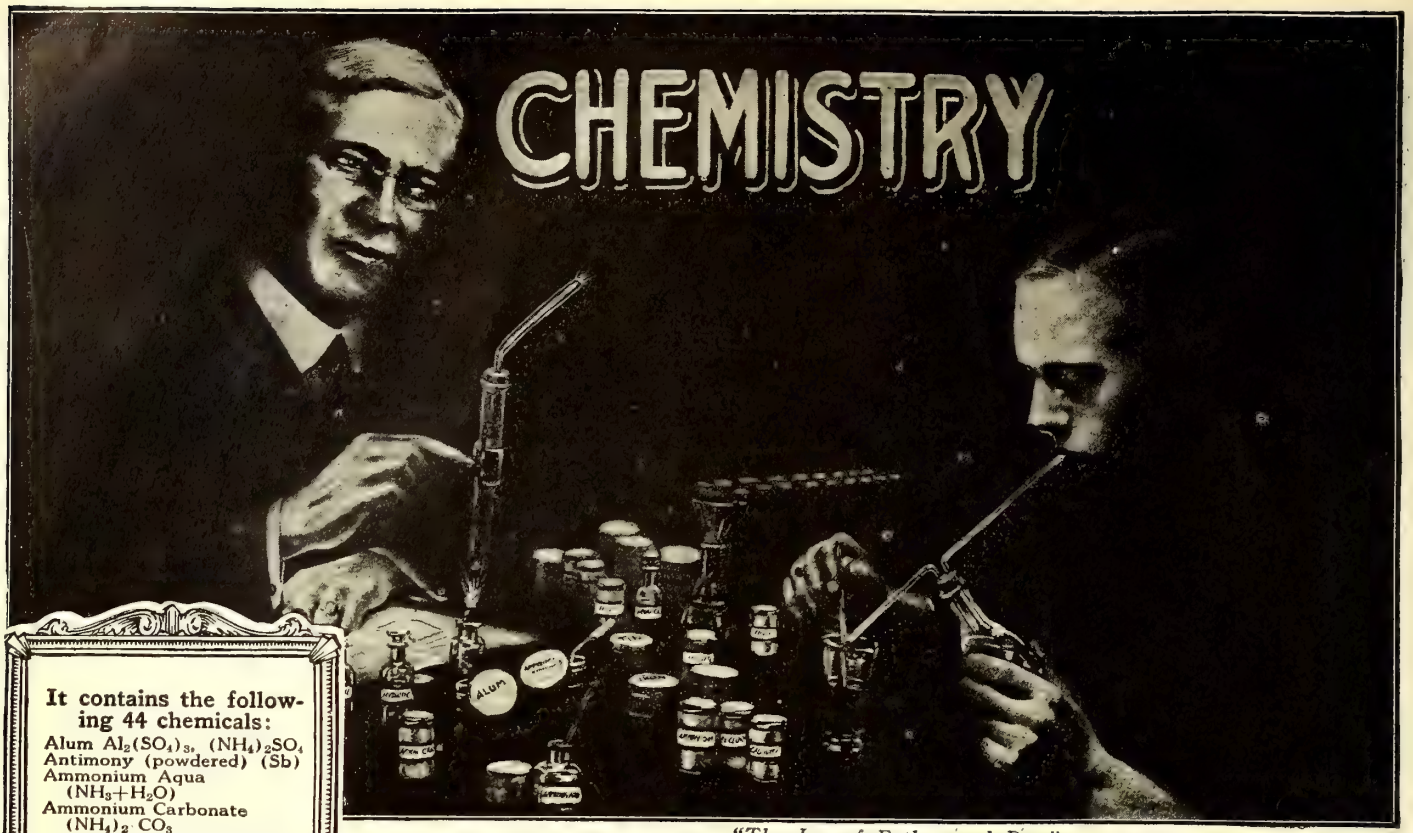
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Ammonium Carbonate $(NH_4)_2\ CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride $(BaCl_2)$
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride $(CaCl_2)$
Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_4 2H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
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Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
Sulphate of Nickel $(NiSO_4)$
Sulphate of Zinc $(ZnSO_4)$
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One Glass Funnel
One Delivery Tube
Six Assorted Test-Tubes
One Test-Tube Holder
Ten Sheets of Filter Paper
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One book containing Treatise on Elementary Chemistry and 100 Chemical Experiments to be performed with this outfit.

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How I Stopped Forgetting In One Evening

How in One Evening I Discovered the Secret of a Good Memory and in Six Months Increased My Business One Hundred Thousand Dollars

By William Gerard

WHO would ever have thought that a $100,000 increase in my business would come from a simple secret learned in one evening. And yet, that is just what happened. I look back on it today, and can hardly believe that it is only six short months since I learned from David M. Roth, the famous memory expert, how to make my memory do wonderful things that I never before dreamed possible.

I consider the evening I met Mr. Roth one of the most momentous in my life. It was at a dinner of the Seattle Rotary Club. Mr. Roth was present and started his exhibition by asking sixty of those present to introduce themselves to him by name. Then he requested a gentleman at the blackboard to write down names of firms, sentences and mottos on numbered squares, meanwhile sitting with his back to the writer. After this, he was asked by various Rotarians to tell what was written down in the specific squares. Mr. Roth gave the entire list without a mistake. After finishing with this, Mr. Roth singled out and called by name the sixty men to whom he had been introduced earlier, and who in the meantime had changed seats and mixed with others present.

After the meeting, I was introduced to Mr. Roth by a mutual friend, and congratulated him upon his marvelous feats of memory. To my surprise, Mr. Roth said, "Why, Mr. Gerard, such things are nothing at which to marvel. Anyone can do these things and even greater things with his memory. A good memory is not a gift. Any person of average intelligence can easily develop his memory. I, myself, am an example of this fact. As a young man my memory was so poor I could hardly remember a man's face or name 20 seconds. I soon realized that this bad memory would scare away any chance I had for success. Right then and there I determined to improve my memory. And now, after 20 years of attention to the subject, I feel that I can do as much for other people's memories as I have done for my own. I have recently finished work on a simple and practical course through which anyone can improve his memory until it becomes a veritable sponge for absorbing facts, faces, names and all the information one wants to remember. This course contains all of my secrets and principles. If you will write to my publishers in New York, the Independent Corporation, you can make arrangements for examining the course without charge."

Needless to say I wrote the Independent Corporation, asking to examine the course. In a few days I received the seven lessons together with a little booklet of letters from many men telling what they had already done through the aid of the course. It was very encouraging for me to read the letter from C. Louis Allen, who at the age of thirty-two became president of the million dollar Pyrene Manufacturing Company, and is now the president of the Sales Company bearing his name.

"Now (says Mr. Allen) that the Roth Memory Course is finished I want to tell you how much I have enjoyed the study of this most fascinating subject. Usually these courses involve a great deal of drudgery, but this has been nothing but pure pleasure all the way through. I have derived much benefit from taking the course of instruction and feel that I shall continue to strengthen my memory. That is the best part of it. I shall be glad of an opportunity to recommend your work to my friends."

You may be sure that after reading the balance of the letters telling of *real results*, I went right at the course that very evening. I expected to find the lessons "brain breakers", but to my surprise, the Roth Course was as easy and fascinating as a game. I hated to put it by that evening and surprised my wife by repeating backwards, forwards and all ways fifty words of all sorts. My wife could not understand how a person with a memory so poor as mine could do such a thing after only about one hour's study. But the course gives the secret of a good memory *right at the start.* I played the memory improving game for a few minutes each evening for a month. And the further I got the more fascinating the game became. Long before a month was up I had amazed my family and my friends on a number of occasions by various memory feats, and to them the astounding difference in my memory was nothing short of a miracle.

And now, my memory behaves so efficiently that my business has felt the impetus of my increased mind power and has responded in a joyously lucrative fashion. Within the last six months my sales have jumped up $100,000—*with no "war-baby" or external force to boost my business.*

The reason I know that my business expansion is due to my own increased power is that I seem to have a new grip upon affairs, I employ old facts and experiences, give them a new twist and have thereby revitalized my business methods. I now remember and apply all that I have heard other people have learned. Nothing slips my mind that can be used to some business advantage. I find and store in my new, iron-bound memory real nuggets of facts and experiences that other people casually let drop. When a condition arises, I just seem to open a certain drawer of my mind, then take out and marshal together all facts and precedents that I have learned. My memory has become an ally that never fails to help me push my business ahead "on high."

I now seize many golden opportunities that before would have slipped by and been out of reach by the time I woke up.

You see the Roth Course has done vastly more for me than merely teach me how to remember names and faces, telephone numbers, etc. It has done more than make me a more interesting talker. It has done more than give me confidence in myself.

Mr. Roth's Course has endowed me with new business perspective. It has made me a keener observer. It has given me a new sense of proportion and values. It has given me visualization—which after all is the true basis of business success.

I feel that I owe the Roth Memory Course a great debt—in fact, a $100,000 debt. I feel that telling my story to the readers of The Electrical Experimenter Magazine is only a small payment for what the course has done for me. Any power that can increase a man's business $100,000 and increase his mind power 90% deserves that man's sincere and truthful endorsement. I *know* that this is what the Roth Memory Course has done for me and for my business. Not alone am I happy to be able to tell my story as it happened, but I am gratified to know that anyone can do the same thing. A mere glance over the first lesson will show that there is a course, not for "high brows" who love to bathe in theory, but practical and easy instructions for every man, woman or child, who knows the enormous value of a good substantial memory. This same hand of mine that gave out $5 for the Roth Course took in $100,000 as a result, and in telling my experience, I feel that in a small way, I am repaying the great debt that I owe to the David M. Roth Memory Course.

William Gerard.

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Today there are over ten thousand people in the United States whom Mr. Roth has met at different times—most of them only once—whom he can name instantly on sight. Mr. Roth can, and has, hundreds of times at dinners and lectures, asked from fifty to one hundred people to tell him their names and telephone numbers, and business connections, and then, after turning his back while they changed seats, has picked each one out by name and told him his telephone number and business.

These are only a few of the scores of other equally "impossible" things that Mr. Roth does—and yet a few years ago he could not remember a man's name twenty seconds. You too can do these wonderful things.

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So confident is the Independent Corporation, the publishers of the Roth Memory Course, that once you have an opportunity to see in your own home how easy it is to double, yes triple your memory power in a few short hours, that they are willing to send the course on free examination.

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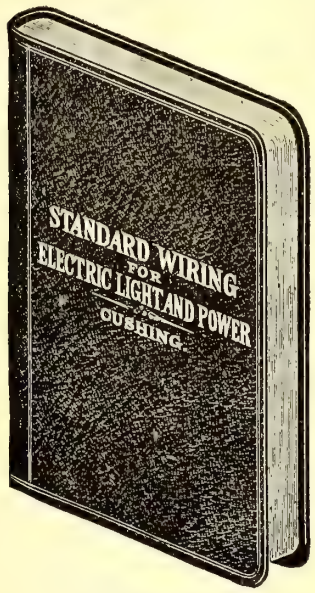
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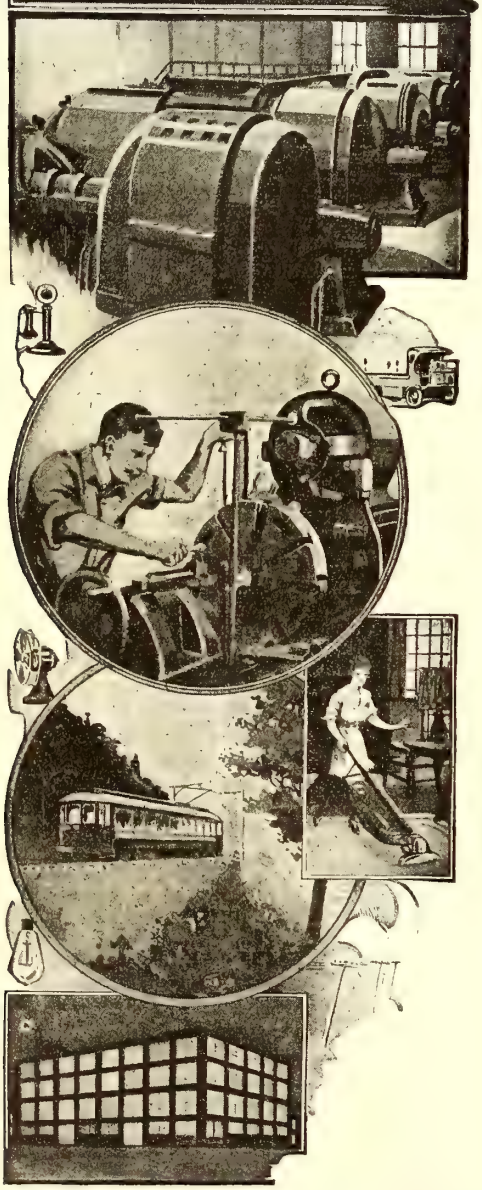
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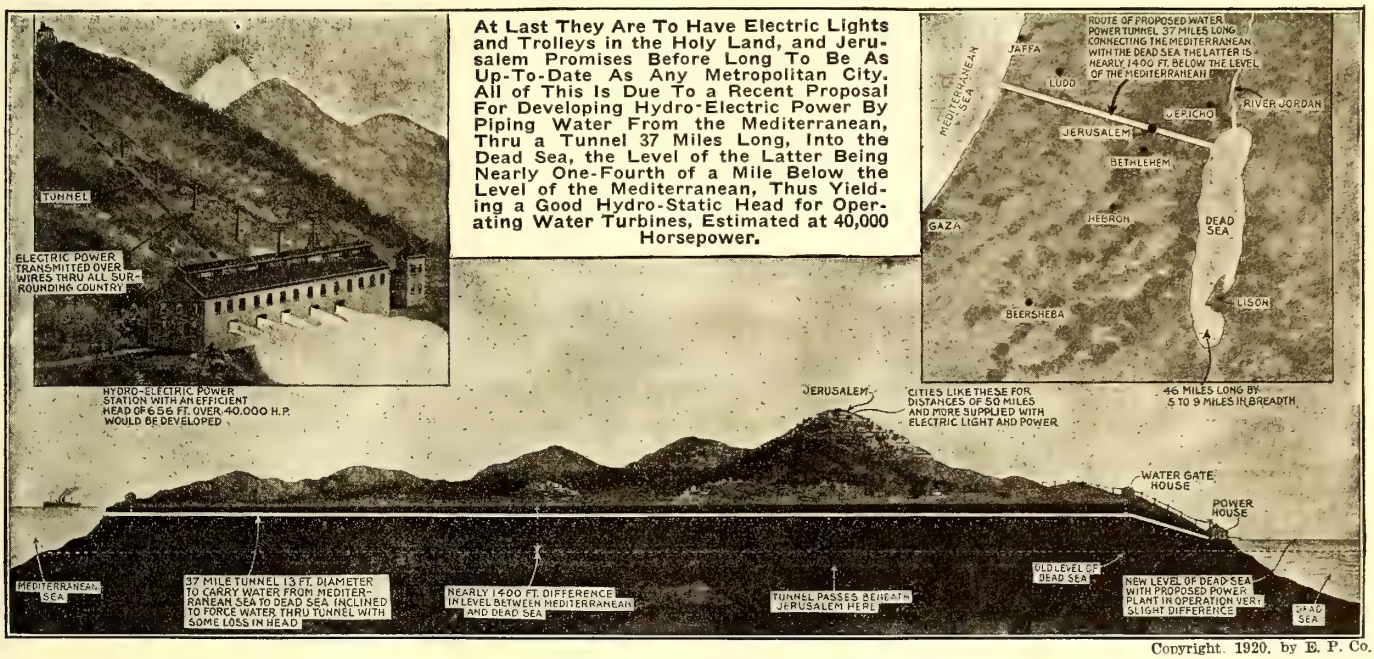
H. GERNSBACK – EDITOR
H. W. SECOR – ASSOCIATE EDITOR

Vol. VII. Whole No. 82 February, 1920 No. 10

Electrifying The Holy Land

By Piping Water From The Mediterranean Into The Dead Sea

THE latest news in international engineering circles is to the effect that a Norwegian engineer, Mr. Albert Hjorth, has perfected a bold yet comprehensive plan for electrifying the "Holy Land." He proposes, for one thing, to pipe water, hundreds of thousands of gallons of it, from the Mediterranean Sea into the Dead Sea, which latter is nearly 1,400 feet below the level of the former.



At Last They Are To Have Electric Lights and Trolleys in the Holy Land, and Jerusalem Promises Before Long To Be As Up-To-Date As Any Metropolitan City. All of This Is Due To a Recent Proposal For Developing Hydro-Electric Power By Piping Water From the Mediterranean, Thru a Tunnel 37 Miles Long, Into the Dead Sea, the Level of the Latter Being Nearly One-Fourth of a Mile Below the Level of the Mediterranean, Thus Yielding a Good Hydro-Static Head for Operating Water Turbines, Estimated at 40,000 Horsepower.

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WHAT IS THE DEAD SEA?

The so-called "Dead Sea" is the largest lake in Palestine, and physically as well as historically is among the most remarkable in the world. The sea is forty-six miles long, and varies from five to nine in breadth. Its bed is the lowest part of the great valley of the Jordan; and its surface has a depression of no less than 1,367 feet beneath the level of the ocean (and also the Mediterranean). The Jordan Valley itself, for a distance of about eighty miles to the northward and thirty to the southward, is also below the level of the ocean. The general contour of the sea is an elongated oval, with a number of bold promontories and deep bays along the western shore, and a large, low peninsula on the southwest. It is shut in on the east and west by parallel ranges of mountains which rise steeply, and in some places in precipices of naked rock, from the water. The water is intensely salt and bitter, and its density is so great that the human body will not sink in it. Its specific gravity is 1.277.

A GIGANTIC TUNNEL 37 MILES LONG.

This plan for developing hydro-electric energy in the Palestine involves the building of a great tunnel, 37 miles in length, passing along the route shown in the accompanying map. A writer on this interesting engineering venture in the *Evening Post*, of New York, outlines the following proposals and data:

Great importance attaches to the sensational project brought forward by Mr. Albert Hjorth, a Norwegian civil engineer, which utilizes the level variation between the Mediterranean and the Dead Sea, by means of great power stations. These plans are the result of a thoro study of the meteorological, climatic and geological conditions of the country, which made it obvious that practically the only possibility for a new agriculture lies in an efficient irrigation.

Mr. Hjorth's plan proposes a tunnel about *thirty-seven miles long*, running west to east from the Mediterranean to the Dead Sea, *passing under Jerusalem*. The tunnel would carry the water from the Mediterranean to the western slopes of the lower end of the Jordan Valley. From this point the water would be directed thru pipes down to the level of the Dead Sea, where a power plant with turbo electric machinery would transform the water power into electricity, to be distributed as light and power thruout the country, and drive a pumping plant at the southern end of the Lake of Genezareth.

The level of the Dead Sea is about 1,367 feet below sea level, that of the Lake of Genezareth about 656 feet below sea level. Preliminary estimates show that tens of thousands of horsepower may be developed thruout the year in this manner, by means of a tunnel of 135 square feet cross-section, or about 13 feet in diameter, carrying twenty tons of water a second. The rise of the Dead Sea caused by this would not be more than a fraction of a yard a year. The surface of the Dead Sea, which is now about four thousand square miles, would be allowed to increase as much as the increased

(*Continued on page* 1058)

Sub-Sea Exploration

By JOSEPH H. KRAUS

MAN'S combined achievements with the forces of nature and the annihilation of space with regard to the earth, the air, and on the ocean have been startling to the extreme, and yet how strikingly is this contrasted with his knowledge and achievements with those forces undersea. From the beginning, on down thru the ages—before ships started to sail, men always wondered what was down there beneath the surface of the ocean; what immense wealth in quantities never realized, lie down there, which offer the greatest, most promising opportunities for investment, aggrandizement and fame.

Practically speaking, all this sunken wealth, including hundreds of thousands of ships which have gone down since the first ship sailed the high seas, (in the days when the Pirates and Buccaneers were waging continual wars, and sailing around in gold-laden vessels)—from that period until the present war, thousands more with their cargoes of mails, treasures, furnishings, machinery, and equipments totalling untold wealth were sunk.

They are still lying down there, in spite of man's best ingenuity, daring, energy, and persistency, because all attempts to reach these depths were barred and *practical results* were limited to a depth of about 100 ft.

Our readers have since the war seen various and numerous descriptions and illustrations in both scientific journals and the press, explaining the manner in which ships and other treasures sunk beneath the waters will *probably be refloated* and how the treasures may be recovered. Those same ships and treasures are still down there, resting calmly, with no one to molest the secrecy of their holds. It is not even necessary to attempt to pry them open as they are there awaiting the taking, if some human being would only go down and salvage them.

The object of this article is to make the subject of sub-sea work comprehensive in its entirety. The human body has been made the frail object of resistance between the forces of nature (air and water pressure) to the limit of endurance, and any authentic records will show that limit to be about 100 ft. depth for producing anything like practical results. This is admitted inasmuch as the means hitherto available have not even scratched the surface, in an attempt to get into the depths where wealth and glory are to be found in abundance.

The new method which is of intense interest at this time has been employed successfully for a number of years. This is the sub-sea flexible tube apparatus invented by Captain Charles Williamson and holds sway over all means hitherto tried. It is not alone sufficient to say that the apparatus in question has proven to be of actual commercial value, but also comments on its basic ideas and principles have never shown any fallacy to exist, nor have any of the many distinguisht authorities who have witnest its action, had aught but praise for it. Captain Williamson, a man advanced in years, but with the alacrity of a most agile youth, a pleasing countenance, and a youthful sparkle in his eyes, explained some of the possibilities and results to the writer. Many of these results are well known, some having been accomplisht by his two sons, Ernest and George, who formed a subsidiary corporation to operate under the patents of their father's corporation. They have thus been able to place before the world, many of the hidden wonders of the

Seeing and Working Under Water By New Invention

undersea. Underwater photography has become an establisht fact, and until one has seen the wonderful moving picture submarine scenes in the Williamson Brothers' picturization of the eternal novel of Jules Verne's—"20,000 Leagues Under the Sea"—one fails in his attempt to compute the future possibilities of this invention. This together with "The Williamson Submarine Expedition" and other well known Williamson productions, constitute but a small fraction, a minute particle of the work which the original apparatus now makes possible.

The Williamson tube apparatus construction is built in segments, each segment in turn making up units. The units are of any desired length, and made to withstand water pressure even greater than exists in the deepest oceans, according to the opinion voiced by one of the highest scientific authorities in the country. Each unit is so arranged that if it were sealed up at both ends it would displace a volume of water equal to its own weight, and placed in water, it would float "awash"—that is to say, on a level with the surface of the water. The circumferential wall of this unit is made collapsible, and so arranged that metallic interlocking segments permit such action freely. These are mounted on suitable annular frames, which maintain a constant diameter and permit the passage of workers as desired. A number of these units make up sections 10 or more feet long and the section again is only one of the parts of the tube apparatus.

The entire length of tube has at the bottom an operating chamber, which chamber is specific for each different purpose and intention. In nearly all of them if the operator must work on outside objects, there is a steel glove into which the operator's hand finds easy access. This glove prevents the terrific pressure at great depths from crushing completely the bones in the human body. The only portion of the operator, therefore, which is subject to pressure, and very little of that, is that portion which extends in the glove.

Now as to the method of submerging the tube apparatus itself. As has been stated before, each section of the tube is made so that it can be sealed at the bottom by means of the operating chamber. This operating chamber is clampt by hatch-hooks or massive bolts to the sections of tubing and the sections of tube are likewise clampt together. These sections will float awash, due to the well known physical law. (Note 35 cubic feet of water weigh one ton.) If we take one ton of iron and from this one ton of iron make a body which will have a capacity of thirty-five cubic feet, and place the same in water, the upward pressure of the water against the body is equal to or slightly greater than its own weight, and the body floats practically awash. Should now a vessel, weighing one ton and having a displacement of seventy cubic feet, be placed in water, it would sink to a depth of only one half the original depth, in other words, half of the body would be out of the water, and that is exactly one of the principles this tube is based on.

The apparatus is brought to the point of operation with only the operating chamber riding along in the water. A section of the tube is bolted to the operating chamber and the operating chamber is released. Immediately it sinks due to the extra weight placed upon it, until again a level of equilibrium is reached. Thus the top of the tube will again be practically awash and another section is bolted in place and so on ad infinitum, until the desired depth is reached. Tools, etc. are operated thru the chamber by means of air tight joints and may be reached at, and set into drills, etc. thru a tool air-lock and clampt into position from the outside via the iron glove. A passageway is permitted thru the tubes into the operating chamber at all times.

The operator in the Williamson sub-sea device is at all times free to work under normal atmospheric conditions.

Several of the more useful applications for this industrial sub-sea exploring apparatus are illustrated herewith, but Captain Williamson states that the greatest revelation of all is still to come.

In applying this apparatus, for inspection and minor repairs, to the hulls of vessels as depicted in scene No. 2, it will be seen how easily an operator can use ordinary pneumatic tools without the necessity of purchasing special apparatus. Imagine if you can, the number of vessels which are being daily dry-docked for minor repairs which can now be made from an apparatus of this character, without the necessity of laying up the ship. This is only one of the many applications. The sides of the ship can be cleared of their growth of barna-

(*Continued on page* 1074)

TO OUR READERS

WITH this issue the price of the ELECTRICAL EXPERIMENTER advances to 25c a copy, $2.50 a year in U. S. and $3.00 Canada and foreign.

The old price of 20c has been in force since November, 1918, and our readers need not be reminded of all the price increases since that time. During the past year many commodities have doubled in price. The price of paper has increased 40% over the price in 1918. The cost of printing has gone up 35%. Engravings and art work increased over 50% in price. Salaries have advanced over 40%. Still in raising the price from 20c to 25c we have only burdened you with an increase of 25%. And if you take into consideration that we have added over 36 pure text pages to the magazine since November, 1918 (this issue has been increased eight pages again), you can readily see that your increase of 25% is really very small. In other words, the advertiser pays twice the increase in price you are asked to pay.

Frankly, we dislike a 25c magazine. It is bad business for us, as it may check the rapid growth in circulation that we have shown during the past year.

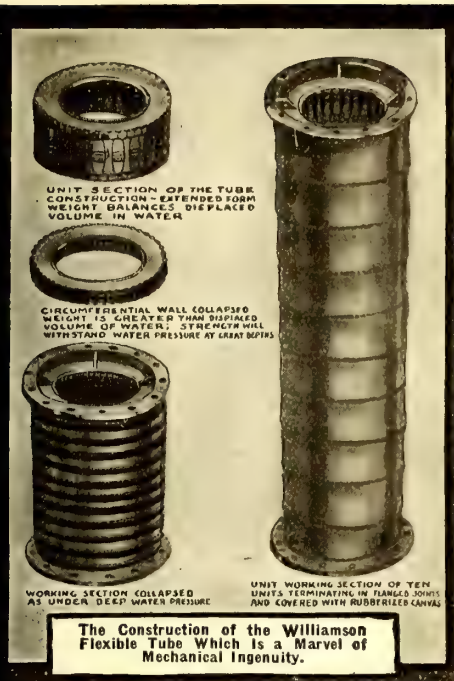
But we cannot publish at a loss, and we refuse to print a 72-page magazine now, after having built up the greatest periodical of the kind ever publisht.

Mr. Gernsback has had dreams of a circulation of 500,000 copies (this issue numbers 175,000 copies)—but this cannot be done at 25c a piece. Some day when conditions are normal once more we hope to come down to 15c again.

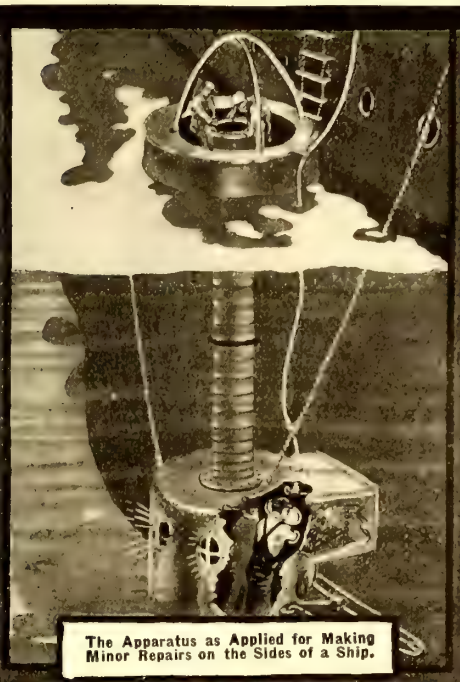
Until that day won't you bear with us and remember that we make less—much less—now than when the price was 15c.

THE PUBLISHERS.

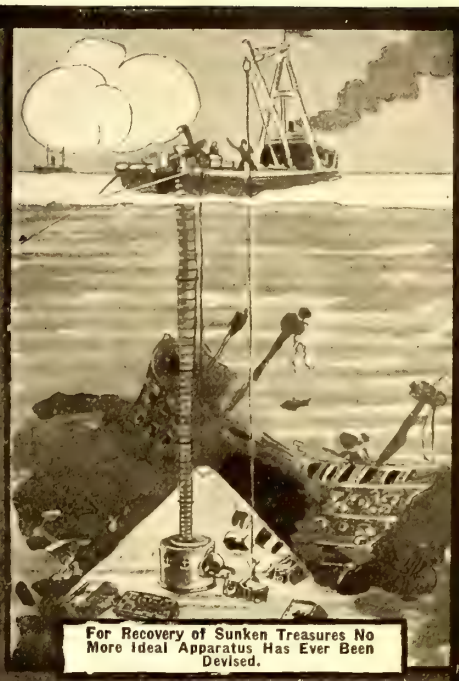
THE SUB-SEA EXPLORER



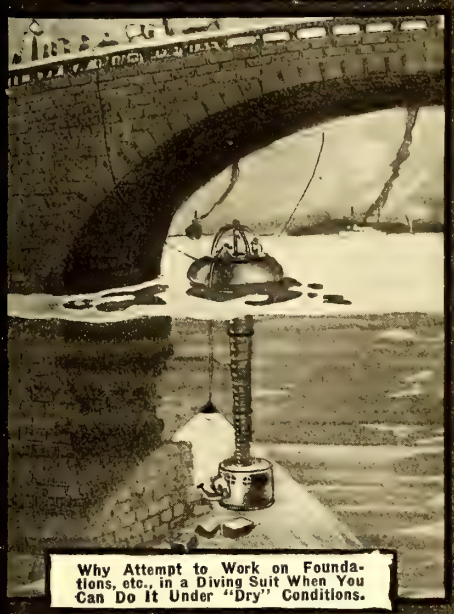
The Construction of the Williamson Flexible Tube Which Is a Marvel of Mechanical Ingenuity.



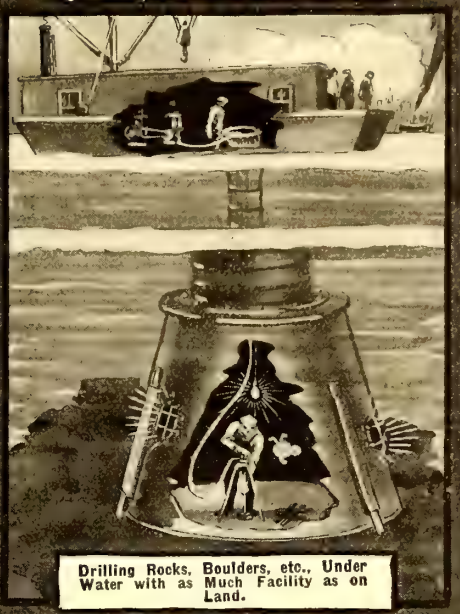
The Apparatus as Applied for Making Minor Repairs on the Sides of a Ship.



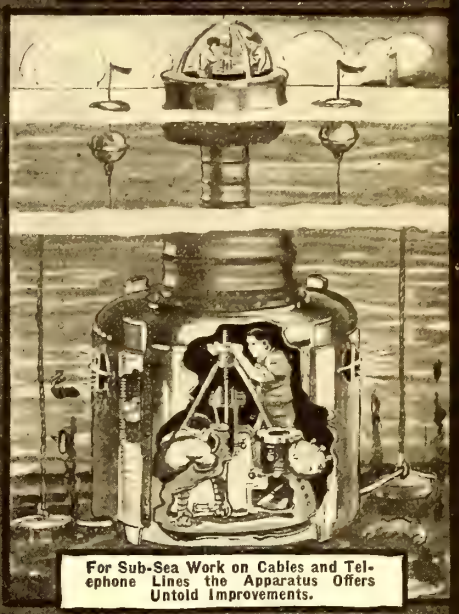
For Recovery of Sunken Treasures No More Ideal Apparatus Has Ever Been Devised.



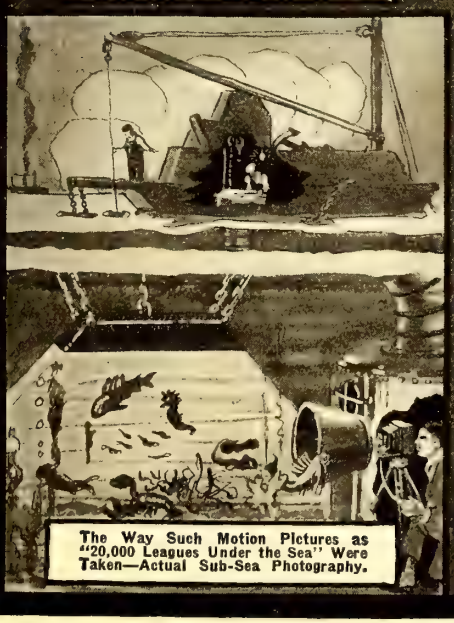
Why Attempt to Work on Foundations, etc., in a Diving Suit When You Can Do It Under "Dry" Conditions.



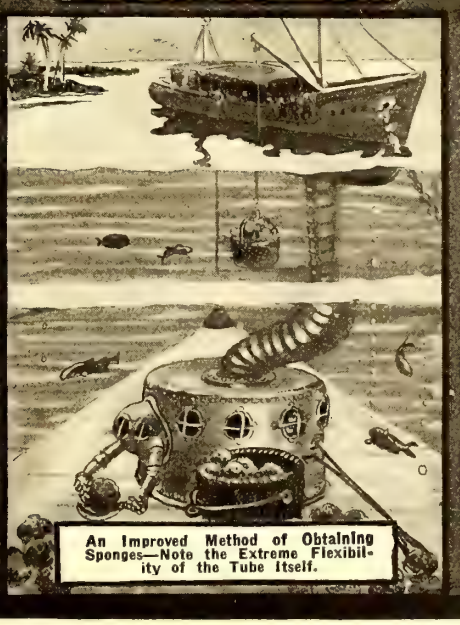
Drilling Rocks, Boulders, etc., Under Water with as Much Facility as on Land.



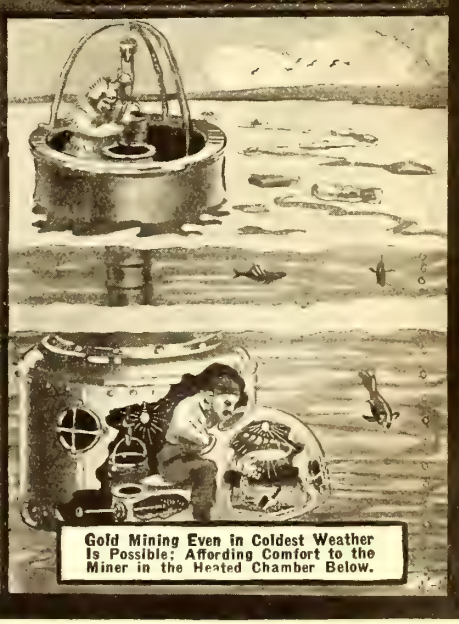
For Sub-Sea Work on Cables and Telephone Lines the Apparatus Offers Untold Improvements.



The Way Such Motion Pictures as "20,000 Leagues Under the Sea" Were Taken—Actual Sub-Sea Photography.



An Improved Method of Obtaining Sponges—Note the Extreme Flexibility of the Tube Itself.



Gold Mining Even in Coldest Weather Is Possible; Affording Comfort to the Miner in the Heated Chamber Below.

(Copyright, 1920, by E. P. Co.)

The Goddard Moon Rocket

SPECIAL AUTHORIZED INTERVIEW WITH THE INVENTOR



EVER since Jules Verne, we have read many proposed schemes how to send projectiles with or without occupants to the moon and to the different planets, but nothing has so startled the world as the recent investigations of Dr. Robert H. Goddard, Professor of Physics of Clark College. This savant has not merely theorized on his invention but has spent years of energetic investigations which prove conclusively and beyond doubt the possibility of building a rocket which could ascend to our nearest satellite, the moon. The description of his apparatus and some of the findings are given in the accompanying article.

There is not the slightest doubt but that a rocket of this nature, or an apparatus of sufficient size would be able to land on the dark side of our satellite. If Dr. Goddard's rocket carried sufficient flash powder its presence could make itself ascertained thru some of the powerful telescopes, which we at the present day, are using. It will not be necessary either to wait many days for any such result. Inasmuch as actual tests have clearly demonstrated the speed of the rocket can be in excess of 230 miles in less than six and a half minutes, the distance of 220,000 miles intervening could be bridged in less than 100 hours.

It is astonishing to note the relatively small initial powder charge necessary to propel a weight of one pound to an infinite altitude, provided of course that the efficiency of the rocket itself is high, the gases that are ejected having an effective velocity of 7,000 feet per second, giving an increase in speed of a hundred and fifty feet per second. Such a rocket requires only 612 pounds of initial mass. How enormous, however, must this initial mass become if we have poor efficiency as found in present day rockets? Suppose that instead of 7,000 feet per second, we had a rocket having velocity of the ejected gases of only 3,500 feet per second. Its initial mass even at starting would then have to be 351,000 pounds. From these figures, it will be seen that if we have an apparatus all set up for sending the rocket to the moon, or further than to the moon, even out to infinity, and the rocket was to travel at 7,000 feet per second, as in actual tests made upon it, we would only require 602 *pounds for every pound that is to be sent to infinity.* Now surely, it does not seem at all improbable that we could build a rocket which would weigh 602 pounds. Furthermore, if this rocket should be filled with flash powder which were exploded automatically upon reaching the dark surface of the moon, it could be observed by the aid of a telescope having a one-foot aperture.

Two and three-quarters pounds of flash powder would be just visible and 13 pounds would be strikingly visible, according to Dr. Goddard. It would be a wonderful experiment to watch this rocket ascend to the moon, and illuminate a small spot on its dark side.

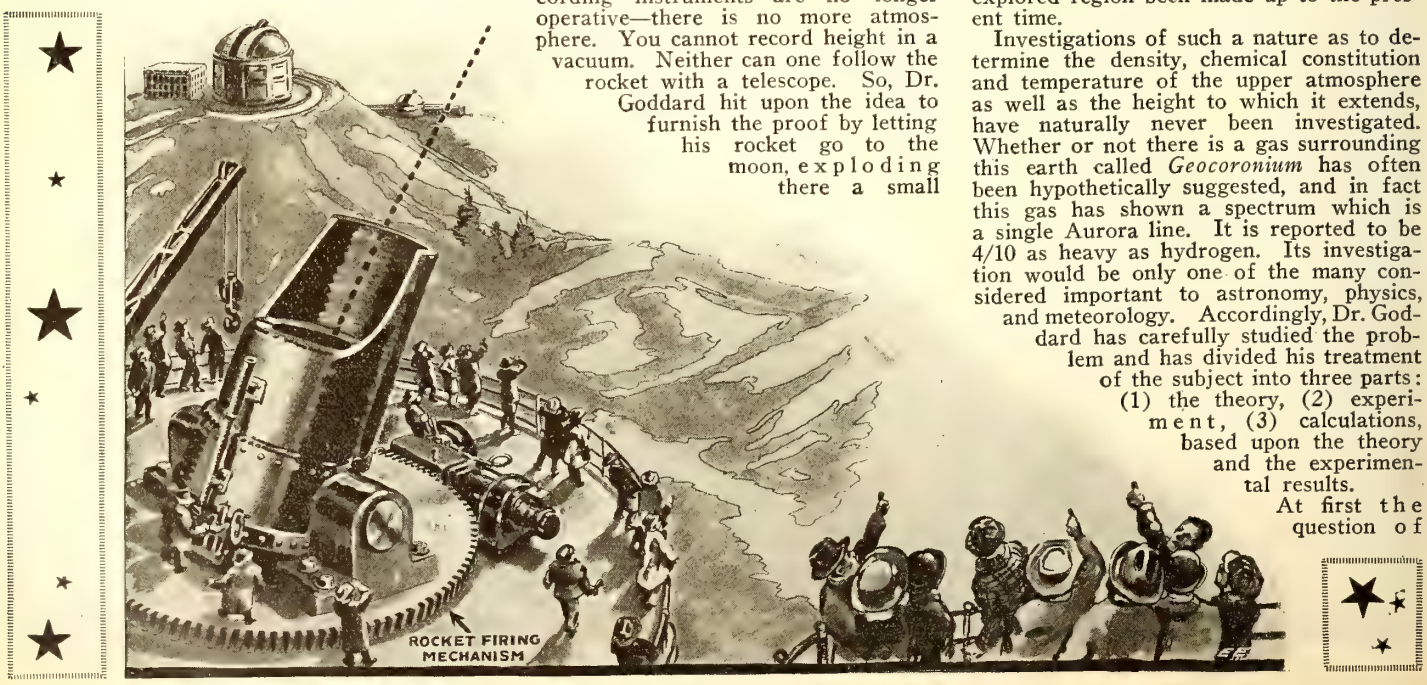
It is for the reason that many people have obtained mistaken conceptions of the principle and purposes of the "Goddard Rocket," that this publication attempts to place it before our readers in as clear and concise a manner as possible, together with its possibilities and results.

Dr. Goddard did NOT start out to build a machine to fly to the moon. He wanted to perfect an apparatus capable of reaching high altitudes of our own atmosphere, in order to explore its many mysteries. The idea of the Professor's rocket landing on the moon was only incidental and came up during his researches. For, once the rocket would reach beyond only 300 miles it would be impossible to prove that it had ascended so high, for at such a height recording instruments are no longer operative—there is no more atmosphere. You cannot record height in a vacuum. Neither can one follow the rocket with a telescope. So, Dr. Goddard hit upon the idea to furnish the proof by letting his rocket go to the moon, exploding there a small charge of flash powder. The effect could then be seen from the earth. That surely would be proof sufficient.

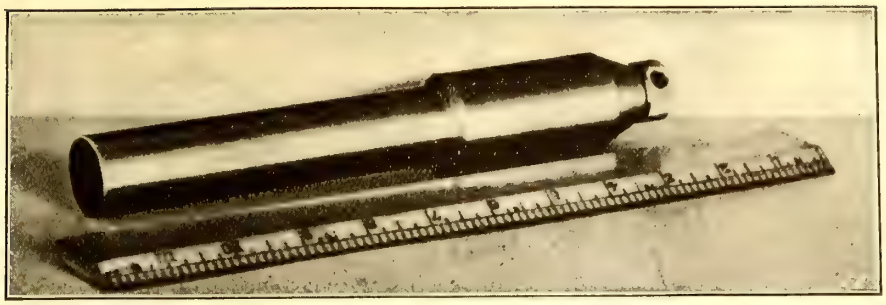
In the past an attempt to reach altitudes of 20 miles or over has been very problematical and doubtful, and only slight enthusiasm was aroused on this subject when the first report and the theoretical and experimental data were submitted to the Smithsonian Institution in 1916 by Dr. Goddard. Sufficient interest, however, by the Institution to set aside $5,000 for future developments caused the inventor to work with zeal and seldomly permitted any publicity of the subject. However, now that the rocket is well under way, and things are running along smoothly, Dr. Goddard thinks that it is well that the world should know more about the apparata which had been used in conducting the experiments and data, and learn something of the results he has obtained. The altitude of 20 miles, as we have said, is a maximum to which sounding balloons have been sent, altho the atmosphere of the earth extends to a much greater height. It is well known how limited our knowledge of the upper atmosphere is, nor has any means for attempting to reach this unexplored region been made up to the present time.

Investigations of such a nature as to determine the density, chemical constitution and temperature of the upper atmosphere as well as the height to which it extends, have naturally never been investigated. Whether or not there is a gas surrounding this earth called *Geocoronium* has often been hypothetically suggested, and in fact this gas has shown a spectrum which is a single Aurora line. It is reported to be 4/10 as heavy as hydrogen. Its investigation would be only one of the many considered important to astronomy, physics, and meteorology. Accordingly, Dr. Goddard has carefully studied the problem and has divided his treatment of the subject into three parts: (1) the theory, (2) experiment, (3) calculations, based upon the theory and the experimental results.

At first the question of

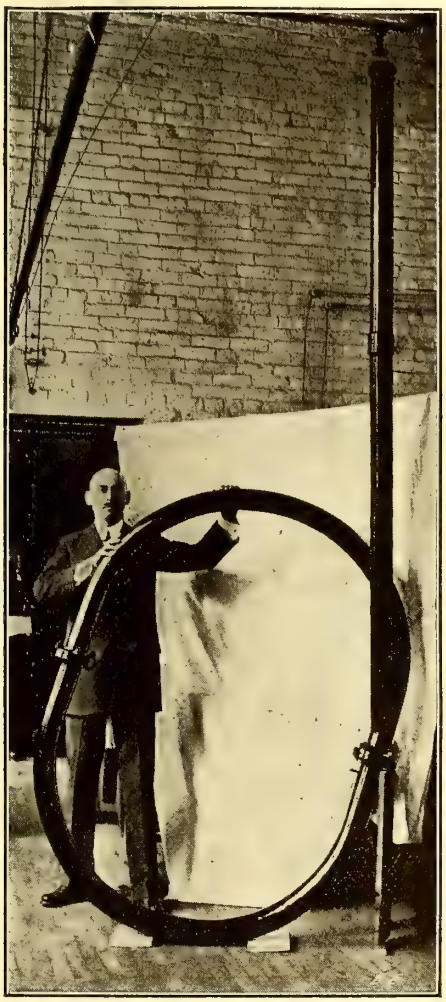


what method was to be employed, was taken into consideration, and decision finally crystallized in the form of a rocket. Inasmuch as a maximum amount of energy necessarily had to be obtained from a minimum bulk of matter, much thought was given as to what substance would liberate such a large amount of energy, at the same time being sufficiently controllable, so that the rocket's explosions would not shatter the apparatus completely.



The Actual Rocket Used By Prof. Goddard in His Laboratory Tests.

An ordinary rocket, however, rises to but a very limited altitude; the powder which furnishes the energy forms only a fraction of the total mass of the rocket and only a portion of this energy is converted into real kinetic energy. This kinetic and potential energy is necessary in order to supply the force to raise the rocket. The ordinary rocket and the Coston rocket is as inefficient as a poor heat engine, and Dr. Goddard proves this by various experiments. It has been found that powder in the ordinary rocket consists of ¼ or 1/5 of the total mass, and its efficiency being only about 2 per cent, the average velocity of the gases expelled was about 1,000 feet per second. Even the Coston ship rocket which is used for signaling on board ships, and which has a range of at least ¼ mile, was found to be very inefficient. Experiments with the rocket invented by Dr. Goddard have shown that the efficiency has been increased to 64 per cent by changing the powder used on other rockets to dense smokeless powder. This is placed in a strong steel chamber provided with nozzles separably fitted, these nozzles having smooth tapering sides. The highest average velocity thus obtained by simply changing the mechanism and the charge was 8,000 feet per second.



Prof. Goddard and His "Vacuum" Pipe, by Which Tests Simulating Those in the Upper Atmosphere Were Made With His New Rocket.

The idea was to have most of the mass propellant, that is to say the efficiency of the rocket would be greatly increased if the contents would be about fifteen times the weight of the rocket and consist of propelling material. It stands to reason and it is quite easy to see that a mass of propelling material will naturally permit the rocket attaining greater speed and higher altitudes, and yet no attempt has been made to improve the ordinary rocket used for signaling purposes and fireworks exhibitions.

Another principle has been incorporated in the Goddard idea whereby a secondary rocket would be fired from the first rocket after it had reached a certain altitude, so that the weight in both would consist largely of propellant matter, and when the smaller charge of powder was left, the larger mass (dead weight of chamber holding previous charges) would drop off as dead weight.

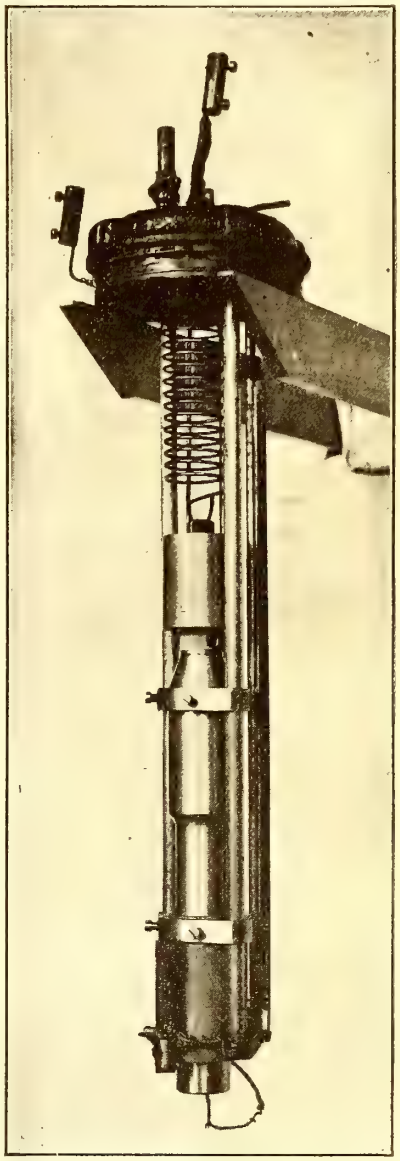
EXPERIMENTS.

Experiments were conducted along these lines of reasoning and the results are absolutely and thoroly accurate. Dr. Goddard has gone into the subject more deeply than an experimenter would. He has clearly demonstrated with photographs and data the possibility and plausibility of his ideas.

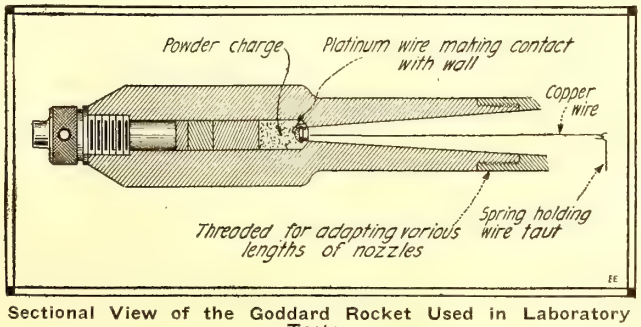
In order to obtain the velocity required, it was necessary to radically improve the form of rocket. Both the Coston ship rocket and the common type rocket used by boys on the Fourth of July are impractical and measurements obtained with a ballistic pendulum showed this to be so. In order to obtain the high velocity required therefore, several innovations were made. First—the employment of a stronger powder; dense smokeless powder was used, as it permitted of a much higher heat value than the ordinary black powder usually employed in the common rockets.

It was next desired to obtain very high pressures and a steel chamber was used for this purpose. Added to this was an addition to the rocket of a new type of nozzle, so that the work of the expansion of the gases would be available.

A small steel chamber was finally evolved. During the process of this work a model was constructed which could be readily reloaded and fired by electricity; readings on a ballistic pendulum and by direct lift showed an ejection velocity up to nearly 8,000 feet per second in the air for the new rocket. Now, the great question arose as to what would happen if the explosions could be continued without interruption until the rocket reached the higher altitudes, where obviously, there is no air. *Would the force of the charge have sufficient kick-back against this highly rarefied air to cause the projectile to continue in its course?* Accordingly a series of experiments were started and the results were even greater than those obtained in air, that is to say, the rocket was mounted in a vertical position, so that expelled gases were shot downward and the chamber moved upward by *reaction.*



The Goddard Design of Aerial Rocket Mounted in Recording and Firing Head, Which Could Be Attached to Vacuum Chamber Shown at Left.

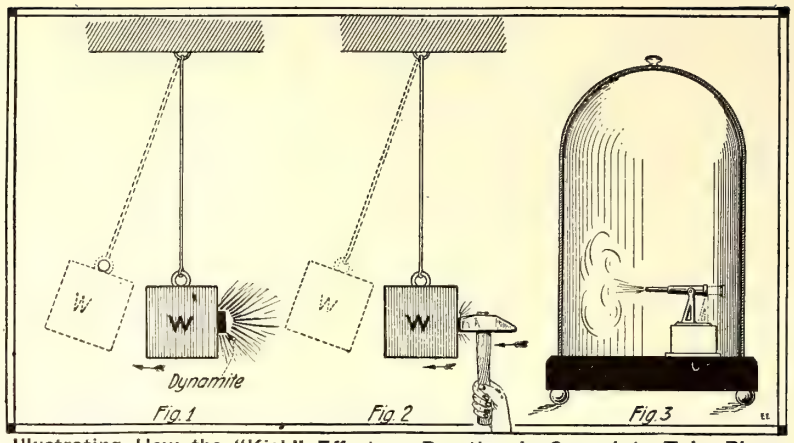


Sectional View of the Goddard Rocket Used in Laboratory Tests.

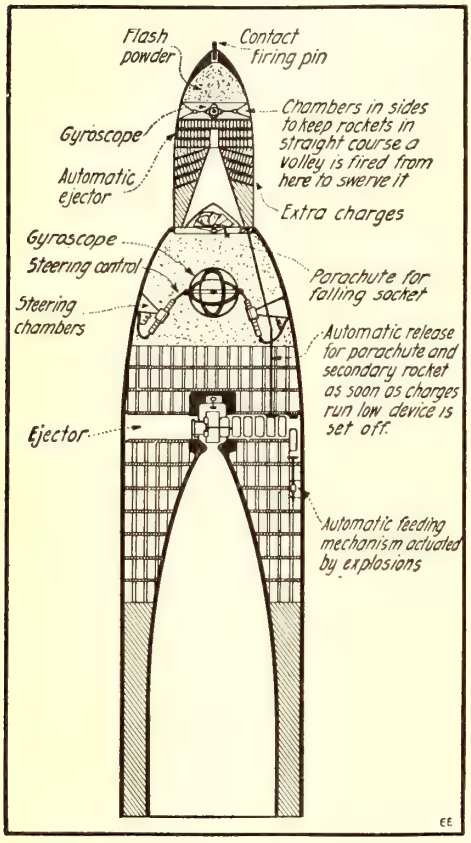
The rocket was mounted in a system which permitted it to be

suspended from a steel spring. A smoked glass plate alongside with an indicator showed exactly to what extent the rocket was propelled upward. The entire system was now mounted in a long tube-like chamber from which the air was exhausted. In the bottom of this chamber some very fine wire screening was coiled around in a spiral form, lying upon criss-cross screening, so as to scatter the force of the explosion and prevent any rebounding if possible. In this way, *only the actual kick-back effect produced* upon the rocket by the discharge, would be recorded. If this were not done, it is obvious that the gases striking the bottom of the tube, would be reflected and cause the rocket to move upward perhaps sufficiently to add quite something to the record obtained. In addition an *impulsemeter* was placed in the chamber to record any rebound. This was simply a thin pencil of lead with a flattened end mounted in a glass tube and suspended by a spring in the top of the chamber, so that if any gas was *reflected*, it would record on the impulsemeter. The readings on the meter were so minute that for ordinary discussion they would not even need to be taken into consideration. Thus the coiled mesh screening acted as a wonderful damper to prevent the mass of gas from being reflected and shot backward.

Notwithstanding the fact that these results would tend to impress even the credulous mind and convince them of the possibility and probability of the scheme, Dr. Goddard devised still another scheme, what he terms a *friction brake*. This consists of a large hollow wheel of iron with a pipe leading to its inner surface so that when an explosion occurs, it will cause the gases to come down on the inner side of this coiled pipe and the force of the explosion makes the gases travel to the outer surface of the oval tube, in this way dispersing their effect by the centrifugal force formed and preventing any reaction on their part by reflection.



Illustrating How the "Kick" Effect or Reaction Is Caused to Take Place, Even in a Vacuum. A Gun Fired in a Vacuum "Kicks," the Same As in Air.



One Proposal for a "Moon Rocket"—Successive Charges Are Fired by a Machine Gun Action. The Lower Rocket Drops Off After Its Charges Are Exhausted.

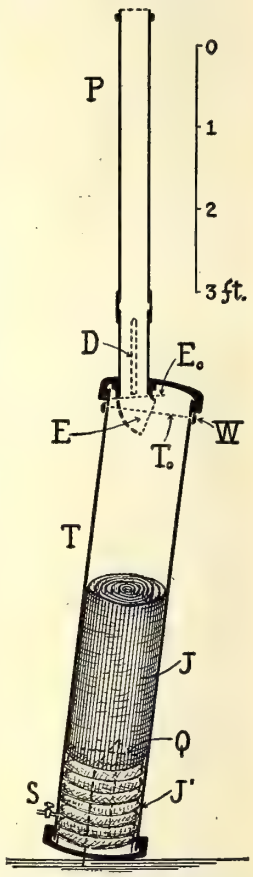
In both the above experiments, the air was completely exhausted from the chambers in which the rockets were being tested by means of a stopcock. The circular testing tube shown in the accompanying photograph, weighed about 200 pounds and was 10 feet high. It consisted of a straight pipe, carefully fitted and welded to two sections of U-shaped pipe. In this way, the gases which were shot downward from the rocket in the straight portion, entered the circular part and passed around, due, as has been said, to the velocity and the centrifugal force, not returning up the pipe again, until of course, the energy was greatly reduced and affecting any record which the rocket itself might be making. Here as in the previous experiment, method of detecting gaseous rebound was employed. *It was found that the rocket had a greater velocity in a vacuum than when the same experiment was tried in air,* using the same chamber, same mass of powder and the same nozzle. The medium and short nozzles gave better results in vacuo than in air, but very little difference was noted when a long nozzle was employed, provided Du Pont powder was used. With other powders different figures were obtained.

In the cylindrical testing tube, which was used, an item of interest was noted in that when the explosion occurred the sound of the report resembled a sharp blow of a hammer on the cap of the pipe. With the results from this apparatus, it was seen that a body of this nature could travel through a vacuum, and make very good speed as the results of Dr. Goddard's experiments clearly show a possibility of obtaining a speed of 7,680 feet per second.

The fact that the velocities are higher in vacuo—as much as 22 per cent—than in air may be due to conditions of ignition quite different from those in air; and also due to the fact that there is no air to interfere with the stream lines of the gas. Photographs taken clearly show that the gas is really a jet having an extremely high velocity and is not merely a reaction against the air. This velocity depends a great deal upon the manner of loading, ignition and forms of nozzle; hence, in practice, care is taken to test out all forms of rockets.

A very peculiar feature of these experiments, demonstrate that an efficiency of fully 64 per cent can be obtained from this interesting engine, if we consider it as such. This is a good deal higher than any gasoline engine or internal combustion machine, the efficiency of which is about 45 per cent, and the best steam engine offers an efficiency of slightly over 21 per cent. It is doubtful whether any engine or turbine could compete with this type if it is considered as such. The highest velocity obtained exceeded 1½ miles per second.

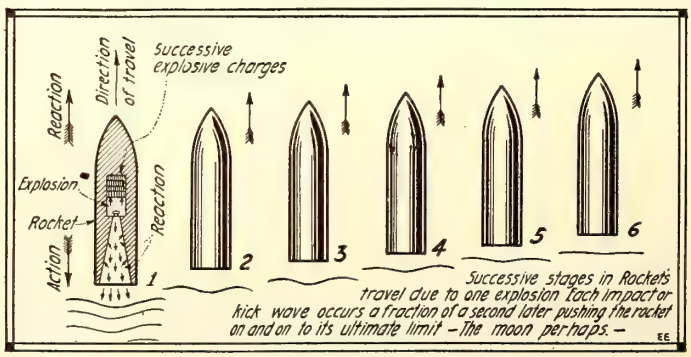
Experiments are now going on, which attempt to decrease the weight of the rocket itself, using a method of reinserting charges which are exploded periodically by machine gun like action. It is likewise the purpose of the inventor to have the mass of propellant material very large, so large in fact that the weight of the rocket itself and the accompanying mechanism will be a comparatively negligible quantity.



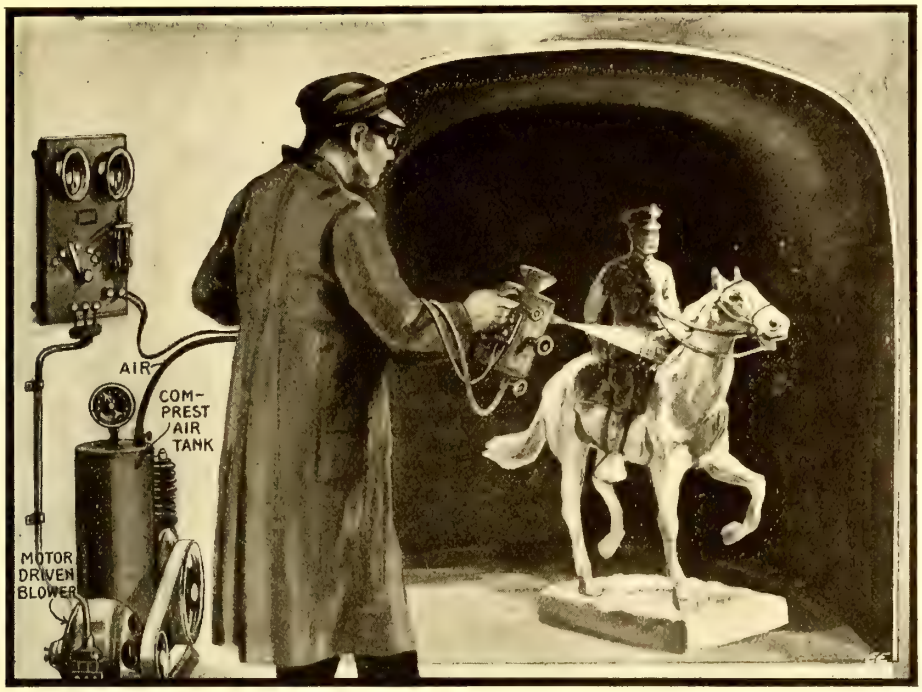
One Form of Steel Tank Into Which the Rocket Was Fired to Simulate High Altitude Conditions.

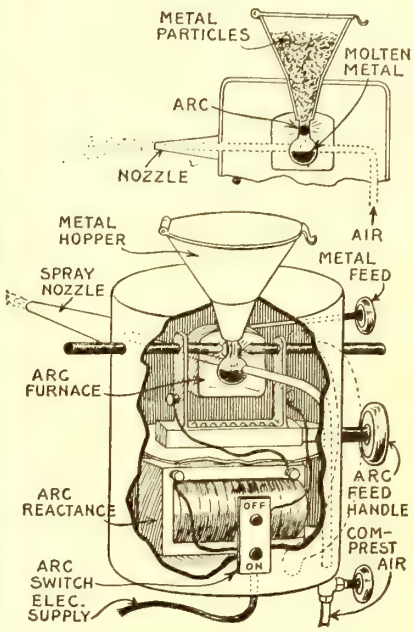
By applying these findings to further experiments for obtaining altitudes greater than the earth's atmosphere, some method must be arranged to bring any recording instruments safely to the ground again after the rocket has reached the desired altitude. For this purpose a small parachute is employed, as it can fall with remarkable speed in and thru the thinner strata of air, but when it reaches the denser areas it falls much slower and finally comes to a resting position without a thud. Hence practically instantaneous reports could be obtained as

(*Continued on page* 1048)



An Explosive Force Wave Will Push Any Obstacle, As a Rocket, in the Direction of the Expanding Waves, Even in a Vacuum.





The Wonderful New Compress Air System of Plating Any Object with Metal to Any Desired Thickness. The Metal to be Plated on to the Object Is Placed in the Hopper of the Electric Arc Heater, Whence It Descends Slowly Into the Arc, Where It Is Instantly Melted and Then Blown by Compress Air Thru a Suitable Nozzle Onto the Object to be Plated.

Plating By Compress Air

A well-informed correspondent, Samuel Crowther, of *The New York Tribune,* lately returned from Germany, observed a method of plating metals, in which compress air was employed. This machine for plating, the correspondent declares, is very highly regarded by the Germans. The surface to be plated is cleaned with chemicals and then a thin sheet of the plating metal is blown on with a device resembling a hand torch. The torch contains a small electric furnace which reduces the plating metal to a liquid and thru the connection with a tank of compress air the molten metal is sprayed onto the surface. See accompanying sketch.

By this method, gun metal, brass and copper were put on iron or steel for such parts of machines as required it, the coated metal parts being used instead of solid gun metal, brass and copper. This saved large quantities of these three products when they were exceedingly scarce in Germany.

This particular compress air and electric furnace plating scheme is portable and declared to be most convenient in usage. It is expected by the Germans to have a permanent and wide use in the coating of ships' bottoms, tanks and other large structures where the plates cannot be plated before erection. In fact, Mr. Crowther reports, it constitutes a new variety of metal painting arrangement.

The well-known Schoop process is said to be about eight years old and is capable of depositing lead, tin, zinc, aluminum, copper, nickel and their alloys on any coherent object, whether metallic or not. The thickness of the coating is under instant control and the application can be limited to any portion of the object.

The difference between the original Schoop method and that described by Mr. Crowther is that the former involved the use of a "pistol," air at 40 lbs. pressure, a tank of hydrogen and another tank containing some reducing gas, usually oxygen, acetylene or blau-gas, the metal to be applied being liquefied in flame; whereas in the latter a small electric furnace is utilized to make the metal molten before it is projected by the air pressure.

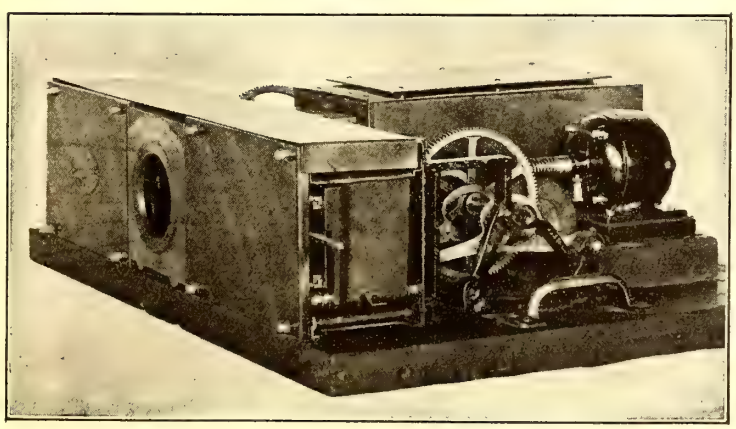
The Schoop process has been used in the United States to some extent, but is still susceptible of considerable development Here its use is said to have been wholly for its convenience in ordinary practise and not as an economical expedient.

New Automatic Stereopticon

The Owen Automatic Stereopticon demonstrates a new use of electricity, and is a simple device that can be carried in a suitcase, costs little to operate, has nothing to wear out or replace, and will last practically a lifetime.

Its essential parts are a 1,000 candlepower, nitrogen tungsten projection lamp, condensing and objective lenses, a screen upon which the pictures are to be projected, the necessary slides, and a small electric motor to be attached to an electric light socket, and which operates by either direct or alternating current.

The usual size projects forty-six slides upon the screen, allowing each to remain in position twelve seconds, when it is automatically replaced by the next. Machines which project one hundred, two hundred or more slides may be built to order.



This New Automatic Stereopticon Has a 1,000 C. P. Tungsten Lamp, and 50 to 100 Slides or More, May Be Changed Successively and Automatically.

The picture may be shown either large or small by merely varying the distance of the objective lens from the screen. The projection is in the form of a cone with the small end at the lens, and the large end on the screen, and the farther the screen from the machine, the larger the picture.

This automatic stereopticon is invaluable for store and window advertising. — *Photo courtesy General Electric Co.*

Suspending Gravitation

By H. GERNSBACK

COMING INVENTIONS No. 4

FOR millions of years the human race has been reared on a planet upon which gravitational effects may be termed as being fairly high. All the various effects produced by the mass of the earth, not only on every human being, but upon every object as well, are so ingrained into us, and we have grown so accustomed to them, that it appears to us the most natural thing in the world when a stone drops or an apple falls from the tree.

We seldom try to fathom why such gravitational effects do occur, and until Newton first propounded his immortal work on gravitation, even deep thinkers did not clearly understand why a stone released from the hand should strike the earth with a thud. Even today few people realize what gravitational effects are. They will give you an off-hand answer, saying "Oh, yes! A stone falls downward because the earth's gravitation attracts it," and leave it go at that. But how many have ever given a thought to the idea what would happen to all of us if gravitation suddenly ceased?

Gravitation is not the same on all planets of the heavenly bodies. We have described in previous articles in this magazine the effects produced upon heavenly bodies smaller than the earth, where consequently the gravitation is reduced as well. For instance, a man who on earth weighs 150 pounds weighs only 25 pounds on the moon. On the little planetoid Eros, which has a diameter of only ten miles, the gravitational pull is practically nothing. Thus, the 150-pound man on this planet only weighs 2 ounces instead of 150 pounds. From this follows that *weight* is only a term conceived in our brain. It is only fairly stable on the earth. Remove the earth and you would be absolutely weightless, there being no gravity, except, of course, for the attraction of the sun or other heavenly bodies, if you came within their influence.

As Professor Einstein so aptly put it in a recent interview: "Take this house and remove the earth to an infinite distance. What happens? The house as well as the objects contained therein will weigh nothing out in space. Our bodies would float in the air providing air was retained in the house. We could just as well walk on the ceiling as along the sides and bounce from ceiling to the floor; it would be all the same. For in space there is no up or down, and the word 'weight' has no meaning."

Recently a cable dispatch from Rome brought the announcement that Prof. Maiorana discovered that lead balls swimming on a pool of mercury lost a certain amount of weight. It was explained that the weight was lost due to a *screening effect* which the mercury produced on the lead ball. In other words, *mercury acts as a sort of insulator against the earth's gravitational waves.* For gravitation certainly is propagated the same as other forms of energy, i.e., in wave-form.

Prof. T. J. J. See, famous investigator of Mare Island, California, in an address before the California Academy of Sciences, announced recently that his researches on gravitation in 1917 and his latest researches on molecular forces confirmed Maiorana's claim that the screening of gravitation has been shown to exist. "In 1917," says Professor See, "I explained the fluctuation of the moon's main motion by the circular refraction of the sun's gravitation waves, as they are propagated thru the solid body of our earth at the time of lunar eclipses. I found also from dealings with capillary forces that quicksilver is indeed very resistant to the waves which produce molecular action, and this developed a new theory of the depression of the mercury in capillary tubes. This would tend to confirm Maiorana's claim that a basin of mercury beneath a suspended mass of lead may decrease the gravitation of the lead by a small amount. My researches on ether show conclusively that gravitation is due to waves in the ether, and certain very resistant bodies in the line of action may thus introduce a slight screening effect."

This reasoning opens up new avenues of thought of what may be accomplisht in the future when we have found *a perfect screen against gravitation.* Let us go back to our famous Newton experiment of the falling apple.

Suppose we find some means of interposing between the apple and the earth a screen which effectively cuts off *all* the gravitational effects *above* it. Then suppose we attempt to let the apple drop. *It will no longer drop because we have neutralized gravitation.* Of course, so far no insulator of gravitation exists, but that does not mean that one will not be found sooner or later. Let us now cite a very simple analogy.

Fig. 1 shows a powerful electro magnet. It will, let us say, attract one hundred pounds of iron. This is shown at A, which represents a mass of iron. The instant the current is turned on the mass leaps forward to the magnet, which will hold it attracted as long as the magnetism acts.

Turn to Fig. 2. Here we repeat the same experiment, but between the magnet and the iron mass A we interpose a thick sheet of copper. The magnet still acts on the mass A just as if the copper piece B were not in existence. In other words, the magnetism passes right thru the copper mass just as your apple will be attracted by the earth, even should you interpose a sheet of copper between the apple and the earth. Gravitational effects will still flow thru the copper as if it were not there, exactly as is the case with our magnet.

If, in Fig. 2, we substitute various other bodies we find that, with one or possibly two exceptions, the effect will always be the same. If the copper sheet B is removed and instead of it we substitute a slab of marble or a plank of wood, or most any other substance, the effect will still be the same. The iron mass A will still be attracted by the magnet, the magnetism passing right thru the marble, thru the glass or thru the other substances, just as if they were not there. *All these substances act to magnetism just like a sieve acts to water.* It makes no difference if our sieve be made of copper, glass or any other substance, the water runs right thru it, as we well know. So with magnetism and the various substances.

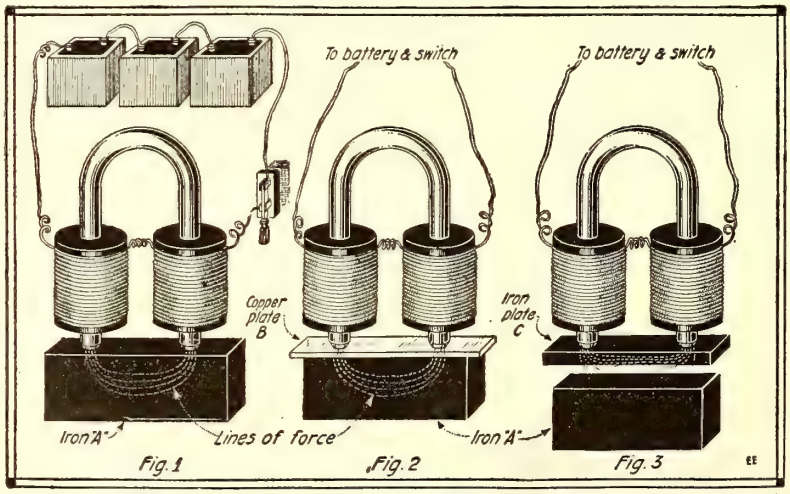
Now turn to Fig. 3. If instead of our copper sheet, we now substitute a thick *iron or nickel* plate, C, our magnet will no longer attract the iron mass A. Why not? For the simple reason that iron and nickel are about the only magnetic substances we know of. In other words, our magnetic lines, instead of attracting the mass A, now attract the iron plate, and effectively short-circuit what we call the *lines of force* emanating from the magnet; for this reason no magnetism worth mentioning reaches the block A. As seen in Fig. 3, altho the current is on, the mass A is no longer attracted. What have we accomplisht in this experiment? Simply this:

We have effectively placed a *screen* between the magnet and the mass A. In other words, the iron plate C no longer acts like a sieve, because it does not let pass magnetic lines of force, *but absorbs them.* Just as if our sieve mentioned above was made of blotting paper. We know that blotting paper has many fine pores, and altho acting as a sieve in a way, we keep the water from rushing thru it because now the sieve, strictly speaking, does not act as a sieve any longer, i. e., it *absorbs* the water.

The same with gravitation. If we can find a means, and I predict that such a means will be found in less than one hundred years, to effectively screen gravitational effects, the most wonderful era will have dawned upon humanity.

We know today that gravitational effects are mainly electrical. We already described in our March 1918 issue (page 743) of the ELECTRICAL EXPERIMENTER, Professor Francis E. Nipher's historical experiment conducted at the St. Louis Academy of Science, in which he actually demonstrated that *electricity acting upon lead balls effectively reduces gravitation.* This certainly proves the correlation between electricity and gravitation, and at a not far distant date I predict that a way will be found to entirely nullify all gravitational effects by means of electricity.

Suppose someone perfects a gravitation screen, a metallic or other screen which is



This Illustration Is Given to Show an Analogy Between the Attraction of Magnetism and the Attraction of Gravitation. In Fig. 1 the Iron A Is Attracted to the Magnet. In Fig. 2 Although We Interpose the Copper Plate B, the Iron A Is Still Attracted Because Magnetism Passes Through Copper the Same As Water Through a Sieve. But in Fig. 3 the Iron A Is No Longer Attracted Because the Iron Plate C Now "Insulates" the Iron A from the Electro-Magnet. The Electro-Magnet Now Is "Short-Circuited." If We can find a similar "insulator" for gravitation, then if you release a stone from your hand, it will no longer fall to the earth as long as the gravitation "insulator" is interposed between the hand and the stone.

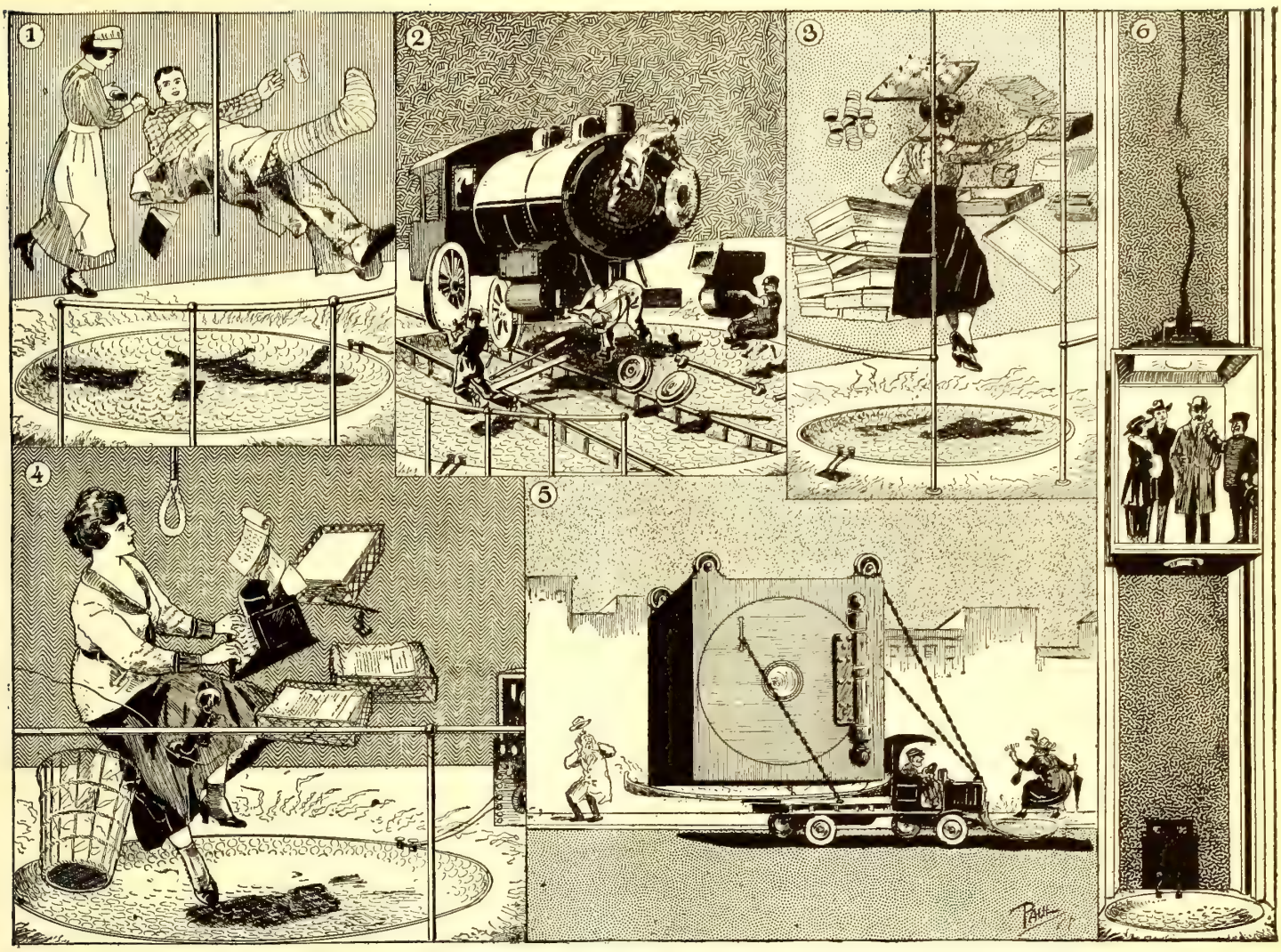


Fig. 5.—Several Applications Showing What Happens When We Have Discovered a Gravitation "Insulator." 1. Shows a Patient Who No Longer Requires a Bed for Resting; He Stays Suspended in the Air. 2. Shows a Locomotive Being Assembled Without the Necessity of Electric Cranes and Winches. The Locomotive and Parts Weigh Nothing, Hence Will Be Assembled in a Fraction of the Time Required to Do This Now. 3. Factory Scene Showing Operator Assembling Goods Practically Without Effort. Note That Her Work Is Spread Over Different Planes. 4. This Is What Your Future Office Will Look Like. The Disorder Is Only Apparent. The Typist Will Keep Her Basket and Papers, Etc., In Most Accessible Positions. There Will Be No Fatigue, and Work Will Be Like Play. 5. How a Very Large Safe Can Be Moved By a Very Small Truck. The Safe Being Weightless, It Can Be Moved Without Effort. 6. When the Elevator Cable Breaks, No Harm Is Done, for the Elevator and Occupants Weighing Nothing, Cannot Drop Down the Shaft, Due to the Suspended Gravitation.

laid flat upon the earth. It is then charged by means of a certain form of electricity as depicted in Fig. 4. The screen here shown is made of round circular discs invented by Nikola Tesla, because round discs, when used in connection with tremendous high frequency currents, do not cause such great loss by radiation in the atmosphere as if a single sheet or net were used. The screen suggested would be in the form of a shallow sauce-pan as shown.

As soon as energized in the correct manner all *gravitation above the screen will be shut off*. In other words, any object placed above the screen no matter how high above it will become weightless. It will have mass but no weight. Suppose two lead balls were suspended above the screen. These would of course not drop down to the ground now. They would stay freely suspended, but a curious thing would happen. These two balls if placed near enough together would gradually draw together and finally collide, because each sphere according to Newton's law of gravitation would now be a "planet" by itself, and one sphere would act upon the other. The effect however, would be extremely slight; all *in proportion to the size of the balls.* This experiment is only mentioned because it should be borne in mind that in the other examples which follow, there will be *mutual gravitational attraction* between the various bodies floating in the air such as shown in Fig. 4.

For instance, there will be a certain amount of gravitational attraction between the man and the little foot-stool. This effect, however, is so negligible that at the distance shown in the illustration, there would not be enough gravitational attraction between the two bodies to attract each other sufficiently to make one object move to the other.

Let us now see what happens, when gravitation is suddenly suspended. Fig. 4 and our cover illustration shows this graphically. There being no weight whatsoever, the two persons shown can move their hands and bodies any way they wish without the slightest effort. They can assume any pose they desire and they will stay suspended, hanging as it were, fixt in space, unless they jerk themselves out of their position into another one. It will be seen that the little foot-stool hangs suspended in a curious



Fig. 4.—A Reproduction from Our Front Cover Drawing, Showing What Happens to You At Dinner When Gravitation Is Suspended. The Girl, By the Way, Is Not Blowing Bubbles, But Is Drinking a Grape-Fruit Highball, Which, of Course, Weighs Nothing. The Ball Formation Is Caused By Surface Tension, Which Causes Liquids to Form Into a Sphere. This Is the Same Principle That Makes Small Drops Perfectly Round.

position. The lady just gave it the very slightest kick, and it immediately collided with the gentleman's leg, only to bump back again towards the lady's feet; this would have kept up indefinitely, were it not for the resistance of the air, which after a few oscillations stopt the foot-stool in the position shown.

How did the lady and the gentleman as well as the different table utensils come to be in the position as shown in our illustration? Before the current was turned on they were seated at a table in the usual manner with the objects on the table. The current was then turned on, effectively making the two human beings as well as the table and the other objects weightless. Holding on to the table, both slightly pusht against the electrified screen and immediately both table and everything else went sailing a few feet into the air. If the push had been too hard they would have landed with their heads against the ceiling, so the push necessarily had to be *very* slight. An attendant then came along and pulled away the tables and the chairs with the resulting effect shown in the illustration. The objects could no longer fall, and therefore remained in the positions shown.

The gentleman now wanted to smoke and removed the matches and cigarettes "laying" beside him. After he had removed his hands from them, *the objects remained just where he left them.* They could not of course fall. The lady then profest a desire to have a grape-juice highball. Her companion took the glass containing grape-juice, turned it upside down, *but not a drop came out.* There was no gravitation, hence the liquid could not flow out of the glass. Then he simply *jerked* away the glass with a quick movement, and the grape juice came out of the glass *by reason of its inherent inertia.* Due to the *surface tension* present in all liquids, the grape juice immediately formed itself into a small sphere. Surface tension in liquids always tends to produce balls of any liquid, as you may easily convince yourself by spilling drops of water on a cloth, and particularly velvet. You will see that the drops form themselves into perfect spheres. But drop a glass full of water on the velvet and it will spread all over. Why? The gravitational effect of the earth interferes with the surface tension and is sufficient to prevent the water from forming itself into a *big* sphere. In other words, in dropping water, *only small spheres can be formed,* because on them the gravitational effect is small, and not sufficient to overcome the surface tension of the liquid. But where no gravitation exists as in our illustration, you can readily take a bucketful of water or any other amount and after jerking the pail away, the water will remain suspended in the form of a sphere.

After the gentleman in our illustration had shown the effect to his companion, he proceeded in the manufacture of the grape-juice high-ball in a novel manner. Instead of mixing the grape juice in the glass, he simply took the siphon which was handy and squirted the seltzer right into the sphere of grape juice while the lady stirred it thoroly by means of her straw. During this operation the sphere did not stay perfect, but wobbled a bit just like a soap bubble wobbles and contorts when we blow against it. The second she ceased stirring, the whole formed itself into a beautiful light purple sphere—the grape-juice high-ball was ready for consumption. She applied the straw to it and drank from it as shown in the illustration.

En passant we might mention that if the lady is fond of spaghetti, she will have no trouble whatsoever to eat it, for it will certainly not fall from her fork, and if it should slide because of its being slippery, it certainly will not fall on her dress. Neither need she fear that her egg would bespatter her, for it would not slide from her fork onto the dress.

A curious thing that these two people find immediately is that literally *they will tread on air.* Their bodies have no weight whatsoever, and therefore nothing will seem heavy to them and all movements will be accomplisht with the greatest ease. An arm left in a certain position, as for instance, the gentleman's arm in the illustration, will stay in the position shown. It will not fall to his body, for it has no weight. It will be a delightful sensation for our weary bodies if we succeed in suspending gravitation. Always remember that *most tiredness is produced mainly by the great weight of our bodies.* Take for instance our feet and legs which have to support the weight of our bodies. Our shoulders and backs become tired because they support our heavy heads and body. Hence, when we stretch out in our beds in the evening, we immediately reduce the gravitation because then our feet and backs do not have to support the total bodily weight any longer.

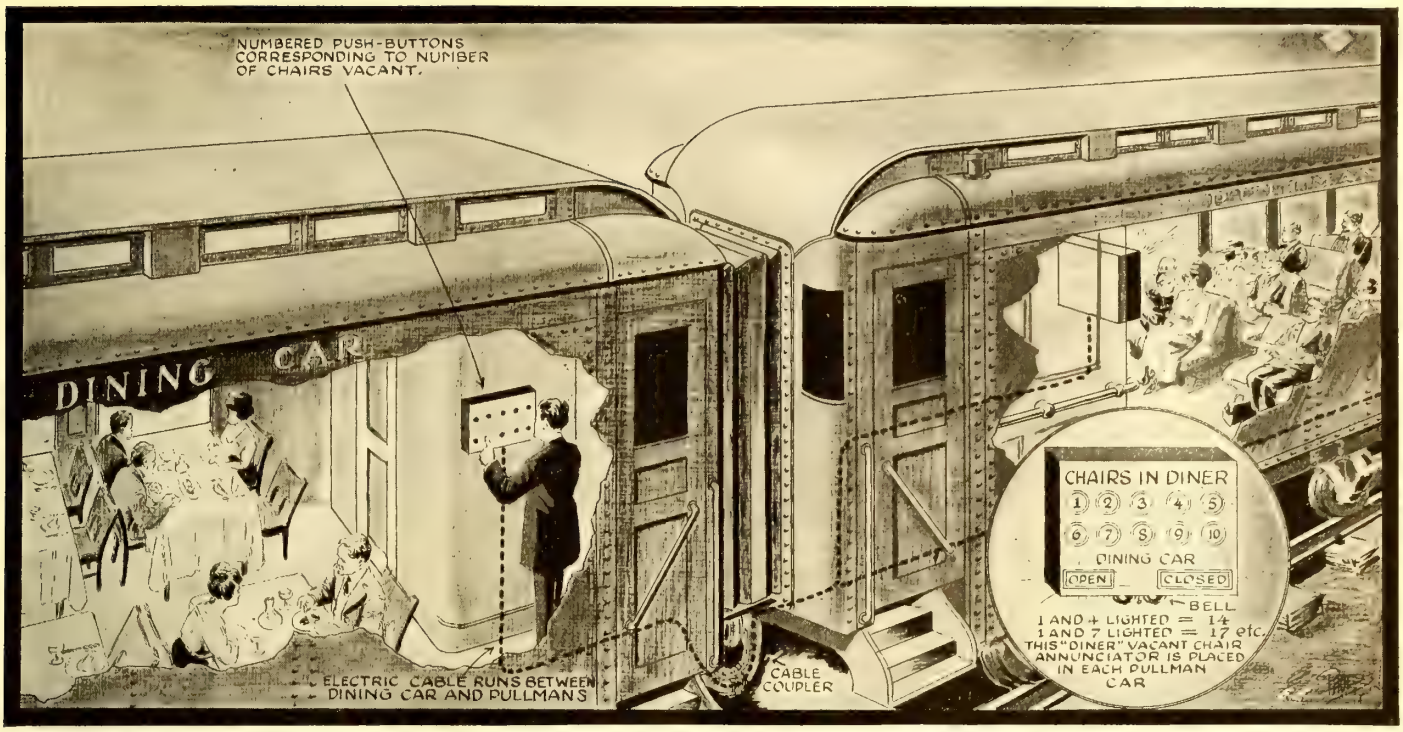
One important thing we must remember in this experiment. If the sun or the moon were overhead and if the room were open, all objects would immediately rise skyward, due to the attraction of the sun or moon if overhead. The two human beings shown in our illustration would then float a considerable distance upward until the wind blew them *beyond the limits of the screen,* when of course they would be dasht to earth and probably killed. This experiment if conducted will have to be made in a closed room, or at least one with a ceiling.

If we wish the objects not to bump against the ceiling, *if the sun or moon are overhead,* it would then be necessary to have an electrified screen *under* the ceiling as well, in order to cut off the gravitational effects from the sun or moon as the case may be. Then the objects would stay readily suspended in mid-air. The reader may wonder how the two people will get down again to *terra firma.* The current is gradually re[illegible] the gravitation will make itsel[illegible] and the bodies will settle dow[illegible]

(*Continued on page* 105)



A Reproduction from Our June, 1915, Issue, Illustrating Mr. Gernsback's Story, "Baron Munchhausen's Scientific Adventures." The Scene Shows What Happens to the Occupants of an Interstellar Space Flyer. As Soon As the Machine Gets Out of the Gravitational Influence of the Earth and Moon All Objects Inside Become Weightless. The Ceiling or the Walls Are All Alike and You Can Walk on Either of Them. A Slight Jump and You Will Bump Your Head Against the Opposite Wall. You Can Get a Refreshing Sleep by Stretching Out in Mid-Air in Any Position You Desire. You Cannot Fall. A Recent Statement by Professor Einstein: "Take This House and Remove the Earth to An Infinite Distance. What Happens? The House As Well As All Objects Therein Will Weigh Nothing and Our Bodies Would Float in the Air. We Could Walk As Easily on the Ceiling As Along the Sides. In Space There Is No Up or Down and the Word 'Weight' Has No Meaning."



Yes, Yes! It Just Had to Happen Some Day! No Longer Will You Have to Walk Thru a Half Dozen Pullman Cars to the "Diner" and Find That You Have To Stand, With a Dozen Others, For Possibly Twenty Minutes Before Being Seated. This New Dining Car Annunciator, One of Which Is Located In Each Pullman, Indicates At All Times the Number of Dining Car Chairs That Are Vacant.

At Last! A Dining Car Annunciator

HAVE you ever traveled any appreciable distance on railroad trains, and been surprised at the unscientific manner in which the dining car service is handled? What we mean to say is—have you ever chanced to be one of a group of 15 to 20 hungry persons who have probably walked about 6 or 8 cars ahead, or to the rear, and found yourself compelled to stand for 20 minutes or more before you were seated? If you are a traveler, undoubtedly you have, and it was on a recent Western trip that the writer had the happy idea strike him to suggest the use of an electric annunciator for indicating in each Pullman car approximately the number of chairs empty at any time in the dining car, and also when this car is opened and closed for service.

The accompanying illustration shows the whole idea in actual operation. In view of the fact that railroad companies have seen fit to place electric berth annunciators in each Pullman car, with numbered indicators for each berth in the car, in order to inform the porter which berth the call comes from, it would seem a reasonable and useful innovation if they were to adopt this dining-car annunciator.

The other features of this electric annunciator system for indicating to the passengers in each Pullman car the approximate number of chairs vacant from time to time in the diner, are as follows:

There is one annunciator, fitted with electric call bell, placed in each Pullman, and all of the annunciators are controlled by the same wires from the master keyboard in the dining car. The dining car chief periodically pushes one of the numbered buttons on this keyboard, which causes an electric light to flash up behind the corresponding number on each of the annunciators. We will not enter here into a discussion as to how the total number of vacant chairs at any one period are to be apportioned to the passengers in the various cars, for there are several effective ways in which this could be handled.

The chief might, for instance, divide up the total number of vacant chairs among the total number of Pullmans, and push a button for each car which would cause the annunciator in each case to indicate the number of chairs vacant for that car.

It would seem, however, a generally satisfactory plan to have the chief select a mean average and take a chance that probably at one time a lesser number, and at another time a greater number, of pasengers would come to the "diner" from all of the cars, than the total number of chairs vacant at the moment. This would cause but little inconvenience in any case.

A detailed view of one of the Pullman car annunciators is shown herewith. In this proposed design, if the lights 1 and 4 are illuminated simultaneously, then the number of chairs vacant is 14. If the lights 1 and 7 are turned on simultaneously, then the number of vacant chairs would be 17, etc. Lower numbers than 10 are indicated by flashing up the respective number. Electric lights also flash up behind the signs "open" and "closed" in the respective cases, and this will save considerable inconvenience on the part of some travelers, who may, at the last minute, decide to visit the dining car, but who cannot be served owing to the nearness to closing time.

The electric cable for this annunciator service can be connected by a quick-acting coupler between the cars when the train is made up. The annunciator system can be operated by batteries, either independent or connected with the electric lighting supply of the cars.

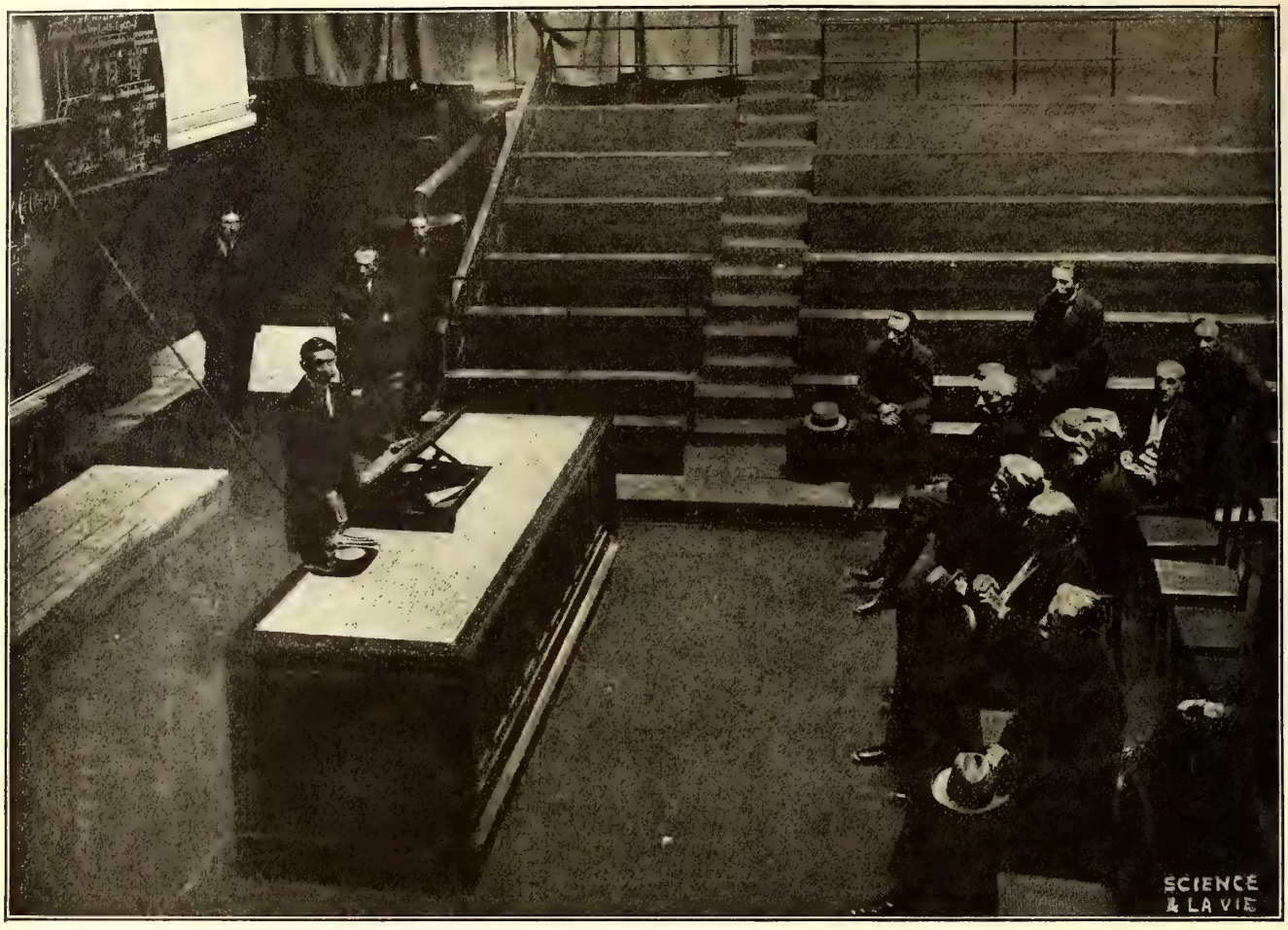
While we have not seen this idea suggested before, and believe it to be quite original and perhaps radical to many railroad men, still we have received several compliments already from people who have done considerable traveling on railroads, and their first exclamation is, "At last! Why didn't someone think of this before?"

100 Flying Hours for Liberty Motor

In the opinion of Colonel H. H. Arnold, recognized as one of the greatest authorities on aviation in the army, one great result of the recent transcontinental air race is the definite knowledge obtained on the probable life of a Liberty motor.

"We have never known before what the life would be of a Liberty motor," said Colonel Arnold. "We have never tested them to the utmost of their endurance before. Now we can say the life of a Liberty motor is about 100 flying hours. We have learned that while it is perhaps the best airship engine made it is not the super-engine some of its designers hoped for. Some of them were hopeful enough to say it never would wear out. The development of the new mica spark plug in the place of those formerly made with porcelain cannot be over-estimated.

"Another fact learned during the race for the first time is that all parts of the Liberty engine are not interchangeable when the parts are made by different factories. Some parts on the engines made by the Ford plant and by the Lincoln plant are not interchangeable, as was demonstrated at Presidio field when the changes were being tried. The assertion that any part of any Liberty engine could be interchanged with any similar part from any other engine, even tho made at a different plant, has been one of the most widely advertised features of the new engine."



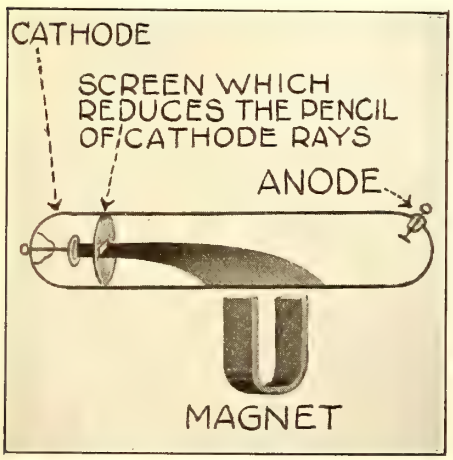
Professor Jean Becquerel of the National Museum of Natural History of France, Delivering a Lecture on Physics.

How Becquerel Discovered Radioactivity

By JEAN BECQUEREL

PROFESSEUR DE PHYSIQUE AU MUSÉE NATIONAL D'HISTOIRE NATURELLE DE FRANCE

TWENTY-FIVE years ago French scientists believed that matter could not emit energy where none had been furnished to it. They thought that the mass of a moving body in no way depended upon its speed; that the atoms of simple bodies had an individuality of their own and were indestructible.



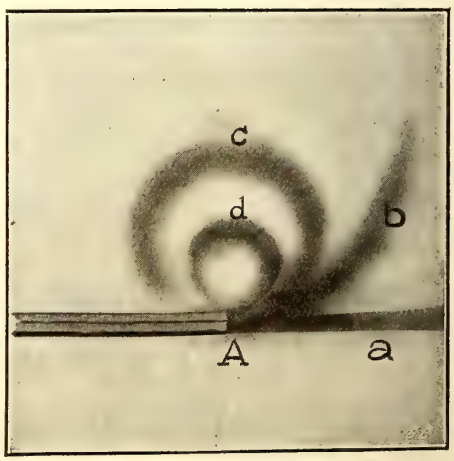
This Illustration Shows the Deflection of a Pencil of Cathode Rays by Means of a Magnet. It Clearly Demonstrates the Inter-Relation of Such Rays With Magnetism.

ONE of the greatest discoveries of all time — perhaps the greatest — was the discovery of "Radioactivity" by Henry Becquerel. It completely upset modern science and changed our entire long-reared structure of matter. Becquerel made the alchemist's dream come true literally, and there is little doubt that the World's great future inventions will have Radioactivity as their basework.

Radioactivity was no chance discovery. Rather it was a family achievement running thru four generations of the Becquerel family. Antoine Caesar Becquerel made extended studies of phosphoresence in 1839. His son Edmond Becquerel collaborated with his father, discovering the reason for phosphorescence, and in 1872 investigated particularly all Uranium salts. The grand-son, Henri Becquerel, who in turn took up his father's work finally discovered Radioactivity on March 1st, 1896. The great discoverer died in 1908.

The great-grand-son, son of Henri Becquerel, tells in this issue how the discovery was made. Of more than passing interest is the fact that all four Becquerels in turn held the Chair of Physics in the National Museum of Natural History of France from 1839, down to this very day.—EDITOR.

A wonderful discovery—that of Radioactivity, suddenly revolutionized science—overturned the best founded ideas and struck a mortal blow to the dogma of invariability of the chemical atom. This discovery showed that certain bodies, and probably all bodies, emitted rays, and that moreover this phenomenon is spontaneous; that the mass of a corpuscle, called Electron, depends upon its speed; that the atoms of



Spiral Movement of Cathode Rays in a Uniform Magnetic Field Perpendicular to the Direction of the Emission of the Beam.

A. Cathode Consisting of an Aluminum Wire Exactly in the Opening of a Small Glass Tube Giving a Very Fine Pencil of Rays.

a. Pencil of Cathode Rays Before the Magnetic Field Has Started. b, c, d. Three Different Circular Spirals of the Rays for Three Different Values of the Magnetic Field.

Written especially for the ELECTRICAL EXPERIMENTER.

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these radioactive elements are transformed in giving birth to other elements. Of these, some are ephemeral and others have a very long duration of life,—in short, matter itself is a formidable reservoir of energy.

The work leading up to this discovery is interesting, for the discovery was not at all due to mere luck; it was the logical consequence of a long chain of work and study accomplisht at the Physical Laboratories of the Museum of Natural History of France—since its foundation in 1839. The continuance of this work necessarily *had* to lead us to the study of the Radioactivity of Uranium—as we will show.



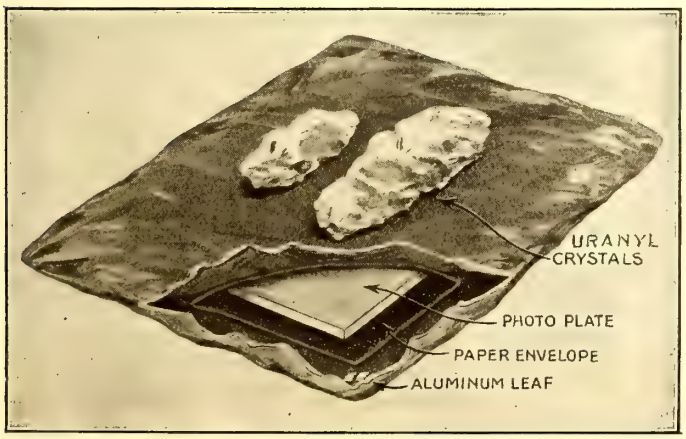
This Is the Famous Historic Photographic Plate Showing the First Evidence of Radioactivity Sought by Becquerel. The Writing on the Photographic Print Is Becquerel's and the Translation Is As Follows:
"March 1st '96. Double Sulfate of Uranyl of Potassium. Black Paper. Thin Copper Cross. Exposed to Sun the 27th, and to Diffused Light the 26th. Developed March 1st."
Note That in the Original the Shadow of the Copper Cross Shows on the Lower Spot. By Holding the Illustration About a Foot Away from the Eye, the Cross May Be Faintly Seen.

Here it is necessary that I indicate briefly the properties of phosphorescent substances. It is thus we term substances which can become luminous at an ordinary temperature, or at least a temperature very much inferior to that from which all bodies become incandescent due to the effects of heat. *Phosphorence is the result of a molecular excitation* which can be produced by visible light or by invisible luminous rays, either by rays obtained from discharges in rarefied gases, or by heat, or by mechanical action (rubbing, friction, fracture or crystals), and lastly by chemical action. Phosphorous, for instance, which becomes luminous while oxidizing.

As far back as can be remembered it was known that certain stones, diamonds in particular, had the property to glow for several instants in the dark after they had just been exposed to light. In 1602 a discovery called attention to the following phenomenon: an artisan of Bologna, Vincenzo Calciarolli, having found a very heavy stone (Sulfate of Baryta) heated it on coals and found that the oxidized matter (Sulfate of Baryta) remained luminous for some time after being exposed to day-light and then examined in the dark. From this time to 1893 several phophorescent substances were thus prepared and aroused the curiosity of scientists. I write the word "curiosity" purposely for no one had the faintest idea of the importance of these researches and nobody foresaw the capital rôle they were to play one day in the development of Science.

In 1839, Antoine Cæsar Becquerel, who until this time had devoted his time to the study of electrical phenomena, was led by his previous researches to study the action of electrical discharges on phosphorescence. He demonstrated that these phosphorescent discharges were only produced by the luminous rays of the spark and not by any electrical effect. His son, Edmond Becquerel, who had collaborated with him at this work, continued alone the study of phosphorescent bodies. He carried on unceasingly, thruout his whole life, the study of this subject; for he understood that these phenomena, which until that time were considered as mysterious, should certainly open a new road to investigation.

He described the means of preparing phosphorescent substances of various tints, sulfur of barium, Strontium, Calcium, etc., and *proved that these bodies owed their phosphorescence to traces of foreign matter;* with sulfur of Calcium for instance, a trace of Manganese gives red and yellow luminous effects; the presence of sodium salts and lithium gives green luminous effects; a small quantity of Bismuth gives forth a very luminous blue discharge. *Phosphorescence is due to the presence of some impurity.*



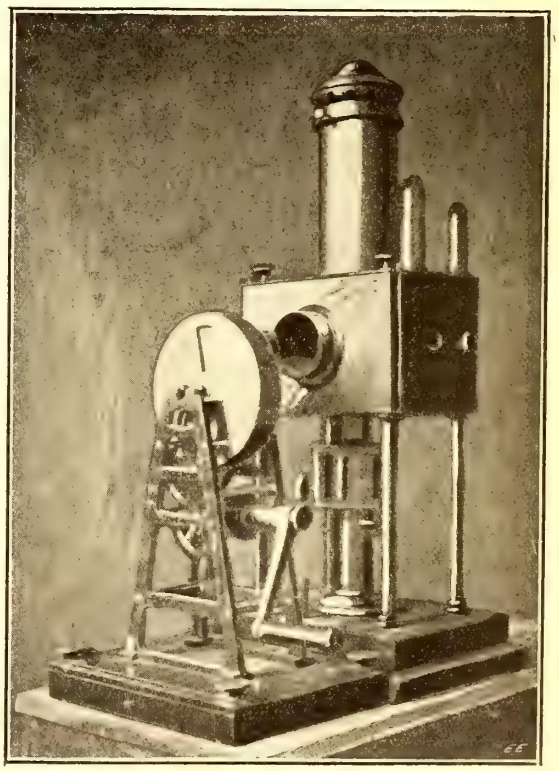
How Becquerel Performed His Historic Experiment. A Photographic Plate Was Wrapped in Black Paper, This Again in Aluminum Foil. Uranyl Crystals Were Placed on Top. The Result Is Shown in Top Illustration.

Edmond Becquerel studied the conditions under which phosphorescence can be excited, examined the light emitted by many substances and invented an apparatus called the *Phosphoroscope,* which reveals the phosphorescence in bodies of which the duration of luminosity is very short-lived. With this apparatus one can readily observe "flash" phosphorescence of a very short period (up to 1/40,000 of a second) in bodies after the light effect has long vanisht. The shorter the interval of time between the illumination and the observation, the larger the number of substances which produce the phenomenon of phosphorescence.

In 1872, Edmond Becquerel made a particular study of the phenomenon of phosphorescence.

Composites of Uranyl give forth beautiful green luminosity of very short duration (1/100 of a second) perceivable thru the phosphoroscope or by illuminating these bodies with violet light.

Everyone knows that white light is composed of different colors which are blended in the rainbow. The spectroscope permits the analysis of any sort of light and the separation of the different colors that light contains. If one analyzes the light emitted by a body one obtains the *emission spectrum* of that body. Furthermore, if one directs into a more or less transparent substance a beam of white rays and if one analyzes



The Famous Phosphoroscope Invented by Edmond Becquerel. With This Instrument "Flash" Phosphorescence of 1/40,000 of a Second Can Be Measured.

what remains of that light after its passage into the substance, one obtains with the Spectroscope, black lines or bands which correspond to the rays which have been stopt by the substance; this is called the *absorption Spectrum.*

Edmond Becquerel, discovered that the phosphorescence emission spectrum of composites of uranyl are composed of seven or eight—regularly distributed, and he also discovered that the absorption spectrum is formed by bands which in the violet and ultra-violet parts (the latter are invisible to human sight, but can be photographed) are an exact prolongation of the bands of phosphorescence.

Henri Becquerel continued his father's work and proved that these phosphorescence emission bands and those of absorption are distributed according to the simplest law which can regulate the distribution of Spectral bands; they form, in a way, a harmonic scale of colors.

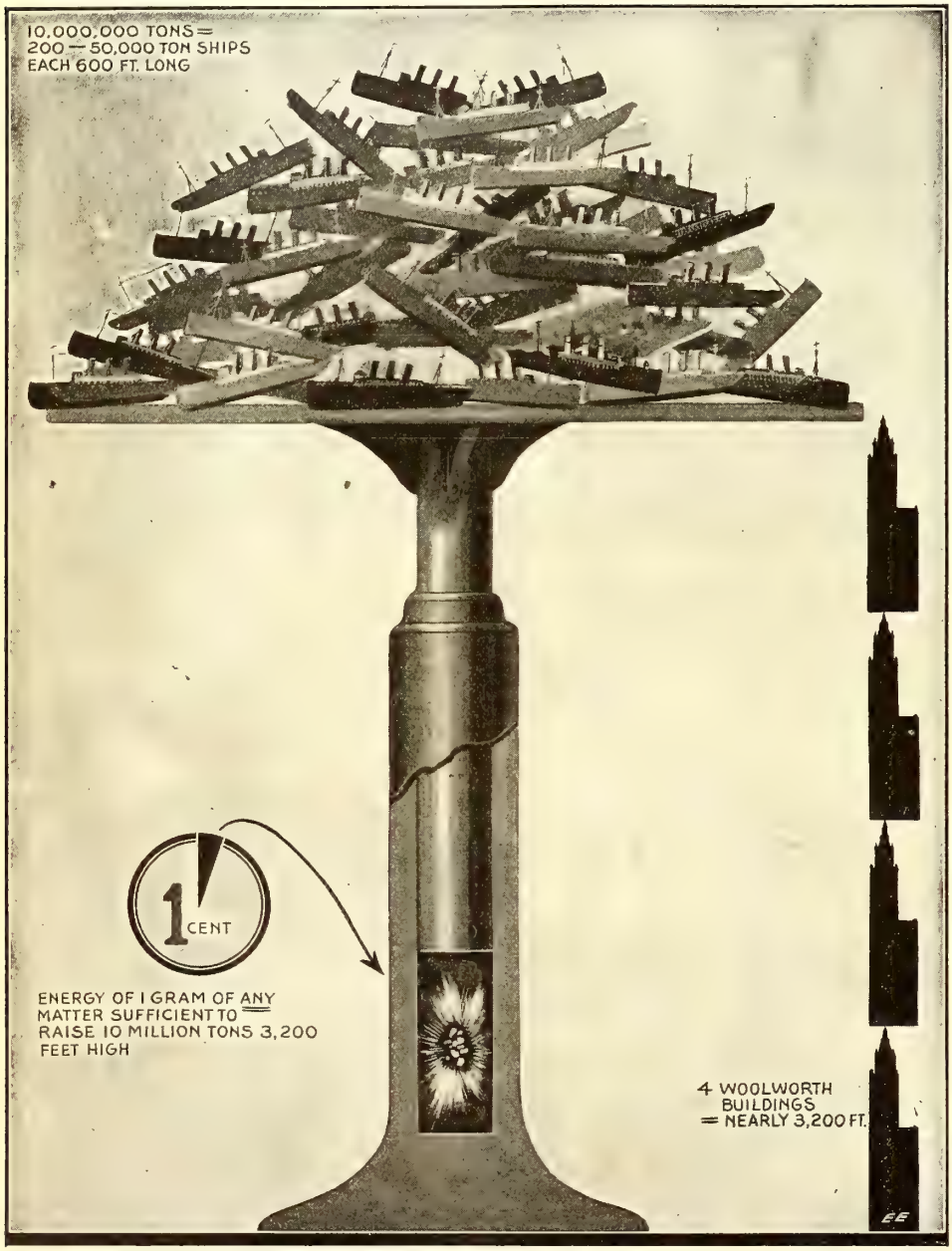
This result attracted his attention to Uranyl Salts. Another remarkable fact is the following:

Whereas the other substances owe their phosphorescence to the presence of impurities, as mentioned above, Uranyl Salts are *phosphorescent by themselves,* without the intervention of any foreign matter. In a word, Uranyl Salts occupy a place by themselves among phosphorescent substances.

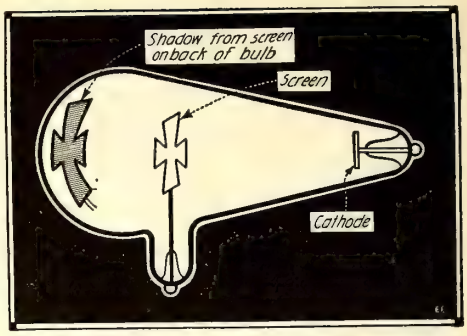
I must now, before telling of the discovery of Radioactivity, recall other phenomena. Imagine a vacuum bulb; let us say in the form of a tube and containing a very rarefied gas as well as two electrodes; by connecting one of the electrodes to the positive pole and the other with the negative pole called the *cathode,* of a static machine or of a large induction coil, discharges are produced in the tube.

Plücker discovered in 1895 that the Cathode emits a certain radiation which has been called *cathodic-radiation;* these rays are invisible by themselves as they emit no light; but they are revealed by their property of illuminating phosphorescent bodies which they strike. It is thus that the glass of the vacuum tube becomes green wherever it is touched by these rays.

Cathode rays are deviated by a magnet, they tend to twist themselves about the lines of force of a magnetic field. They are also swerved from their course by an electric field: if past between two electrified plates (one positively and the other negatively electrified) a pencil of these rays describes a *parabolic* curve, just as does a falling body under the influence of gravity. Cathode rays are formed by a flow of corpuscles loaded with negative electricity. It is these cathode rays which give birth to the X-rays; the latter are generated every time cathode rays are suddenly stopt by a solid body. Nowadays we obtain X-rays by letting cathode rays fall on a tungsten electrode, called *anticathode.* But, during Röntgen's first experiments the anticathode was simply that part of the bulb which was opposite to the cathode.



As Pointed Out in the Present Article by Prof. Becquerel, Computation Shows That if We Were the Master of Atomic Forces We Could Disintegrate 1 Gram of Any Matter and Liberate Sufficient Energy to Raise 10,000,000 Tons Four Times As High As the Woolworth Building.



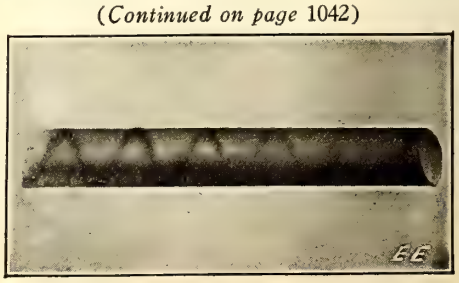
If a Screen Is Placed in the Path of Cathod Rays, a Shadow Will Be Thrown on the Opposite Wall As Shown in the Illustration.

The sensation caused in 1895 by Prof. Röntgen's discovery was considerable. On the day when this discovery was announced at the Academy of Science of Paris, Henri Becquerel asked Mr. Poincaré, who presented the note sent by Prof. Röntgen, "Just *where* in the bulb is the exact location from which the new rays are emitted?" He was told that it was the *phosphorescent* spot on the glass which received the cathodic flow. The phosphorescent part being the seat of emission, Henri Becquerel immediately conceived the idea to find out whether certain phosphorescent bodies could emit rays similar to the X-rays.

What then were the phosphorescent substances to be used in this experiment? Henri Becquerel did not hesitate; Uranyl Salts, which had been the object of so much research work in our laboratory and which distinguished themselves by their exceptional properties, were the natural and logical selection.

Believing that excitation by light was necessary to produce the desired radiation, Henri Becquerel placed crystals of double sulfate of Uranyl and potassium on an envelop of black paper, the latter covered with a thin leaf of aluminum and containing a photographic plate. He then exposed the closed package to the sunlight. The envelop of paper and aluminum prevented, of course, the light from acting on the photographic plate, but this could not be an obstacle to rays having like X-rays the property of penetrating opaque bodies. The plate was developed after being exposed for a few hours to the light and it showed very feeble spots which were *limited to the outlines of the crystals.* Naturally, Henri Becquerel wisht to repeat the experiment immediately, but as the sun was not shining the entire device was placed in a drawer to await better weather. The sun reappear-

(*Continued on page* 1042)



Spiral Formation of Cathod Rays in a Uniform Magnetic Field Where the Lines of Force Are Oblique to the Direction of the Emission of the Rays.

The Golden Vapor

By E. H. JOHNSON

This is the story of a man possest of the highest type of scientific training, and who, because of disappointments that had come into his life, used his highly developed talents to plan and carry to a successful conclusion an enterprise mystifying to an extent unequalled in the annals of modern crime.

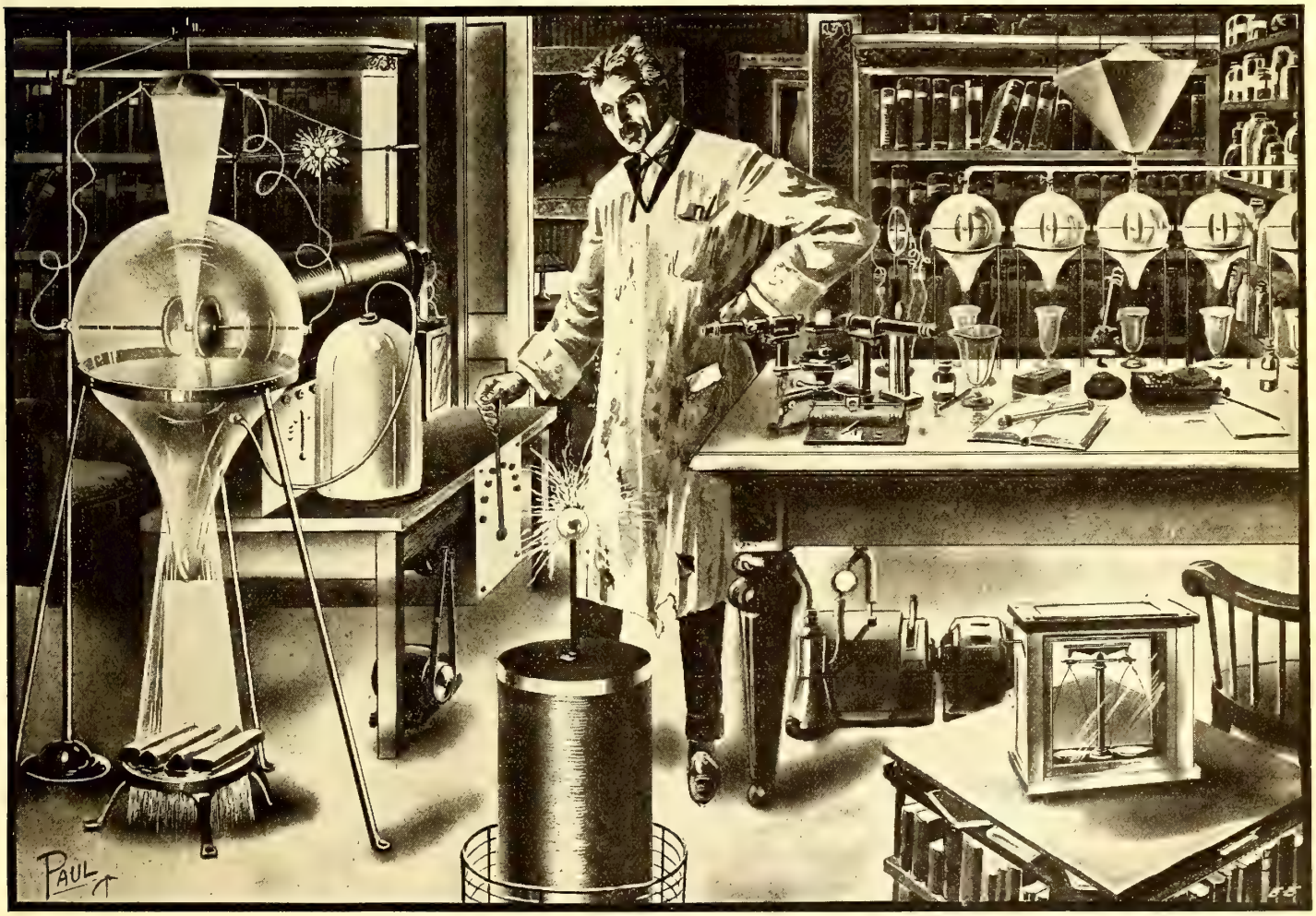
ON the fourth of December, 1919, the home-going crowds on the streets of San Francisco, like those in any other great city, were busy with their own thoughts. The louder noises of the day had ceased, and with the gradual peering forth of the myriad lights with which, like jewels, the fair queen was wont to adorn herself for an evening at home—a sense of calm security warmed the hearts of old and young alike. Comparative peace reigned on earth, and in the heavens above shone forth stars as yellow as the gold of California itself—and no more illusive. One alone of all the hurrying throng saw little of charm in that color. Though as thoroughly conscious as any other of his own safety, this conviction was of a defiant type which finds its assurance in the knowledge of successful craftiness, and fears little because little is loved. Occasionally he smiled grimly, almost cynically, as some ostensibly rich person swept by, or as he caught the faint odor of some rare perfume. These were but pretenses to a satisfaction that he had little faith in. They proclaimed a comfort which he thought at best to be but an illusion. Yet, human-like, he could not help wondering, for such a life was now well within his reach, but he only buttoned his coat a bit tighter about his meager form, glimpsing furtively, tho perhaps unknowingly at the darkened door-ways and the starless patches overhead. This strange appearing man was Dr. Rudolph Grieg, a doctor of philosophy, not of medicine and surgery.

Suddenly, familiar shouts filled the air as a half-dozen news-boys burst forth from a nearby building—a towering structure whose lower levels were teeming with chattering machines and dodging human attendants. The evening edition of a great paper was just emerging with its tales of a thousand horrors and frivolities which, regardless of variety, length or sense, were soon to beguile the fireside hours in a thousand homes. With the usual jargon, each boy tried to drown the advertising efforts of his fellows, so that however attentive a listener might be, he could only conclude that the day's events were not much different from those of other days. And each night, regardless of the nature of these announcements, each boy disposed of his wares before the "next car" with its strap-holders, swaying and reading, oblivious of their promiscuous human contacts in their absorption in greater or lesser human affairs—rushed away beyond the twinkling lights in the heart of the city.

Of all this crowd, Dr. Grieg alone seemed in no haste to depart. His keen ears had caught a word in the howling clamor of the newsboys and then with all his heightened sensibilities alert he had heard enough to cause him to do a thing which for him had become quite uncommon—to buy a paper. He had fairly snatched it from a boy who was running past, had cast a quarter in his direction and turned to a lighted window to scan the headlines with an evident excitement. The boy looked several times at the quarter he had received, started to speak once or twice, but then seeing that his customer seemed satisfied, raced on.

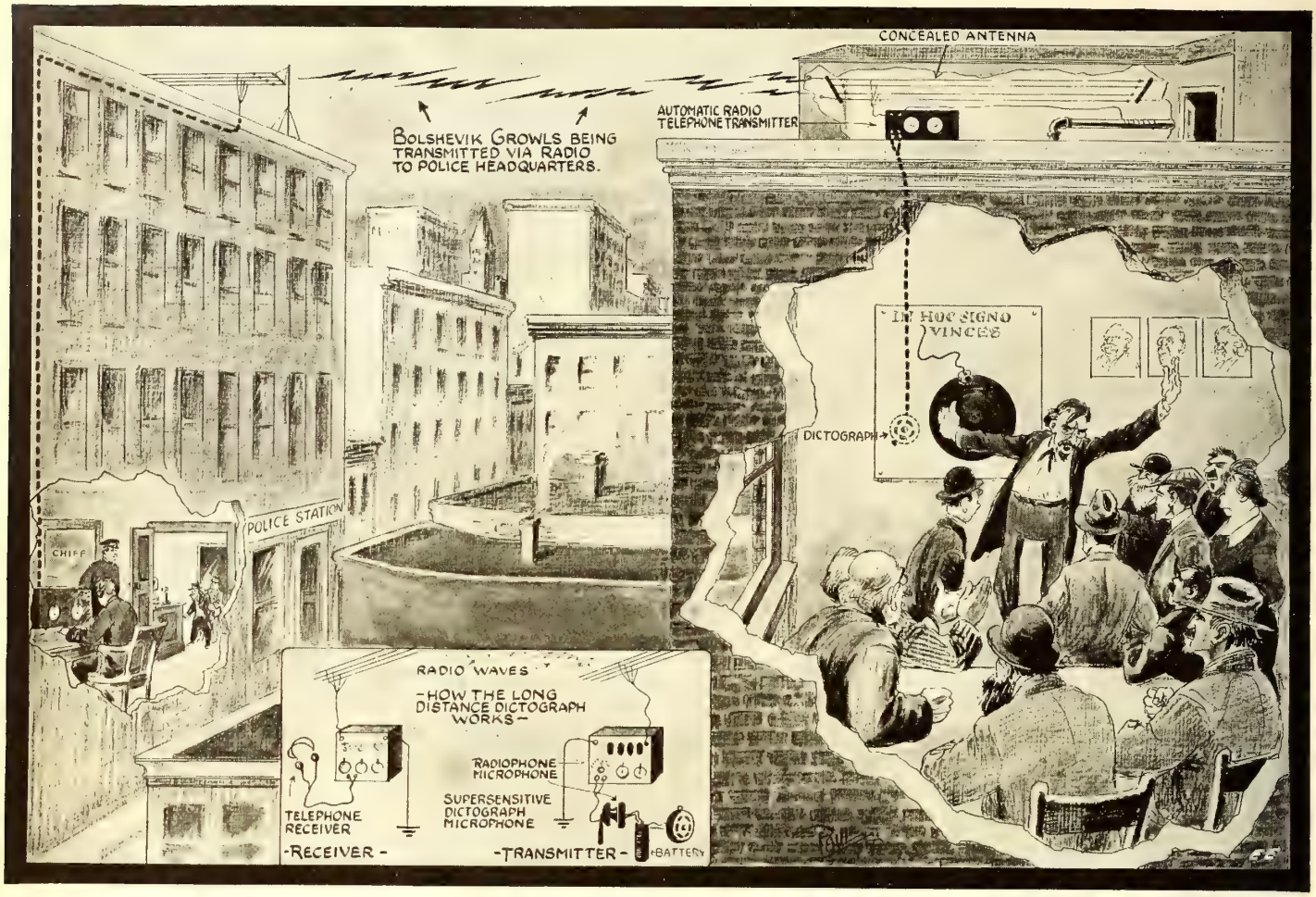
Then with scarcely a glance about Dr. Grieg hurried on into the darker streets toward the edge of the city, where he might have been followed far into the night, walking, walking on and on with the apparent aimlessness of one who has a deal of time to spend and does not find the pastime disagreeable. And yet, if his course was aimless, no one would have described his physical appearance in such terms. First, with his hands deep in his pockets, he hurried along as if in haste from some dreaded pursuer. Then, and apparently without any forethought, he

(*Continued on page* 1062)



". . . Slowly Dr. Grieg Turned the Great 'Medior' Bulb First One Way and Then Another, and Finally He Clamped it Pointing Directly Downward. After Opening One of the Inlet Cocks, So as to Let a Little of the Gray Powder Down Into the First 'Materializer' Bulb, He Watched it Intently for a Long Time. Suddenly He Stopt Sweeping the Rays, and for a Moment He Seemed as One Stupefied. The Iron Bars on Which the Downward Rays Were Playing Slowly Seemed to 'Dematerialize'—Nay, Vanish—Into the Thin Air! The Iron Bars had Disappeared and in the Glass Bulb the 'Golden Vapors' Had Condensed Into a Fine Powder—and it was Distinctly Yellow! . . ."

A Long Distance Dictagraph



The Latest Thing In Dictagraphs Is the "Long Distance Wireless Dictagraph," Shown Here In Actual Use. It Is Not Always Desirable or Possible to Have a Detective or Secret Service Operator Located in the Same Building Where the Dictagraph or Dictagraphs May Be Located in Order to Record any Conversations Picked Up by the Instrument and This Wireless Dictagraph will Undoubtedly Find Many Uses in Police, Private Detective and Secret Service Operations. The Dictagraph Operates the Automatic Wireless Telephone Transmitter Which, Together With Its Antenna, Is Carefully Concealed. The Mutterings of the Much Maligned (?) Bolsheviki Ladies and Gentlemen, Are Thus Hurled Toward the Nearest Police Station at the Rate of 186,000 Miles a Second.

THE *dictagraph* is known to practically everyone today, for this wonderful scientific device has figured quite extensively in all modern detective stories, and in actual police departments and private investigations all over the world. Plainly described, the *dictagraph* comprises a super-sensitive telephone which can pick up at a considerable distance from the transmitter ordinary speech sounds and in some cases even whispers, and transmit the sounds, electrically, over a circuit of considerable length to a pair of telephone receivers worn by a detective or Secret Service operative. The operative who makes use of the dictagraph, and who invariably has to be a shorthand expert so as to record the incoming conversations, is usually located in the same building and in some cases in the room or apartment next to that in which the criminals or conspirators are located.

The dictagraph telephone circuit includes a battery, a pair of low resistance telephone receivers wound to about four ohms each, so as to permit a fairly heavy current to pass thru the circuit, and a very sensitive carbon-grain microphone.

A New York engineer has recently suggested a combination of the wireless telephone and dictagraph, shown herewith in one of its possible applications, and by which means the application and versatility of the dictagraph is increased manyfold.

In a building where the suspected persons have their rendezvous or living quarters, there is installed the usual supersensitive microphone of the dictagraph outfit. This is sometimes hidden behind pictures, under tables, or other furniture, and in some cases it has been placed in the drawer of a sideboard or china closet. The wires are scrupulously concealed and installed by the detectives investigating the case, at some time when the occupants of the apartment are absent. The speech waves picked up by the microphone, are transmitted to the receiver of the loud speaking receiver of the instrument, which is secured in close relationship to the microphone of an automatic wireless telephone transmitter, preferably of the noiseless vacuum type or Audion type.

This latter apparatus is carefully installed in some out-of-the way location where it is not likely to be found, and no attendant is required to stay and watch the apparatus, once it is set into action. This releases the usual dictagraph attendant for more important service. Any conversations picked up by the wireless telephone dictagraph are thus amplified and transmitted in the form of Hertzian waves, from the concealed antenna in the manner shown, whence they are pickt up by the antenna of the radio receiving station located at police or detective headquarters. Here the Bolsheviki's growls and aspirations for running the world are transmitted into articulate speech once more, thru the wireless telephone receiving apparatus, all in a well known manner.

The receiving set can be of the Audion or vacuum tube type and as is the case with all up-to-date radio stations, it may be equipt with a vacuum type amplifier, so that the incoming messages can be intensified until they are thoroly audible, or they may be recorded independently or simultaneously on a phonograph for further reference and record.

At the present time when the United States Secret Service officials are rounding up thousands of the Bolshevist gentlemen and sundry, this "long distance wireless dictagraph" should prove of valuable service. All that is required is to connect up the dictagraph, which is already well standardized and available in the open market at a reasonable cost, to the automatic wireless telephone instrument. This is not the only use of the scheme here illustrated, as there are many others, of course. For instance, why not rig up this arrangement in connection with a phonograph which can have recorded on it the location of the instrument as regards street, floor, room, etc., and in case of fire, the phonograph would be liberated and put into operation, as well as the necessary switches for closing the wireless telephone transmitter circuits. This can be very well carried out in the manner described in a talking fire alarm patent recently granted to a member of the New York Fire Department.

Talking Movies That Talk

WHILE hundreds of our most eminent motion picture producers and inventors have been working their "thought tanks" overtime—morning, noon and night—trying to produce real "honest-to-goodness" movies that would talk at the right time, with the right accentuation and never, never get out of step or synchronism—lo and behold! Their problems have all been solved overnight, for here comes Charles F. Pidgin of Silver Lake, Mass., with the final solution of everything!



We Have All Been Waiting for the Successful Talking Movies. Several Varieties of Talking Motion Pictures Have Been Exhibited and Demonstrated at Theaters for Several Years, But None of Them Have Had a Very Long Life for Obvious Reasons. At Last, However, the "Bugaboo" of Synchronizing the Speech With the Pictures Has Been Obliterated in a Single Master Stroke of Genius—Let the Actors Speak the Words and Photograph the Words Themselves, as the Diagram Shows Very Clearly. Eureka!

As Mr. Pidgin points out in his patent covering this newly devised movie scheme, the motion picture public is surely tiring of the customary method of exhibiting to the audience now and then, as a six-reeler proceeds on its merry way, short speeches or sentences to give them some inkling as to what Mary said to John—and curses! curses!—what the "villiun" thought about it all.

It is comparatively easy in cartoon and other movie drawings of this nature to show the words issuing from the mouths of the cartoonist's actors, but when *living* actors are employed, there has not been heretofore any method whereby the words could be shown in the scene directly, altho several talking machine schemes have been tried out, including that of Mr. Thomas A. Edison. As is well known, in the *talking machine* scheme, the speeches of the actors are "canned" simultaneously with the photographing of the various scenes and afterward the talking machine record is run off simultaneously and synchronously with the projection of the motion picture. For several reasons this has not been entirely satisfactory, and after having demonstrated this arrangement some six or seven years ago, there has not been any presentation of the talking phonographic movie in some years.

But behold how simple the talking movie is to Mr. Pidgin's mind! Look at the accompanying illustration and you have the whole secret in two seconds! The actors fairly spit out their words to portray their unclassical sayings, and this is accomplished in the simplest manner imaginable. The letters are then printed on a collapsible and transparent celluloid strip which can be extended or contracted by pressing or releasing the pneumatic bulb held in the coat pocket or in the hand, and the actor, or actress is thus enabled to "actually speak their thoughts."

The method of accomplishing these results as described by the inventor consists in causing a selected arrangement of letters which will spell the spoken words to appear from behind the actor, preferably from behind his head, in line with or substantially beside his mouth, while the photographing is proceeding, in order to produce that portion of the photoplay which is to be emphasized by such words or sentences.

Regarding the celluloid strip on which the letters or words are printed, this is made transparent so that the end toward the camera will not unduly contrast with the color of the actor's hair, or otherwise this strip may be colored or made to match his or her hair. The collapsible strip bearing the letters is fitted to a flexible tube leading to an air bulb or bellows which may be operated by the hand or else located under the arm of the actor. When the pressure of air is created by squeezing the bellows or bulb, the quick acting coiled tube is inflated—and out pops the word or words in line with, and apparently from the actor's mouth. As Mr. Pidgin points out, even those in the audience who are experts on lip reading will find this system to be synchronous and very natural in its presentation, as the actor can actually pronounce the words and produce the necessary facial and mouth movements as the word appears.

Owing to the fact that the film on which the words are printed is transparent, *only the letters* will appear on the developed moving-picture strip.

When the camera is in operation and the point is reached at which it is now customary to interrupt the scene for the introduction of a separately flashed "speech," the actor simply compresses the bulb or air pump and the word carrier is projected and the words photographed. The actor may, at the same time, for the sake of realism, speak those words which have been prearranged upon the flat tube. He then releases pressure on the bulb which is of that character possessing a normal tendency to expand, and said bulb sucks the air back thru tube and the carrier recedes and recoils itself, so that the exhibited words disappear from the continuation of the film. For a different later speech a change is made in the word carriers. If the action requires the actor to turn around before the end of the scene, the entire device is so easily slipt off that it can be removed during some motion when the audience would not notice the removal.

It will be readily understood that the head piece can be applied so that the word carrier, in normal condition, and the arm, will be concealed from the camera whether the speech is to be delivered to the right or left.

Other forms of word carriers may be employed instead of the coiled type described. For instance, a three-armed rotary member made of transparent celluloid or other suitable material, and bearing letters or words which will compose a sentence when rotated may be easily applied.

The Versatile Audion

By H. WINFIELD SECOR

Some of the Many Practical Uses to Which the Audion Has Been Adapted

MANY world-startling experiments in Radio Science have been either directly or indirectly based on the remarkable performance of the *Audion,* the little evacuated glass bulb which greatly resembles the ordinary incandescent lamp, but which contains, besides the filament, two other elements,—a wire grid and a flat metal plate. Some of the most remarkable phenomena in the realm of pure and applied science are due to the as yet not fully understood electronic action taking place within this bulb.

The action in the audion is based on the fact that a heated body, such as a heated filament, radiates millions of tiny electric charges of a negative character or *electrons,* as they are called by the scientist. The wire grid in the audion is placed between the heated filament, which is constantly shooting off the electrons, and the cold plate. When a battery or other source of electric current is connected to the filament and plate, a positive current flows from the cold plate to the heated filament, and this is due to the fact that the electronic flow in any case is *opposite in direction* to the positive current flow. Thus, the hotter the filament, other things being equal, the more electrons there are radiated, and the stronger the current which can be transferred across the space between the plate and the filament, up to the point of saturation.

Now, if we can manage to vary the electron flow between the heated filament and the plate or wing, in some delicate manner, we would have, it would seem, a very sensitive wireless detector, and this is just what Dr. de Forest thought when he first started to develop the audion idea. Suiting his action to the thought, he produced after years of experiment a bulb made in this fashion with three electrodes, one at least of which must be heated. The first grid audion gave results far beyond all expectations.

We may say that today it would really be very difficult to conceive of a single radio or electrical device which is more versatile or universal in its applications than the audion. Some of the more prominent and practical applications of this device are illustrated and described herewith, but it has apparently only just started on its mission of usefulness.

RECEIVING RADIO MESSAGES.

First and foremost in many ways is the application of the audion, or *vacuum valve,* as it is sometimes miscalled, to the reception of radio messages. The audion will receive and amplify under proper conditions, both radiotelegraphic and radiotelephonic messages. It has the advantage over the crystal and other forms of detectors that, whereas these depend upon the finding of a sensitive spot, often microscopical in size, where the metal wire (cat whisker) touching it proves most responsive; the audion, once the battery currents are properly adjusted to it, keeps right on receiving hour in and hour out.

The action of the audion in this case is along the lines cited in the introduction; that is, one of the antenna circuit wires carrying the incoming signal currents is connected to the grid or intermediate member of the audion. Thus, any variations of electric charge or current on the grid, as would be occasioned by the dots and dashes or short and long signal currents, or else the fluctuations of the radiotelephonic current, causes a corresponding and exactly similar variation in the electron stream passing from the heated filament to the cold plate. It is at once evident, therefore, that as these variations are occasioned by the increasing and decreasing volumes of electric charge on the grid, the current flow from the high-voltage or "B" battery connected in the telephone receiving circuit to the plate, will be varied in correspondence to the grid charge variations. This action is very delicate, positive and accurate, and where more than one bulb is used is of enormously high amplifying character.

The audion, with slight circuit modifications, can be used for receiving both damped and undamped radio signals and therein lies one of the most tremendous advantages of this device. By the mere turn of a switch or readjustment of the circuit the audion can be made to oscillate and receive either damped or undamped radio signals equally well. This was of inestimable service to the Allied armies and navies during the war, as may be readily imagined, and audion sets were built by the thousands, and the consumption of bulbs by the Allied armies and naval fleets was at the rate of 1,000,000 per year during the last months of the war. See figure 1.

AUDION CAN TRANSMIT MESSAGES.

At Fig. 2 the audion is shown in use for transmitting wireless messages. It can and has been very successfully used for sending radiotelegraphic and radiotelephonic messages. Usually, but not in this case, the audion for this apparatus is made of a somewhat larger size; the average audion such as that used for receiving apparatus is about the size of a 30 watt tungsten lamp, but the bulb is tubular in form and not pear-shaped. The French audions, however, resemble the average Tungsten lamp shape, while the German types are tubular.

It was found in various experiments that the vacuum tube of the audion type; that is, under certain circuit conditions, and where a sufficiently high voltage direct current (such as that produced by a 500 to 800 volt, D.C. dynamo) was applied to the plate, that the bulb action took on an oscillating nature and caused a radio-frequency alternating or oscillating current of an undamped form to be produced. By simply connecting up a microphone in one of the circuits, for which there are now several different schemes available, it thereupon became readily possible to easily and perfectly modulate this converted radio-frequency oscillating current produced by the audion into speech currents, which can be radiated from the antenna in the form of Hertzian waves and picked up at any wireless receiving station.

Several years ago the first trans-Atlantic wireless telephone speech was transmitted successfully, thanks to several hundred large oscillating audions, which were connected up in a common bank in the government high-power station at Arlington, Va. Just to show how easy it is to control 50 or 100 K.W. of energy as produced by a bank of audions such as this, it may be mentioned that an ordinary microphone, such as we have in this case, can readily modulate or control telephonically the entire bank of bulbs, totaling 15 K.W.

During the war many of these audion transmitting sets with one or more bulbs on them were designed and built for the American and other Allied armies. The U. S. Navy Department, as well as the aircraft divisions of both army and navy, have also found the audion bulb transmitting sets of inestimable value, both for transmitting radiotelegraphic and radiotelephonic messages.

RADIO AMPLIFIER.

The audion as an amplifier of radio signals, either telegraphic or telephonic, has proven to be far in the lead of any other form of amplifier ever devised. It is not to be inferred from this statement that there are not available at the present time several very interesting and very useful forms of electro-magnetic amplifiers, for there are several which possess meritorious features, indeed,—but the audion is unique in that, with very simple circuit arrangements, one can keep on connecting up audion bulbs until they have amplified the faintest imaginable signal or spoken word, until it roars forth with the strength of a hundred horses. Practically every army and navy station today is equipt with an

(*Continued on page* 1080)

For "March"

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The "Finer Workings" of Static Electricity—Part II. By Frederick von Lichtenow.

The Secret of the Magnet Poles—How the Magnet Works. By Walter E. Keever.

Gaseous Telephone Transmitters—A startling new invention of extreme simplicity. By Richard A. Engler.

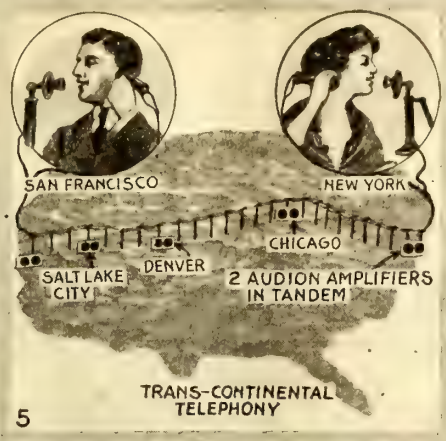
AUDION APPLICATIONS

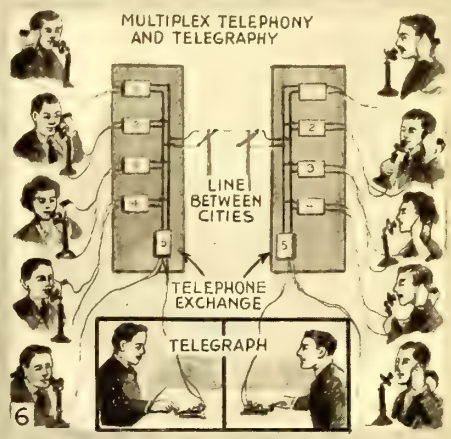




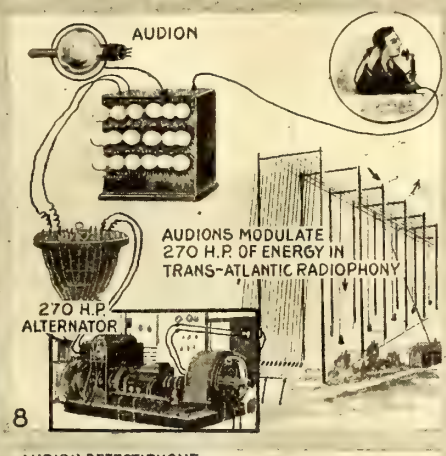








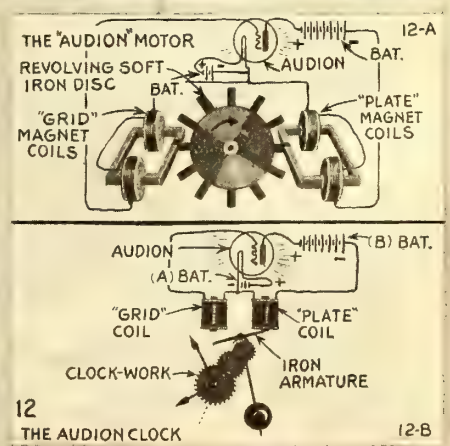












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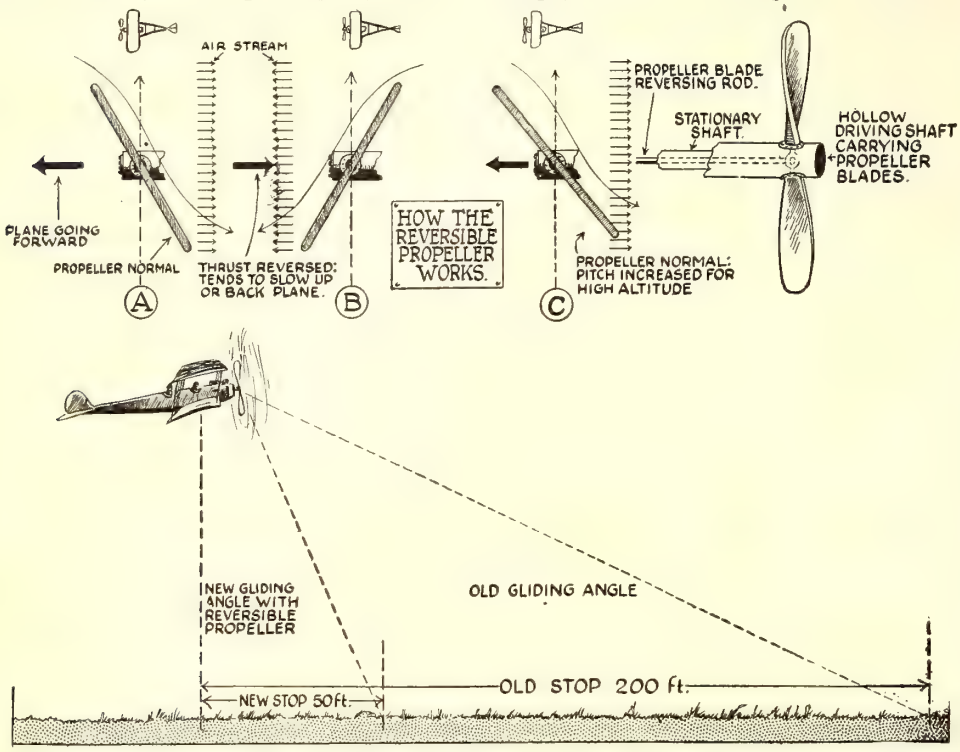
Reversible Airplane Propellers

ANNOUNCEMENT from McCook Aviation Field, Dayton, Ohio, in the latter part of October, stated that successful tests had been made with a reversible airplane propeller, which means, according to experts, that the day of the "backyard" airplane is here.

With the new propeller, airplanes can land and be brought to a stop within 50 feet by actual test, it is said.

The new device will also increase the climbing speed of an airplane 40 per cent and permit of higher altitude flying, 50,000 feet being a possible limit. Seth Hart of Los Angeles, Cal., is mentioned as the inventor of the new reversible propeller.

The accompanying diagram chart shows how the reversible propeller functions. Normally, it is regulated by suitable mechanism controlled from the aviator's cockpit, so that a medium pitch is obtained at the blades, as shown at Figure "A." When the speed of the plane is to be reduced, the *pitch control* rod of the propeller is varied so as to *reverse* the pitch of the blades, as at "B," thus reversing the stream of air, and likewise lowering the thrust or forward pull on the airplane. This gives us the "backyard" plane. At high altitudes where the air is thin, a better "hold" is obtained by the tractor screw by increasing the pitch, as at "C".



With the Reversible Propeller the Airplane Pilots Can Descend at a Steeper Angle and Stop in a Shorter Distance Than Ever Before. It Also Allows Him to Increase the Pitch of the Propeller at High Altitudes, Where the Air is Thin.

Dr. William Whitney Christmas, the inventor of the "Christmas Bullet," the fastest plane in the world, with a speed record of 200 miles per hour, had the following to say on the performance of the "Reversible Propeller":

The Possibilities of a Reversible Airplane Propeller

For a period covering probably five years there has been more or less discussion along the line of *reversible propellers* on airplanes. The prime practical factor in the correct building of an airplane is as few parts as possible in its construction. Any kind of mechanism which has a multiplicity of parts must necessarily run a greater risk of disintegration than a device which has fewer parts.

There are several inventions, it is believed, which have to do with changing the pitch of a propeller on an airplane while the plane is in flight. These inventions have also included means for a reversing propeller for the purpose of quick landing in small areas. The difficulty with such devices has been that the mechanism which controls the blades has been found to be both weak and uncertain in its operation. Centrifugal force plays a most important part in such a device because this force is astonishingly great and must be reckoned with under all circumstances. Centripetal force also has its important bearing on the case and it has been found from experience that these two forces have a most decided disposition to defeat the intention of the designer and inventor of any device which has to do with changing the pitch and reversal of the propeller blade.

Undoubtedly if such a device could be made practical, it would go a long way towards solving some of the bad features of airplane landing, but it is not within the limits of reason to attribute certain features to this device which cannot be accomplished.

A plane must have what is called a *gravitation index*. This gravitation index varies in different planes and concerns both

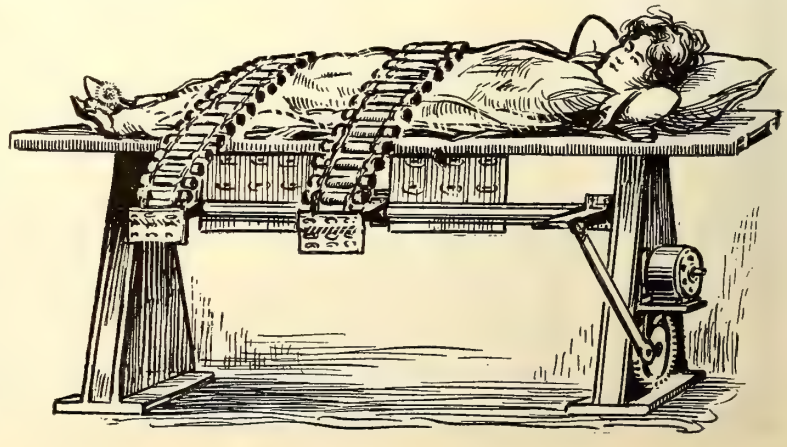
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Making Fat People Thin By Electricity

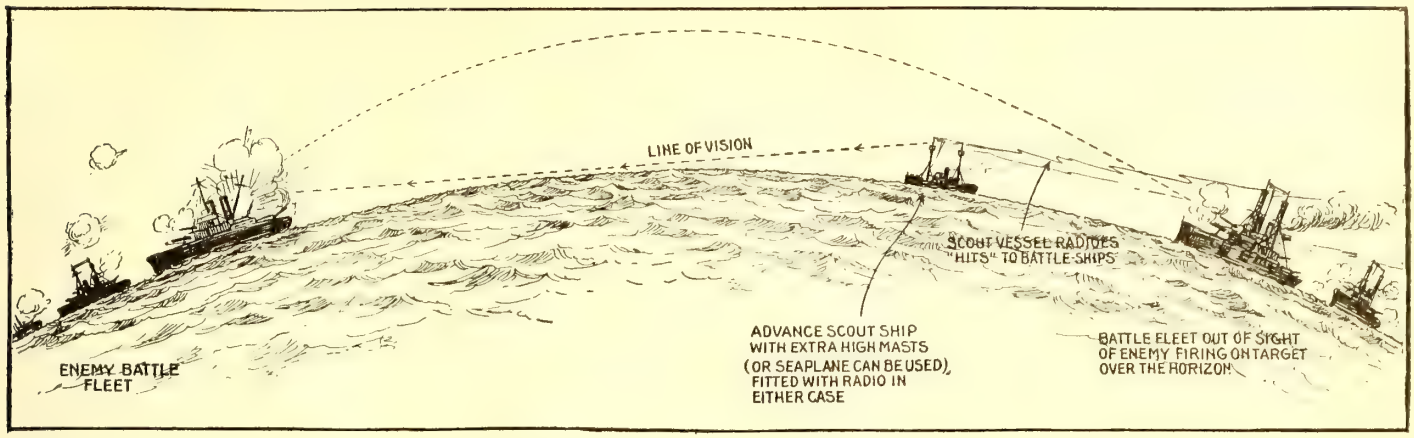
IT has remained for a woman, Fanny J. Niles, of Philadelphia, to invent what she calls a "normalizing machine," which comprises a clever electrical massaging machine adapted to massage the fatty tissue or superfluous flesh on any part or the whole of the body. Massaging members comprise two strips of wooden rollers or bars mounted on flexible belts, so that they can be supported by and also secured to the two opposite sides of an oscillating frame. In this manner the bars can be moved to and fro more or less rapidly as desired.

The belts at the ends of the series of rollers are connected by pins passing thru flexible sheets, made for instance of heavy canvas or other strong material, in which there are a plurality of eyelets. These eyelets pass over a series of turned buttons, and thus it is seen that by providing several series of eyelets in the sheets at the ends of each series of rollers, that a wide range of adjustment is provided so as to give the necessary pressure on the body, and thus enabling the physician or person giving the treatmcnt to adjust the roller sheets so as to conform to the shape of the patient's body.

A small electric motor drives the machine thru the medium of a set of reduction gears in such a manner that a frame to which the roller belts are connected will be given an oscillating movement. Thus the rolls are more or less rapidly oscillating over the body and the speed of this massage movement may be regulated by controlling the current supplied to the electric motor. The inventor also provides in this device a feature whereby varying widths of belts carrying the rollers may be used as desired; also two or more roller units may be used on the patient. This type of machine has been in use for several years with great success in several electrical treatment institutes in the East. The machine is simple in its functioning and sure and positive in the results it aims to produce.



Are You Too Avoirdupois? Just Step Up and take a Treatment Now and Then on This Electric Normalizing Machine, Which Massages the Superfluous Tissue From the Body. This Machine Has Been in Use and Gives Excellent Results.



This Explains How It Is Possible to Shell Enemy War Vessels Which Are Over the Horizon or Out of Sight of the Attacking Battle-fleet. A Scout Vessel Provided with Extra High Masts for Spotting the Enemy, Is Sent in Advance of the War Vessels and Radioes Back the Results of the "Hits," or Else a Seaplane Can be Used for the Purpose, and in Either Case, with Deadly Results to the Enemy.

Hitting Invisible Targets

MANY times during the recent world war one would often read in magazine and press articles of various naval engagements where vessels were hit by shellfire over the horizon and out of sight of the vessel firing the shell! One of the ways in which this can be done and which was recently explained to the editors by a U. S. naval officer, is shown in the accompanying illustration.

At the left we perceive an enemy battle-fleet just over the horizon and out of sight of the attacking battle-fleet. Naturally, unless the gunners behind the attacking war vessels know exactly where the enemy is located, they cannot fire a shell to hit his ships. To gain this information, there are several possible ways in which it may be done. One of the practical methods which has been employed is here shown.

A fast scout vessel such as a battle cruiser, goes ahead of the main battle-fleet and for special observation it is fitted with an extra high mast, so as to have the greatest range of vision possible. When the lookout in the crow's nest atop the scout ship's mast spies an enemy vessel, he immediately radioes this fact to the battleships and they begin firing. The officers on the scout vessel can with their powerful telescopes, easily determine whether the shots are passing to the right or to the left, or to the rear or in front of the enemy target or targets, and this information is instantly radioed to the attacking battleships. Seaplanes from the battleships themselves can also serve the purpose of the scout ships in spotting the effect of the gun fire on the enemy, as well as discovering their position.

It may be easily imagined that a seaplane at an altitude of several thousand feet and provided the atmosphere is fairly clear, has a wonderful range of vision toward the horizon. Naturally, the question arises as to what would become of such a scout ship, the mast of which could be undoubtedly sighted by the lookouts in the crow's nest of the enemy war vessels.

To make a long story short, there are

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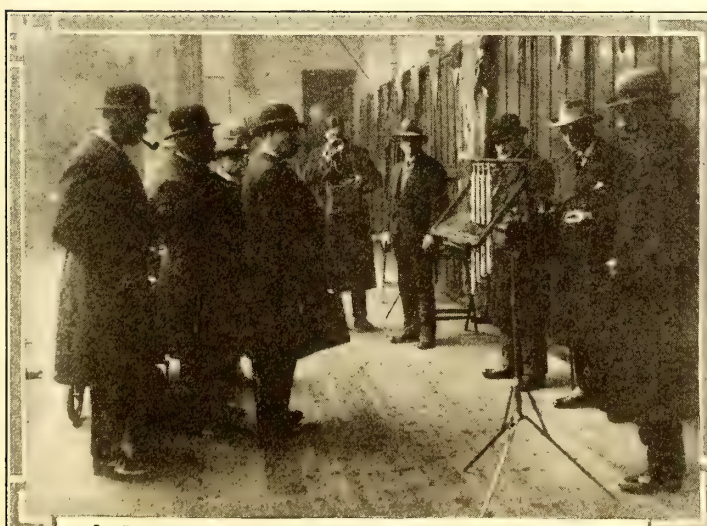
His Whistle Stops Auto

BY means of a whistle a miniature motor car, containing two lay figures, was run, stopt and turned at the will of the whistler in a hall off Tottenham Court road recently, in England.

Further, by the influence of a ray of light the mustache of one of the lay figures twitched and its hand moved rhythmically, while in a corner the Westminster chimes rang out on an instrument.

The magician who produced these wonders was Captain Alan Roberts, an Australian. After long experiment he believes he has perfected apparatus for control by light and sound waves. One of the photos herewith shows Captain Roberts starting and stopping a mechanical musical instrument (tube bells) by means of a ray of light. This photo was taken in the Drill Hall, Chelsea Street, W. C., London. The second photo shows Captain Roberts demonstrating his new invention, the small motor car being entirely controlled by the sounds from a whistle.

Captain Roberts gave a demonstration on the possibilities of light and sound control. Standing in the middle of a crowd of men, Captain Roberts blew a blast on an ordinary police whistle. Immediately the electric motors of the car began to hum, and the little vehicle in which was seated two models slowly glided across the floor. He blew another blast and the car stopt, turned around, glided deftly past chairs and apparatus and finally moved slowly back to its starting place. By turning a beam of light on and off, a gong was made to sound at will and by blowing on whistles of different keys, little electric bulbs were lit up thirty yards away.

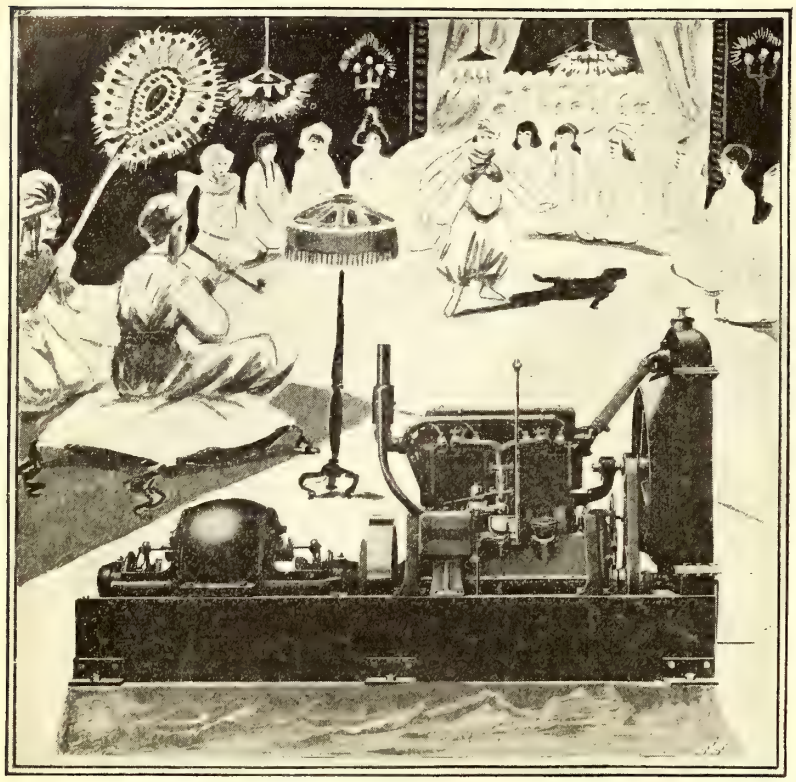


An English Inventor Is Here Shown Operating a Set of Musical Tube Bells by Sound Waves.



The Above Picture Shows the Miniature Motor Car Which Captain Roberts Causes to Obey Each Blast On a Whistle.

King of Siam Electrifies His Palace



The King of Siam, Among Other Recent Acquisitions to His Palatial Home, Has Added an American Lighting Plant, Which is Shown in the Picture Herewith. This Electric Lighting Plant Is Driven by a Gasoline Engine, Similar to an Automobile Engine, as Shown in the Illustration and It Is Rated at 5 K. W. Electric Output. This Electric Light Plant of Which a Large Number Have Been Sent Abroad the Past Few Years, Is Interesting Owing to Its Full Automatic Features. A Gold-plated Typewriter Was Also Purchased on This Trip, but History Doth Not Record Whether or Not the Dynamo Was "Gold-plated."

HIS Majesty the King of Siam, recently purchased a 5 kilowatt electric plant to furnish light and power for his luxurious royal palace. The special representative sent by His Majesty spent considerable time investigating many factories and in studying the features of the various plants on the market, and because of its full automatic features the latest type full automatic plant, illustrated, was selected. On this same American trip a *gold-plated* typewriter was purchased. History doth not record whether or not the dynamo was gold-plated.

A 10 kilowatt electric light and power plant of the same type was recently shipt to Rene Berndes, who is the ex-Hungarian consul for Cuba. Señor Berndes has recently gone into the sugar business and has an immense, modern plantation which requires an ample installation for both light and power.

The Presidential train of the Republic of Mexico, renowned as perhaps the most elaborate train in the world, presented by the Pullman Company to the Mexican Government, has just been equipt thruout with electric lights and one of these full automatic plants was installed. This train was presented during the regime of ex-President Diaz and has been in constant service ever since. It is most lavishly decorated and finished without regard to expense, several of the interiors being trimmed in gold-leaf, with intricate and classic hand carvings, and inlaid with ivory.

These plants are the same as are used thruout America on thousands of farms, but are of larger models. The patented full automatic features make it a most popular plant where reliable service is expected. It gives the battery full protection at all times against over-charging or excessive discharge. It starts and stops itself automatically. These plants are built in seven sizes—from 1/3 to 25 kilowatts.—*Photo courtesy Consolidated Utilities Corp.*

Lighting the "Big Top"

Nowadays when the Circus comes to town, at least if it is one of the big fellows like Ringling Brothers and Barnum and Bailey, the "big top" and the "side show" and the "menagerie" are all electrically lighted. The old-time, dangerous flares are not to be seen in the tents where the crowds are entertained. As soon as the canvas is in place and guy-ropes are tightened the electrician appears to hang his lamps upon the poles. Then his helpers bring in wheeled reel-holders containing the heavily insulated feed lines, run the wires out, and finally connect the terminals to the generating plants outside the "big top."

These portable sets are mounted upon ordinary circus wagons, well built to stand the continuous wear of country roads and city pavements. Each unit consists of a four-cylinder gasoline motor, of seventy horsepower, turning a twenty-five kilowatt generator and making 120 volt current. Then of course there is a switchboard. Each unit uses three gallons of fuel per hour operated.

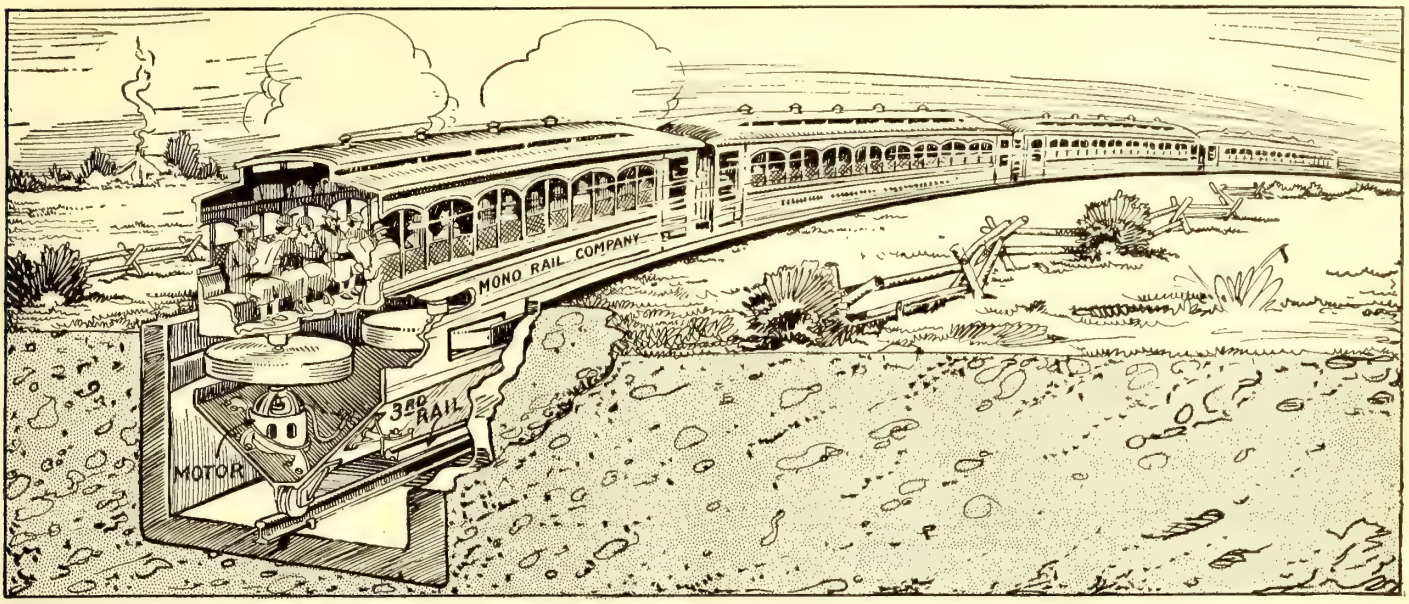
The "big top" contains twenty-four big arcs, twelve 750 C.P. lamps and twelve 500 C.P. lamps. The "side show" and "menagerie" tents have fewer lamps because they are much smaller. For afternoon shows only the "big top" is lighted but in the evening the electrician opens up with all the juice he has in stock. Needless to say, electrically lighted tents are safer than those lighted by any sort of combustion system. In addition the grounds may be illuminated by using the flood lights placed upon one of the wagons. Yes, it sure is some change from our fathers' and grandfathers' day when they used to chew peanuts and drink pink lemonade by the flickering light produced by a series of kerosene or gasolene torches. Later, there came into use the very efficient but always dangerous acetylene gas lighting systems, while at the present time most of the traveling shows "under-canvas" employ electric lights exclusively. If they do not carry their own electric light generating plant, then they invariably procure the necessary electric current from the local town supply.

Generally speaking, the most satisfactory method of lighting "tent shows," would seem to be the one utilizing the independent lighting plant of the type illustrated below. Some smaller tent shows, have made use of storage batteries having these charged periodically,—but without a shade of doubt the most efficient and satisfactory way, is to have a suitable size dynamo, driven by a gasoline or other form of engine. With the advent of the modern high-powered tungsten lamps with nitrogen filled bulbs, the tent lighting problem has been much simplified as some of these bulbs are available in 1,000 candle-power units, which corresponds to the illuminating power of the average arc light.

Contributed by G. B. WOODS.



The Circus Will Soon be with Us Once More, and in the Event That You Do Not Know Where the Electricity Comes from for Lighting the Immense Tents Carried by Such Shows as "Ringling Brothers," Here Is the Answer—Complete Electric Lighting Plants Driven by Gasoline Engines Are Mounted in Trucks. The Flood Lights Seen on Top of One of the Trucks Are Used for Lighting the Grounds.



A Newly Proposed Monorail Rail-road, One Form of Which Is Here Illustrated, the Cars Traveling in a Trench and Being Propelled by Friction Wheels as Shown, or by Gears Meshing with Toothed Racks. The Propelling Wheels Are Driven by Electric Motors and Procure the Necessary Current from a Third Rail. The Monorail Is Reputed to be the Fastest System of Transportation.

Novel Electric Monorail Car

It is a well-known fact that cars placed on a single line of wheels will run much faster than if placed on a double rail as at present, and it further follows that if a car or locomotive can be made to run on a single rail in a normal, stable and upright position, it must necessarily travel faster than the ordinary trains, at the same time using an equal amount of fuel or electricity. So says Max Scheftel, of Brooklyn, New York, the inventor of the new monorail shown in the accompanying illustration.

Mr. Scheftel proposes two different methods of applying his monorail railway system. In either case the cars run on a single or monorail track as becomes evident. Electric current for propelling the cars may be taken either from a trolley wire or a third rail, and the current returned thru the center monorail on which the cars run. The cars may be propelled, according to Mr. Scheftel, either by having an electric motor or motors drive large friction wheels which protrude thru openings in the sides of the car, so as to buck against flat friction rails on the sides of the trough in which the cars run, or else they may be operated by gear wheels protruding from the sides of the cars, which gears may mesh or engage two toothed racks placed along the sides of the conduit.

The latter undoubtedly would make a very severe noise and prove objectionable, excepting for some short run railway such as a scenic railway or roller coaster.

The inventor has designed the cars with a tapering bottom and other mechanical features, so that they will permit the car to run with the utmost efficiency and at the highest speed possible.

In cities where the building of such excavations is not permitted, the inventor describes a different construction for the cars and trackage, which is made of structural steel upon the level of the street, the center monorail on which the car travels being laid on the street surface. In this case the guide rails on the sides are supported by structural steel arches.

Had Your Teeth X-Rayed?

Here's the newest dental X-ray machine. It's noiseless, yet extremely powerful and rapid, requiring a minimum exposure period. Relative to the technique of taking dental X-ray pictures, it naturally requires a film or plate behind the portion or parts of the body to be X-rayed, but the advantage claimed for this machine is in the time and milliamperes required for making an exposure.

Exposures on all machines are figured in milliampere seconds. This, being arrived at by the time of exposure, multiplied by the milliamperes. In other words, with a meter reading of 25 milliamperes and an exposure of 4 seconds, it would give an exposure of 100 milliampere seconds. Where other machines operate on anywhere from 50 to 150 milliampere seconds, this machine operates on from 4 to 8 milliampere seconds.

The current is turned on and off by the foot treadles operating from both sides of the machine.



Have You Had Your Teeth X-rayed? That Is the Question You Hear Everywhere Today, for Our Best Dental Experts Aver That No One Can Tell Just What the Trouble with Our Teeth Is Until They Look Thru Them as Well as At Them, by Utilizing an X-ray. One of the Latest Dental X-ray Machines Is Shown in the Accompanying Illustration. This Machine Is Very Powerful and One of the Highest Speed Types Yet Devised, Yet It Is Simple to Operate and Does Not Frighten the Patient. The Position of the Patient Is Shown Herewith When Taking a Skiagraph of the Teeth. A Foot Pedal Turns on the Power.

The matter of safety is one that must be looked into very thoroly. In this machine the tube on the inside is completely incased in a *lead casting*, which shapes out into the funnel from where the exposures are made, giving absolute protection as far as the operator of the machine is concerned, there being no chance for the rays to escape except thru the opening in the funnel. As to the safety for the patient the low milliampere-second exposure is again the big factor here. According to the best authorities on X-rays, it takes a minimum of 800 milliampere-seconds directed at the same spot to cause X-ray burn. It is readily seen, therefore, how much leeway this outfit has over a machine using 100 milliampere-seconds to an exposure, as compared to 4 milliampere-seconds here required. The lead covering of the tube also protects the patient on all parts of the body except just where the rays from the funnel are directed, or in the region of the teeth.

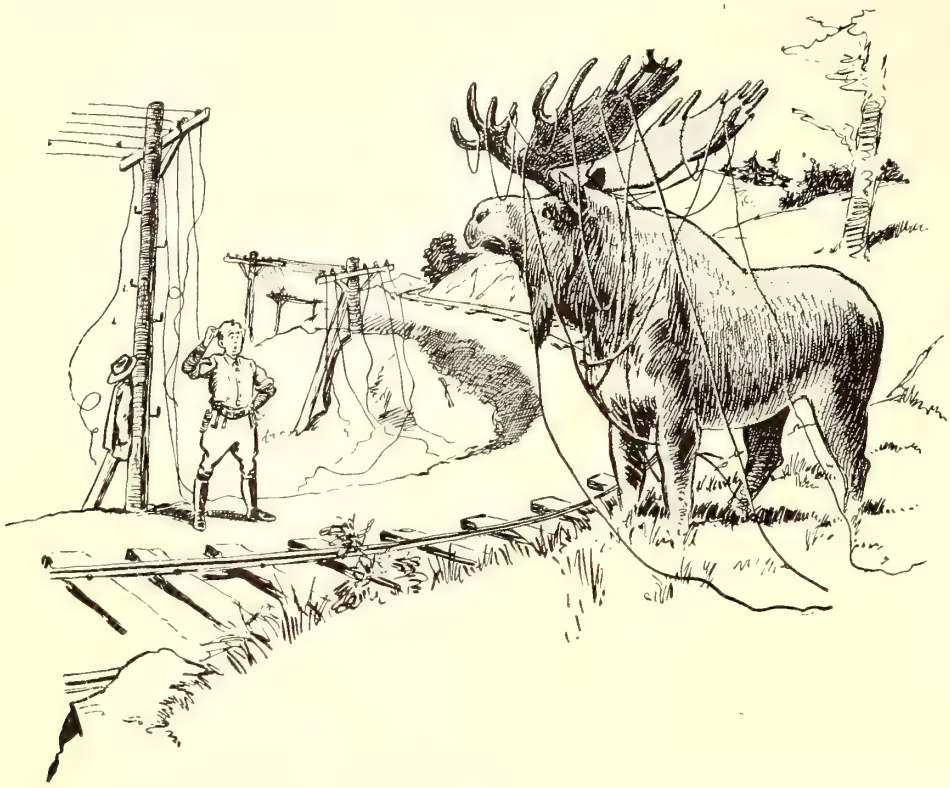
"Bull Moose" Steals Wire

Any sportsman from the big cities who finds a bull moose running around in the neighborhod of Wassataquoik stream with 40 or 50 feet of telephone wire coiled around his neck and horns, and a loose end trailing ten or fifteen feet astern of him, is hereby informed that the wire belongs to the Lincoln Pulpwood Co., of Lincoln, Me., and that the moose stole it and thus put the line from Trout Brook to Bangor, Me., out of business for a while. Herbert S. Stone, of Bangor, lineman for the company, tells how it happened in the following realistic tale:

"I had just got to McCarty's camp at the head of Trout Brook when the boss told me that there was an open wire between there and Staceyville. As this is the direct wire to Bangor, down over Pogy Mountain and by way of Wassataquoik, I rustled some grub and struck out to find the break. Got to Pogy same night. All right there. Followed the wire down to Wassataquoik and from there to Halfway Camp at the mouth of Katahdin Brook, where I arrived the next night. Still no break. Next morning I took up the trail again and a couple of miles down, near Daisy Dam. I found the slack wire and the break, but to my surprise I could find but one end. Hustled along looking for the missing end and finally found it 500 feet further on. What had become of the missing 500 feet? There I was, two days' travel from headquarters camp, with only about 50 feet of wire on my back, for short splices. Fine fix! I sat down on a stump and finally thought of an abandoned branch line that once connected a lumber camp two miles further along. Went down there and got enough wire to fill the gap.

"When I got back to the break in the line I soon found out what had become of the missing 500 feet. There stood a bull moose as big as a truck horse, looking straight at me as much as to say: 'Here's your old wire. Come and get it.' Well, so long as I'd hoofed it better than four miles to get my wire I thought I'd repair the break and argue with the moose afterward. The job was soon done, and after I had called up Staceyville on one end and McCarty's camp on the other and told them all was clear, I turned to the moose, having first picked out a handy tree to climb in a rush should the bull get too fussy.

"There stood the moose," he said, "just at the edge of the road, with six or eight turns of the wire twisted tightly around his horns, several turns around his neck and three or four hundred feet of slack behind him, reaching, Lord knows where, into the woods. Sneaking around, the moose watching me all the time, I managed to get hold of the slack wire and hauled in until I got the end, which I made fast to a big tree. Then cutting a good-sized sapling, I started toward him. He began to sidle around, with head down, mane bristling and blood in his eye, and it looked like war. Pretty soon, however, he managed in his circling movement to make a turn around another tree, which gave him much less scope, and when the wire came taut with his contant traveling he stumbled over it and fell in a heap. Now was my chance. I sneaked up as close as I dared—maybe within fifteen feet, snipt off the wire with my pliers and made for my tree."



It Sounds Impossible, Doesn't It, That a Real "Bull Moose" Should Walk Off Very Mysteriously with a Goodly Length of the Telephone Wires and Leave a Complete Gap in the Pole Line? But, This Actually Happened Up in Maine, and as They Have Had "Prohib" in That State for Many Years, It Must be as True as Gospel. Friend Moose Reappeared After the Gap Had Been Repaired.

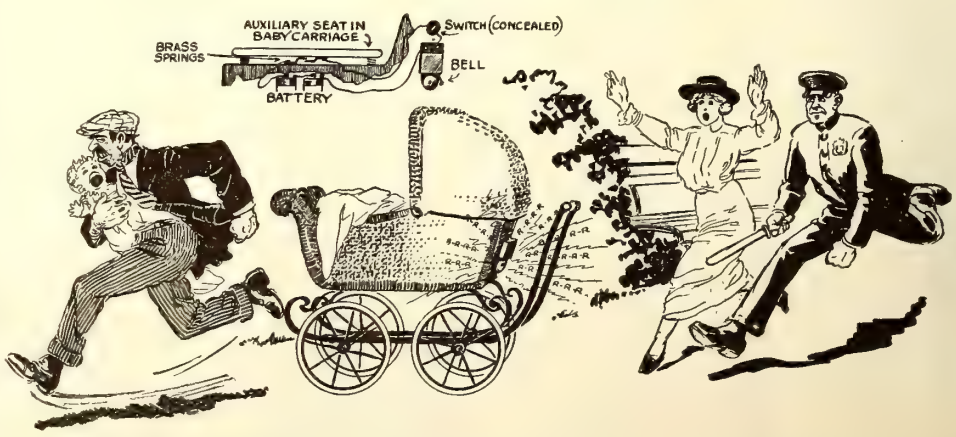
Electric Bell Foils Kidnappers

Dozens of babies are kidnapt or stolen every year, especially in the large cities, and while electric bell alarms have been with us for the past fifty years, no one has ever thought, it seems, of putting such an electric bell alarm on the baby carriage.

Now, Nursey can spoon on the park bench with her friend "Mike The Copper" to her heart's content, without having to worry herself into a French fit whether the baby is or is not within the carriage, several yards distant. For never fear, Snookums will be there!—when she goes to look for him—thanks to this electric alarm.

The diagram shown in the accompanying illustration explains in a clear manner, the simple way in which the electric alarm is attached to the baby carriage. As will be seen, when the infant is lifted from the seat, the springs under it push it upward, causing the electrical contact springs to come together, thus closing the electric circuit thru the dry battery and bell. An ordinary 25-cent bell, together with a dry battery or two, is all that is required. A hidden switch of course, should be placed in series with the circuit as shown, so that the bell will not ring unnecessarily.

We should certainly be thankful to the budding genius who has presented us with this "long felt want"—and now we shall expect to be presented with a multitude of other greatly needed electric alarms. Why not tie one of these electric thief announcers to little Fido's neck or better yet, to his tail. Of course it would take quite some study to find just which part of Fido will respond or move in an unusual direction when a stranger happens to pick him up. Possibly, however, this can be arranged in the form of a harness with a handle, said handle being made in two parts with electric contact springs between them, so that when the handle is grabbed, it will cause the springs to touch, thus ringing the bell. "Doggone" that sure is a clever invention, if we do say it ourselves. But what if he uses a net!?XO?



No More Will the Naughty Kidnapper "Nap the Kid,"—Not While the Electric Bell Alarm, Here Shown, Is In Working Order on Little Snookum's Go-cart. Isabel and Her Friend "Mike the Copper" Will Make It So Hot for Him That He Will be Glad to Give Up the Kid and Take a Nap.

Trolleys We Have Met

IN OUR travels here and there about the country, we have often met some interesting electric trolley cars and some of these impressions we have attempted to record in the accompanying illustration. It is perhaps rather interesting anyway, to the average layman, to know for a certainty just how the current is taken into a trolley car of the ordinary type, down the trolley pole, thence thru the controller and motor on the car axles or truck, and how the current passes back thru the rails to the power station.

THE SINGLE WIRE TROLLEY.

This is the simplest form of electric trolley car and one which has been used not only in the United States, but in practically every civilized land under the sun. They are even now talking of electric trolleys in the Holy Land, and we presume that before many moons have past over our heads, they will have a trolley running up the corners of the great pyramids of Egypt and climbing the grades of the Sphinx's nose in the far-away land of Cleopatra. Thus, the trolley has its romance as well as its seamy side in history. And here is how it all works!

One wire from the trolley power station is connected to the overhead insulated trolley wires and this is usually the positive line. The potential used on the average trolley is from 550 to 600 volts, direct current. This current passes along the wire, thru the trolley wheel and pole, from which point it divides and passes thru the lights and heaters on the car, which are controlled by suitable switches, while the heaviest part of the current is carried thru heavy insulated copper wires down to the motorman's controller on the platform. The current then passes from this speed controller to the motor or motors mounted on the car trucks and which are suitably geared to the car wheels. One side of the motor windings is grounded and the current then passes thru the axles and wheels to the rails on which the car runs, and thru which the current is returned to the negative side of the power station dynamo.

Of course, the rails must form a very good conductor, and any ordinary joints between rails will not do, and so these are made electrically perfect, or as nearly so as possible, by "bonding" them with copper cables, welded or riveted to each rail. Even then there is often considerable leakage of the current from trolley rails, and in cities this leakage current often works considerable evil by passing thru water and gas pipes, and when they leave such pipes as these, they carry with them in an electrolytic manner some of the metal composing the pipe.

THE DOUBLE WIRE-TWO POLE TROLLEY.

For the reasons just enumerated—that is due to electrolysis of many city water and gas pipes and also from the point of scenic effect, many cities have never allowed the trolley companies to install any overhead wires, or in some other cases they have prevented the trolley companies from holding franchises to permit the return current to pass thru the rails.

In Cincinnati they have one of the cutest little trolley systems you ever saw in your life! They do not return any current thru the rails, and a glance at Fig. 2 tells you the reason why! Every trolley car has *two poles* bearing against *two trolley wires*—these members being spaced about 18 inches apart. One wire is charged with positive current while the other is the negative wire, that is, the current comes from the power station dynamos along one wire, passes down thru one pole, thence to the controller and motor, from which point it is returned thru the second trolley pole to the negative trolley wire.

When one first sees this double trolley pole arrangement and until he has seen these cars negotiate curves and corner turns, he is almost willing to bet his last dollar that they cannot get around a corner very fast without having trouble, and lots of it! But such is not the case, and from what the writer recently saw of them, they turn corners faster than the slot system trolleys in New York and several other cities employing that method.

THE THIRD RAIL SYSTEM.

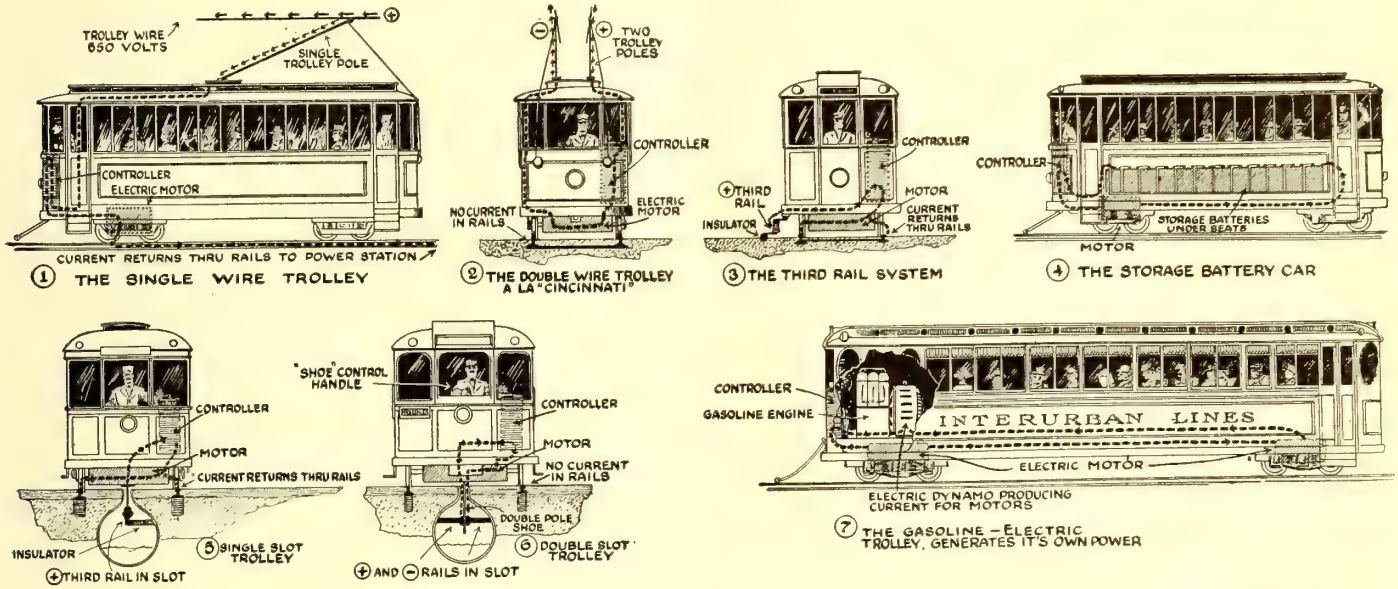
This method of supplying current to electric trolley cars and trains has been widely employed, and it is, of course, in its usual form not adapted to city use, as the third rail would be too dangerous even tho it were covered in some way.

In the third rail system, this member serves the same purpose as the trolley wire in Fig. 1 (See Fig. 3). The positive current passes along from the power house generators or sub-stations on the insulated third rail and the car takes current from this rail continuously by means of a specially flexible contact shoe. The current then enters the controller, whence it goes to the motor and then to the wheels and rails thru which it returns to the power station. There are systems in Europe which have been operated by means of two and three third rails with contact shoes bearing on each, so that no current has to pass thru the rails.

THE STORAGE BATTERY CAR.

At quite an early date in trolley history, there was proposed a storage battery car, to do away with the overhead poles and the ever-attendant troubles accruing therefrom, not to mention the marring of the beauty along the boulevards and prominent city thorofares. Many of these cars have been used from time to time, but not until recently was the storage battery car very successful owing to the fact that the fumes given off by the battery while working escaped thru the battery cabinets under the seats and into the passenger compartment of the car, and there is hardly anything more irritating to the throats and comfort of the passengers than the sulfuric acid battery fumes. However, in more recent years, and by suitable ventilation means as well as by improvements in battery design, this objection was practically overcome, and in New York City there have been operated lines of storage battery cars for a period of several years. These were the little red cars which ran along the "Belt Line" circuits, and those who are familiar with New York transportation lines will undoubtedly remember them. They were operated over some of the old horse-car belts, for the pur-

(*Continued on page* 1057)



Among the Trolleys We Have Met in our Perambulations About the Country Are Those Illustrated Above. Out Cincinnati Way They Have the Double Pole Trolley With Two Trolley Wires Spread Along the Streets. In New York and Washington They Have the "Slot" System, Which Obviates the Use of a Third Rail or Trolley Pole—and Then There Is the Storage Battery Car and the Gasoline-Electric Car for Long Interurban Runs.

Popular Astronomy

By ISABEL M. LEWIS, M.A.

Of the U. S. Naval Observatory

Meteorites

METEORITES are stones that fall to the earth from the heavens. They furnish the one tangible evidence that we possess, aside from that of the spectroscope, as to the composition of other bodies in space and it is a significant fact that no unknown elements have ever been found in meteorites, tho the compounds are so characteristic that they make these stones readily distinguishable from stones of terrestrial origin.

The origin of meteorites is not definitely known tho the evidence is very strong in favor of the theory that they are the larger fragments of disintegrated comets of which meteors, shooting stars, fire-balls and bolides are the smaller; the distinction between the two being simply that the latter class includes all bodies that are completely consumed by friction with the earth's atmosphere and, therefore, only reach the surface in the form of meteoric dust.

According to other theories meteorites may be fragments of shattered worlds that have chanced to come too near to a larger body and have been disrupted by tidal friction or they may be possibly the debris left after the major planets and their satellites were fashioned from the primitive solar nebula.

Interplanetary space is far from being a void. Our own planet sweeps up in the course of a single day, it has been estimated, approximately twenty million shooting stars or meteors of sufficient size to be visible to the naked eye while the estimate for the telescopic particles runs up to four hundred million.

Meteorites on the other hand are far less numerous. On the average it has been concluded, about one hundred meteorites strike the earth in the course of a year of which number only two or three are actually seen. According to Bulletin 94, U. S. National Museum, approximately six hundred and fifty falls and finds of meteorites have been reported, representatives of which appear in museums and private collections.

Meteorites, as well as shooting stars and meteors, frequently appear in showers. In such instances the fall usually consists of several hundred or thousand individual stones and the area over which they fall is several square miles in extent and roughly ellipsoidal in shape. One of the most remarkable of such falls occurred in January, 1868, when something like one hundred thousand stones varying in weight from fifteen pounds to a small fraction of an ounce fell near Pultusk, Poland. Another remarkable fall of meteorites occurred at L'Aigle, France, in 1803. Between two thousand and three thousand stones fell over an ellipsoidal area six and two-tenths miles in greatest diameter, the aggregate weight of the stones being not less than seventy-five pounds.

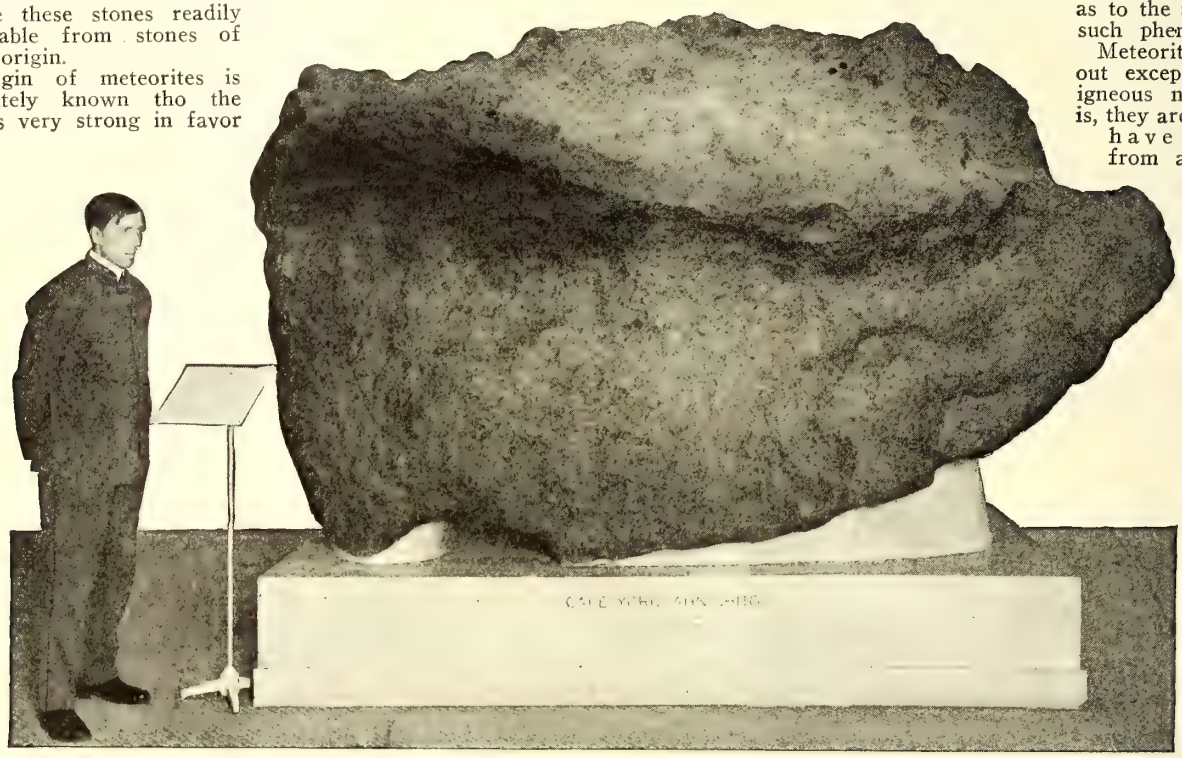
This fall of stones is of particular interest since it took place at a time when men were still very doubtful as to whether or not stones actually fell to earth from the heavens.

After this fall had occurred in a most populous district of France in broad daylight and attended by violent explosions that lasted for five or six minutes and were heard for a distance of seventy-five miles no reasonable doubt could longer be held as to the actuality of such phenomena.

Meteorites are without exception of an igneous nature, that is, they are rocks that have solidified from a molten condition. They can be classified into three groups, Aerolites or Stoney Meteorites, Siderolites or Stony-iron Meteorites, and Siderites or Iron Meteorites.

Strange to say, of all the meteorites that have been seen to fall only nine belong to the group of Siderites or Iron Meteorites tho the three largest meteorites known Peary's meteorite from Cape York, Greenland, weighing 37½ tons, the meteorite lying on the plain near Bacubirito, Mexico, weighing about 20 tons and the Willamette, Oregon meteorite weighing 15½ tons all belong to this group. Moreover, all the Canyon Diablo meteorites which are strewn concentrically around Coon Mountain crater in northern Arizona to a distance of about five miles are members of this same group. Coon Mountain or Meteor crater itself is a perfectly round hole about six hundred feet deep and over four thousand feet in diameter and was formed, it is believed, by the impact of a huge meteorite which has never been found. It is believed that the Canyon Diablo meteorites of which there are nearly four hundred individuals in the U. S. National Museum alone, were members of this same fall. It is possible that these meteorites of the Canyon Diablo district with the huge meteorite that produced the crater itself formed the nucleus of a comet that struck the earth not more than five thousand years ago according to the geological evidence.

All iron meteorites or siderites (from the Greek sideros, iron) are composed chiefly



The Largest Meteorite in Existence, Weighing 37½ Tons. Note Its Immense Size. The Material Is Chiefly Iron With a Small Percentage of Nickel. The name Ahnighito Is Eskimo, Meaning the "Tent," Due to Its Tent-Like Shape.

Photographs, courtesy American Museum of Natural History, New York.

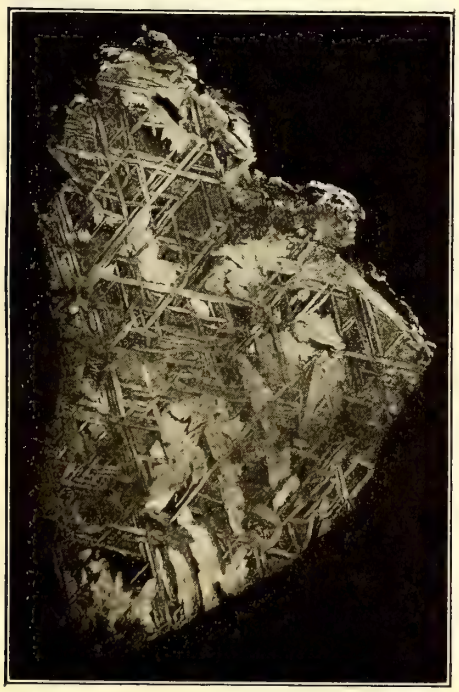


Slice of Kingston Meteorite Showing Widmanstätten Figures. This Meteorite Fell in New Mexico. The Figures Are Obtained by Polishing and Then Etching the Metal by Means of a Weak Acid.

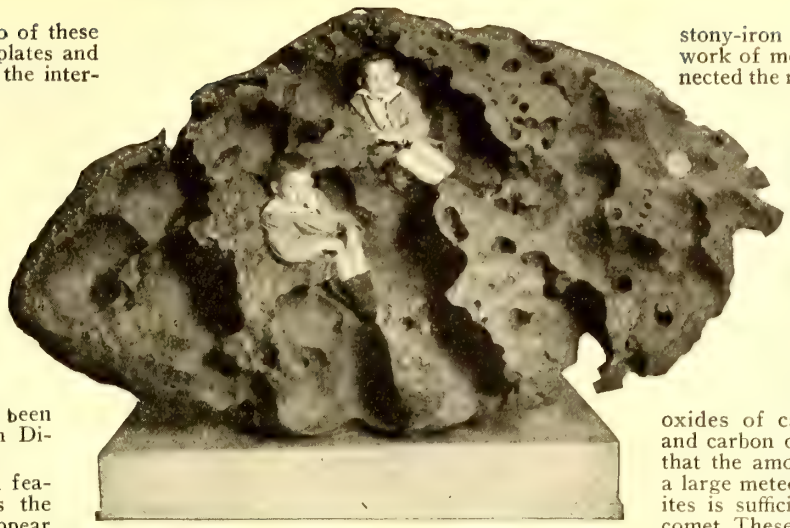
of alloys of nickel and iron. Two of these alloys occur in the form of thin plates and a third fills the space formed by the intersection of these plates. The percentage of nickel in these iron meteorites is very small, usually from five to ten per cent, while the iron forms about ninety or ninety-five per cent of the whole. Cobalt is also present in practically all iron meteorites in small quantities of 1 per cent or less. Usually small quantities of iron sulphide and phosphide as well as graphite or some other form of carbon appear in the iron meteorites and in some instances black and white diamonds have been found, as in some of the Canyon Diablo irons.

A very interesting and beautiful feature of many iron meteorites is the Widmanstätten figures which appear when a section of such a stone is polished and treated by means of a weak acid. These figures are due to the unequal solubility of the three different alloys of nickel and iron of which the stones are composed. (See photos.) The irons giving the Widmanstätten figures are known as octahedral irons. Other irons known as hexahedral irons give figures of a different type known as Neumann figures when the polished section is treated with weak acid while other irons are so homogeneous in their composition that they show no figures at all.

Aerolites or Stony Meteorites occur more abundantly than iron or stony-iron types and they are classified into many divisions and subdivisions according to their composition. In these stones appear certain compounds that are commonly met with in terrestrial igneous rocks. The mineral that is most abundant in the stony meteorites, composing sometimes nearly seventy-five per cent of the stone, is a magnesium and iron silicate known as olivine which is also usually present in terrestrial rocks of an igneous nature. Certain compounds found in the stony meteorites are rarely if ever found in terrestrial rocks, however, and these serve to distinguish the stony meteorites readily, from stones of terrestrial origin. The alloys of iron and nickel, for instance, that occur in minor quantities in the stony meteorites and make up usually about ninety-five per cent of the mass of the iron meteorites are not found in terrestrial rocks. Altho about thirty of the terrestrial elements are to be found in meteorites, the forms and compounds in which they appear are so characteristic and to a great extent so different from those occurring in terrestrial rocks, that the analyst has no difficulty in distinguishing between the two. There are, for instance, certain formations known as chondrules, peculiar spherical and oval shapes, varying in size from minute particles to objects the size of a walnut, appearing in many varieties of stony meteorites that are never found in terrestrial rocks, and that are one of the most interesting puzzles associated with the origin and nature of these stones. Sometimes the chondrules are so loosely embedded in the stone that they fall away when it is broken. In some instances almost the entire stone is made up of these chondrules. According to one theory the chondrules were originally molten drops, like fiery rain, and their internal structure which is greatly varied depends upon their conditions of cooling.



Section of Knowles Meteorite Showing Widmanstätten Figures. These Lines Are Characteristic in All Meteorites.



The Famous Willamette Meteorite from Willamette, Oregon. One of the Largest Meteorites in Existence. Note the Peculiar Pit Formations Large Enough to Seat the Two Boys. These Pits Were Probably Formed by Gases While the Meteorite Still Was in the Molten Form While Passing Through the Earth's Atmosphere.

Stony meteorites in which these chondrules are to be found are spoken of as chondrites. There are white and gray and black chondrites and crystalline and carbonaceous chondrites according to the nature of the chondrules found in the stones.

Stony meteorites also contain minute quantities of iron and nickel alloys in the form of drops or stringers.

Upon entering the earth's atmosphere stony meteorites become coated with a thin black crust which is a glass formed by the fusion of its surface materials by the heat generated during its passage thru the atmosphere.

In many of the stony meteorites there also appear fine thread-like veins which are due to the fracturing of the stone prior to its entrance into the atmosphere. The material filling these veins is coal black in color, opaque and of an unknown composition.

Many meteorites show signs of collisions and encounters with other meteorites outside of the atmosphere as would be expected as they travel in swarms and groups. Sometimes the entire meteorite is composed of fragments of two or more distinct stones cemented together. Such a stone is spoken of as a *breccia*.

In the third class of meteorites to which we now come, known as the stony-iron meteorites, there is a network or sponge of nickel-iron alloy the interstices of which are filled with stony material.

When this network or sponge is continuous the meteorite is spoken of as a stony-iron pallasite. When the network of metal is more or less disconnected the meteorite is a meso-siderite.

If meteorites are heated in a vacuum, the conditions existing in interplanetary space being thus produced to a certain extent, they give forth their occluded gases and it has been found that these gases give spectra identical with the spectra of certain comets. Meteoric irons give forth hydrogen as their characteristic gas while the gases occluded in the stony meteorites are chiefly the oxides of carbon, carbon monoxide and carbon dioxide. It has been found that the amount of gases contained in a large meteorite or shower of meteorites is sufficient to form the tail of a comet. These facts all tend to strengthen the belief that meteorites are indeed cometary fragments.

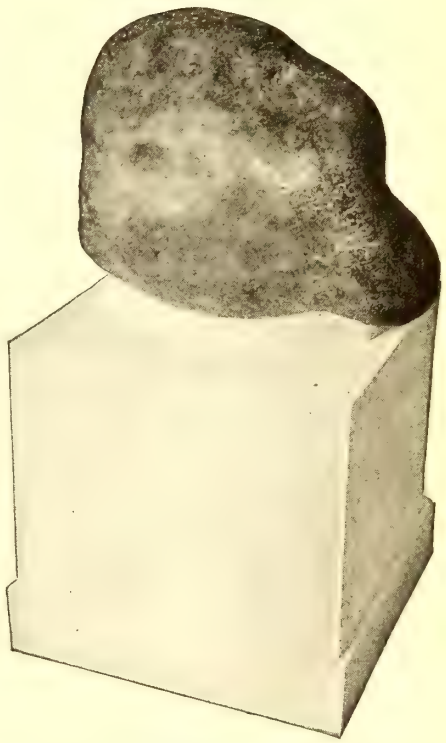
In view of the fact that some geologists believe meteorites may be fragments of other worlds it is of interest to know that so far no fossil-bearing meteorites have been found and if meteorites are fragments of a shattered world such worlds must have been reduced to a molten condition at the time of the catastrophe.

The rapid passage of the meteorite thru the air leaves a partial vacuum in its trail into which rush the molecules of air from all sides producing the characteristic noises that accompany the passage of a meteorite which have been compared to the rattle of artillery, the distant booming of cannons or the rumble of thunder.

There may be, moreover, explosions of inflammable gases occluded in the crevices of the meteorite which will shatter it into fragments or the meteorite may be shattered by the resistance and pressure of the atmosphere or as a result of the extremes of temperature existing between the interior and its surface. Many meteorites have actually been seen to burst into fragments in the air with a loud report.

There is practically no foundation for the belief that germs of life have been brought to our planet on such igneous rocks. No

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This Is the Famous "The Dog" Meteorite from Cape York, Greenland. It Weighs Several Hundred Pounds.

THE Canadian GIANT Reflector

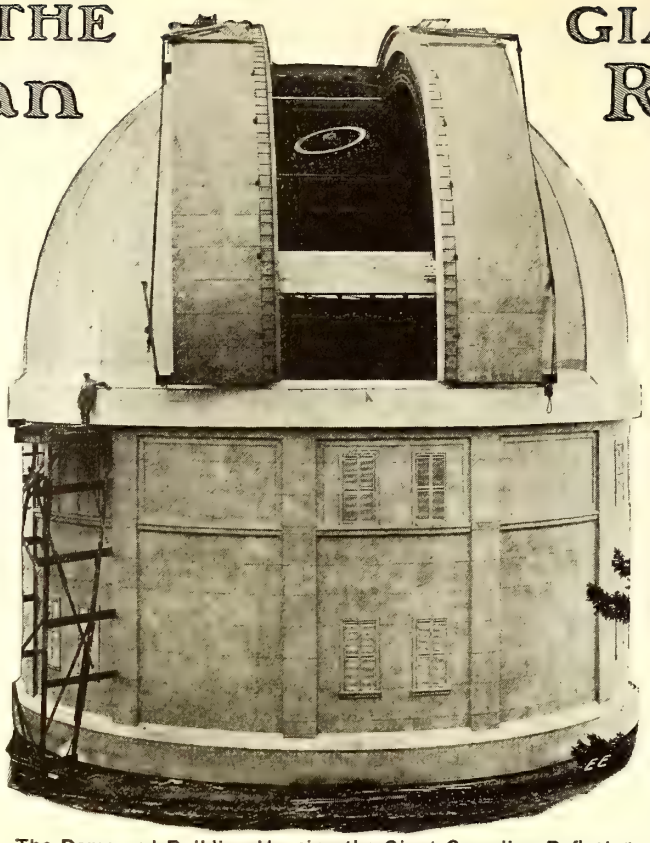
By Professor Floyd L. Darrow

THE 73 INCH CANADIAN TELESCOPE

SECOND PAPER ON BIG TELESCOPES

A DECADE ago the world celebrated the three-hundredth anniversary of the invention of the "telescope," and in fitting recognition of the tremendous service to science of these marvelous adaptations of lenses and mirrors there were under construction at that time the two largest telescopes ever projected. The 100-inch reflector at Mount Wilson, California, was described in the January issue, and in the present article we shall consider the big Canadian telescope which for a brief period enjoyed the distinction of being without a peer among the observatories of the earth and is still of very great scientific interest.

Crowning the summit of Saanich Hill, Victoria, B. C., stands the Canadian observatory at an elevation of 732 feet. There the "seeing" qualities of the air were found to be much better than in Ottawa, and this is the fundamental factor in determining an observatory site. The exacting requirements of science and not those of politics or local pride must be the sole consideration in a work of this kind. Fifty acres of land were purchased around the summit of the hill and an electric railroad built to the top.

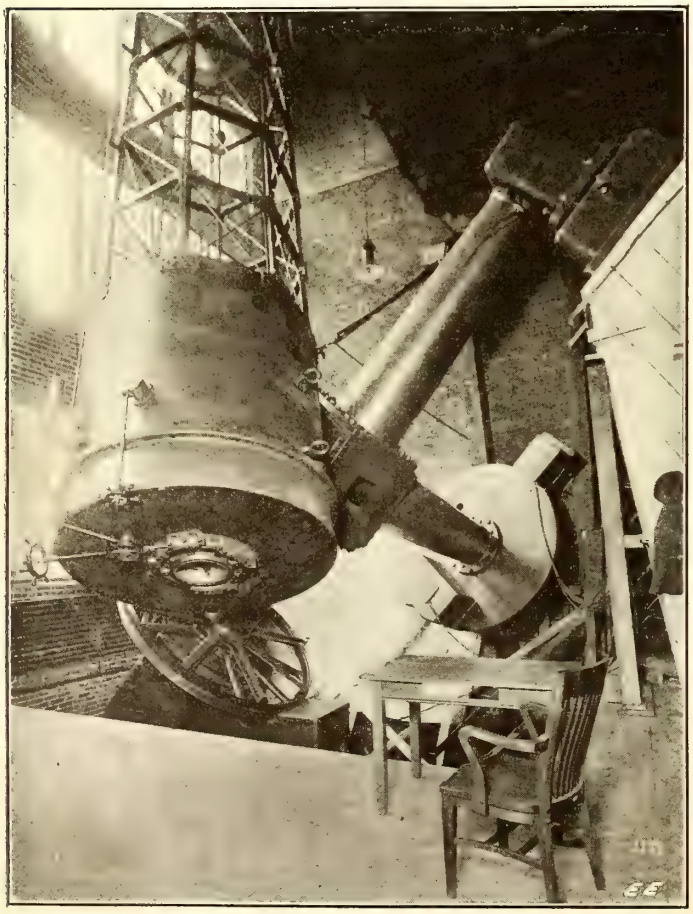


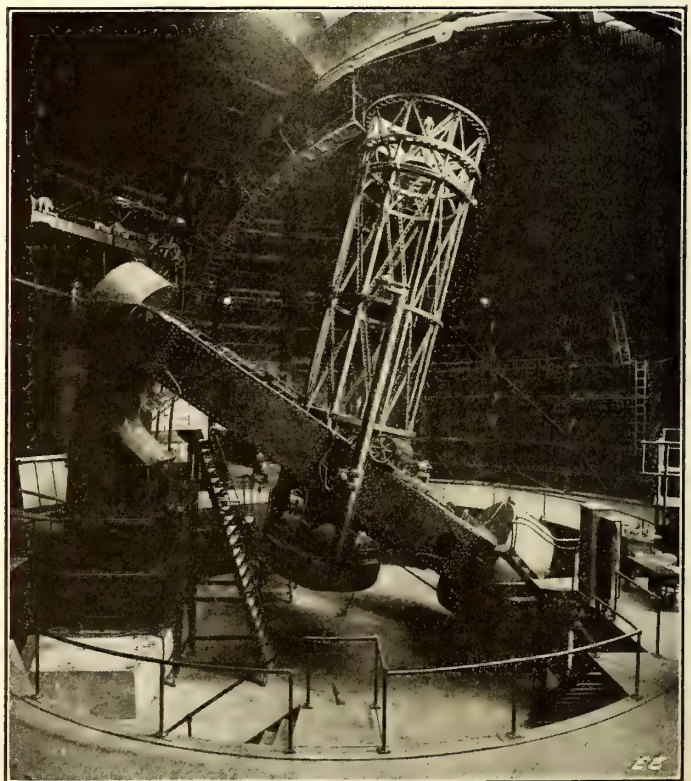
The Dome and Building Housing the Giant Canadian Reflector, Photographed from the North. Diameter 66 Feet, Height 75 Feet. The Dome "Shutters" Open Up to a Width of 15 Feet, Exending Past the Zenith. The Upper End of Telescope Tube with the Observing Platform in Position Are Seen Half Way Up the Shutter Opening. Note Size of Man on Scaffold.

The mirror was cast at the famous works of St. Gobain, France, now in ruins from German occupation. It was placed on ship-board for transportation to Canada just two days before the beginning of the Great War, and it is good to know that in the midst of this great world cataclysm, so noble a work of science could proceed unmolested. Its purposes are as eternal as the universe and as far removed from world strife as the stars are high above it.

It is true that the mirror of the famous Rosse telescope had an aperture equal to that of the big Canadian reflector, but it was of *speculum metal* instead of glass and far from perfect. The art of grinding and figuring mirrors has made marvelous progress in the last three-quarters of a century. The mounting, too, of the big English telescope did not permit of its convenient use for astronomical observations. Previous to the building of the Canadian telescope, the 60-inch reflector at Mount Wilson was the largest practical instrument ever constructed, but this has now been twice out-distanced and what the future holds in store no man can foretell.

The mirror, the fundamental element of the giant telescope, is 73 inches in diameter, 12 inches thick at the edge, and is pierced by a hole at the center 10⅛ inches in diameter as shown in an accompanying view. Its weight is 4,340 pounds. The back is flat and the front concave, being very slightly parabolic in form. The con-





Above:—Excellent Photo of the Mt. Wilson Telescope Described in the Last Issue of the Electrical Experimenter. Note the Different Style of Mounting as Compared to the Canadian Reflector Here Described and Illustrated.

At Left:—View of Large Canadian Reflector, Showing Mirror Cell and Lower End of Tube. A Wonderful Electric Controlling System Enables the Astronomer to Train This Telescope on Any Heavenly Body and Follow It Accurately.

cave surface differs from a true sphere by only one one-thousandth of an inch and nowhere deviates from the theoretical curve calculated by the mathematicians by more than the *two-hundred-thousandth of an inch!* The grinding of such a mirror is one of the most exacting and delicate tasks of the optician's art. Anything less than the most skillful craftsmanship will ruin the glass and bring to naught long years of patient labor. No other product of the mechanical arts speaks so eloquently of the infinitude of human toil and painstaking care as a finished lens or mirror. There is not a moment from the mixing of the batch materials for the casting of the glass down to its successful mounting in the telescope tube, that it is not the object of anxious solicitude.

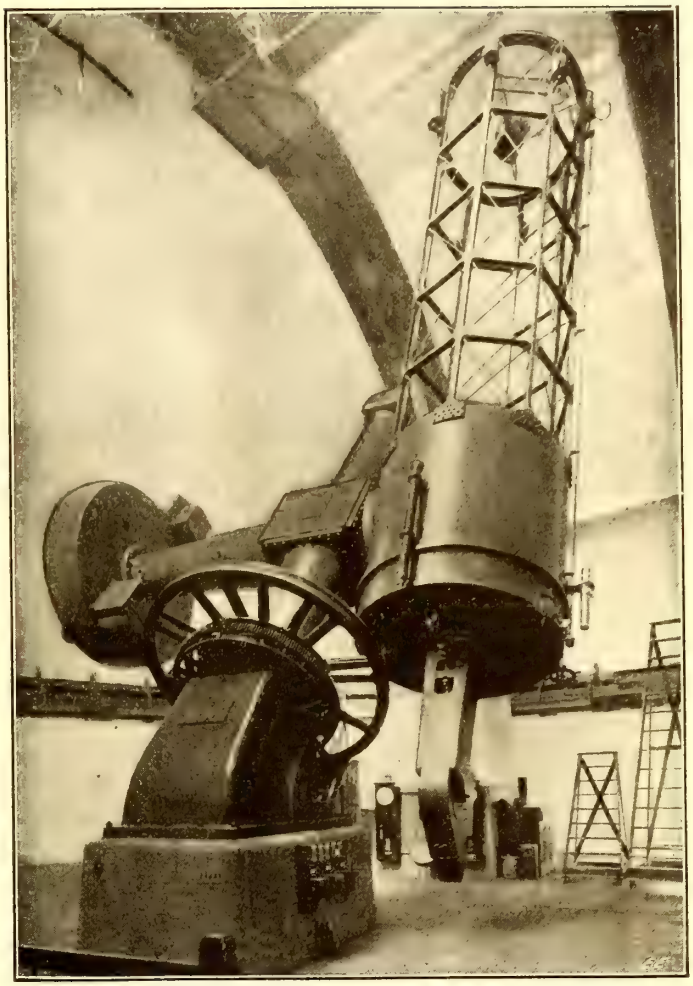
Second only in importance to the mirror itself are the mounting and housing of the telescope. The telescope tube is 31 feet long, 7½ feet in diameter and weighs 12 tons. It consists of three sections, the lowermost one being the mirror cell, in which the massive glass is held so securely that no flexure or distortion can occur. Above this is a central cylindrical casting 6 feet long and weighing 7 tons, to the upper end of which is firmly attached the rigid skeleton tube. This skeleton is 23 feet long and weighs 2 tons.

The telescope tube is mounted on two axes at right angles to each other. The *polar axis* is parallel with the earth's axis and therefore points constantly to the pole star. It is 23 feet long and weighs 10 tons. The other axis, called the *declination axis,* is 14½ feet long and weighs 5 tons. At its right hand end it carries a flange 41 inches in diameter, to which the telescope tube is attached. At the opposite end of the *declination axis* a heavy counterpoise keeps the weight of the axis in perfect balance. So nicely is this huge mass, representing a total weight of 55 tons, poised on the ball bearings of the polar axis that *a pressure of 5 pounds will set the tube in motion.* The two axes can be clearly seen in an accompanying photograph. The circular housing at the left contains the motors and gearing for rotating the telescope on either axis.

The housing at the foot of the polar axis contains the driving clock with the gearing of which the toothed wheel, 9 feet in diameter and weighing 2 tons, meshes. The driving weight of the clock is a falling mass of 1,000 pounds. This clock is so made that it will turn the polar axis and with it the telescope around once in exactly 24 hours. The necessity for this will become apparent from a consideration of the fact that a star does not stand still in the heavens but appears to move from east to west just as the sun does. Thus if the telescope were trained on a star, the latter would remain centered for only a few moments and would quickly pass out of the field of vision if there were not some provision for counteracting its apparent motion. The motion is due, of course, like the sun's rising and setting, to the rotation of the earth on its axis. Therefore, by turning the telescope about its polar axis at the exact rate of the earth's rotation, but in the opposite direction, a star once centered will remain so until it disappears from view below the horizon.

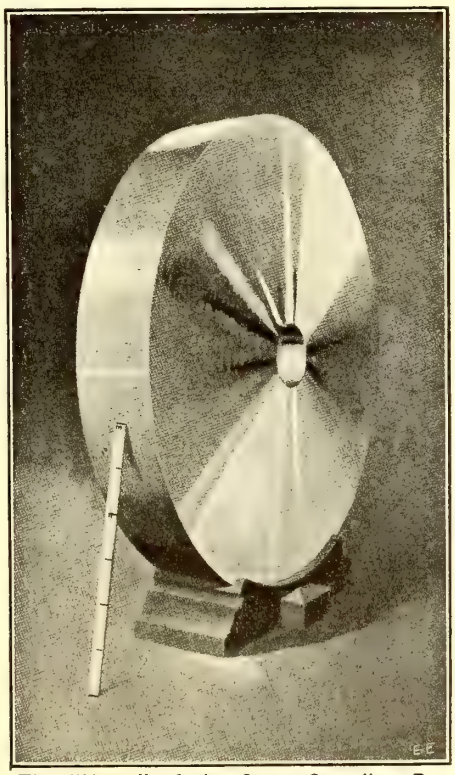
Aside from the driving motion of the clock the telescope may be subjected to three other motions. These are accomplished by means of 7 electric motors with solenoids and magnetic clutches. The first is a rapid movement for the approximate training of the telescope on any star. This motion is at the rate of 45 degrees per minute and it may be about either axis. The two slower motions are for "fine setting." There are two electric switchboards for controlling these motors, one on each side of the observatory, and in addition a portable switch-board from which the operator may set the telescope, rotate the dome and elevate or lower the floor without leaving his chair. When a star has been found the driving mechanism is thrown into gear and the star seems to stand still in the field of vision.

The polar axis is mounted on massive piers of reinforced concrete and the whole is housed in a steel structure 66 feet in diameter. Double walls of sheet metal surround the sides and these are surmounted by a dome weighing 120 tons. The dome is provided with a shutter 15 feet wide, which is opened when observations are being made. An electric motor turns the dome completely round in 6 minutes, thus enabling the operator quickly to turn the opening to any point of the compass. The observing bridge, controlled by electric motors, may be brought into any desired position.



Another Remarkable View of the 72-Inch Reflecting Telescope of the Victoria Observatory, Canada, the Second Largest in the World. Its Mammoth Glass Mirror Measures 73 Inches in Diameter, 12 Inches Thick at the Edge (See Cut of Mirror Below), and Weighs 4,340 Pounds. The Telescope is 31 Feet Long, 7½ Feet in Diameter, and Weighs 12 Tons.

The silvered surface of the mirror brings the light of distant stars and planets to focus 30 feet above its surface. For use as a *Newtonian* type telescope a plane mirror 19 inches in diameter and inclined at an angle of 45 degrees is placed at this point, and the light is reflected to the eyepiece, photographic plate or spectrograph at the side of the tube. An electrically operated elevating platform permits observations at the top of the tube. For very faint stars the photographic plate or spectrograph can be placed at the prime focus itself.



The "Heart" of the Great Canadian Reflector—the 73-Inch Reflecting Mirror. Thru the Center of the Mirror is a Hole 10⅛ Inches in Diameter.

More frequently, however, the telescope will be used in the *Cassegrain* form. For this combination a 19-inch convex mirror is mounted 7 feet from the upper end of the tube and reflects the light back thru the hole in the center of the large mirror to the eyepiece, photographic plate or spectrograph. Used in this way the equivalent focal length becomes 108 feet.

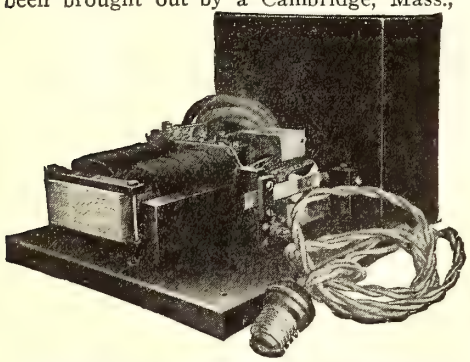
The principal work for which this telescope has been designed is to analyze the light of the stars by means of the *spectrograph.* A spectrograph is an instrument for dispersing light into its component colors and photographing the spectra thus produced. These spectra not only tell us what elements are present in the star's atmosphere but also reveal the motion of the star. When a star is approaching our solar system its spectrum is shifted toward the violet, and when receding the displacement is toward the red. By the amount of this shifting the star's velocity may be determined within two or three miles per second. The spectrograph also reveals the physical state of stars, nebulæ and comets. A continuous spectrum means an incandescent solid or a gas under great pressure, while a discontinuous or bright-line spectrum proves the presence of a light, vaporous firemist.

(*Continued on page* 1054)

. . . Automobile News . . .

NEW RECTIFIER FOR BATTERY CHARGING.

A practical and economical device for charging storage batteries from an alternating current source of supply has just been brought out by a Cambridge, Mass.,



A New Battery-Charging Rectifier Which Cannot Charge Backwards.

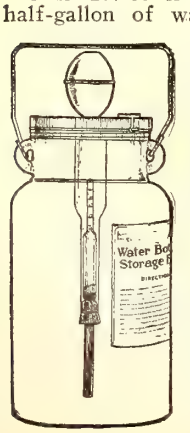
concern. It is intended for home, garage or laboratory use where it is not desired to charge a large number of cells at one time.

The operation of the rectifier is as follows: The current on entering the device is passed thru a transformer to lower its voltage to slightly more than that of the battery. The current is then conducted thru a vibrating reed which oscillates to and fro in unison with the changes in direction of the alternating current. On the end of this reed is a contact point which makes contact with another similar point connected to the storage battery whenever the current is flowing in the correct direction to charge the battery. It disconnects the battery from the circuit when the current is flowing in the wrong direction.

The impulses thus flow into the battery in one direction only. The maker states that the instrument is so constructed that it automatically charges in the right direction regardless of which direction the battery is connected. The advantage claimed for this device is its simplicity, there being no lamps, liquids, rheostats or other parts liable to become broken, or to require frequent renewal. The instrument is supplied with a cord and plug for connection to any 60-cycle lighting circuit. The battery may be charged overnight if desired, and the battery need not be removed from the car or other place of mounting. The rectifier is self-starting and in the event of temporary failure of the supply current, the battery is automatically cut off so that it cannot discharge back through the rectifier. Upon the restoration of service it automatically starts charging again.

UNIQUE DISTILLED WATER BOTTLE AND STORAGE BATTERY FILLER.

This device is made of glass, holds a half-gallon of water, has a dial on top to show last date battery was filled, while thru the fiber cap, and down into the bottle, is a Hydrometer Syringe, which is used for transferring the water from bottle to storage battery cells, and testing the strength of the solution.



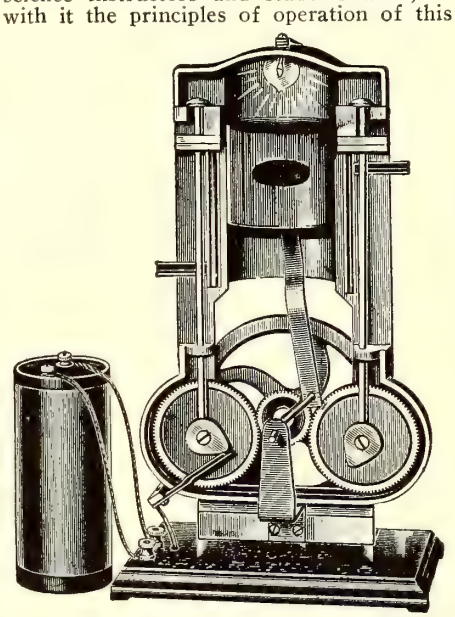
The old method of filling storage cells with distilled water by pouring the water thru a funnel, subjects the water to contamination from two sources: First—Thru contact with a metal funnel; and Second—Thru contact with dirt, dust and grease that has accumulated in the funnel. However, with the arrangement here shown, the water comes in contact with no metal, and it is impossible for dirt, dust or grease to be injected into the cells.

Filling thru a funnel is also apt to cause an overflow from the cells, but with this new filler—the point of the syringe resting just over the mouth of the cells—the operator can see just exactly what he is doing, and there is no chance of over-flowing the cells and thus weakening the battery.

The Hydrometer furnished with this equipment will show at a glance whether your battery is partially or fully charged.

CLEVER ELECTRIC GAS ENGINE MODEL.

No gas engine is more extensively employed at the present time than the vertical four-cycle type. It is the heart of the automobile, motor truck, airplane and motor boat. In view of these facts the electric gas engine model designed by a Chicago firm will prove exceptionally valuable to science instructors and students alike, as with it the principles of operation of this



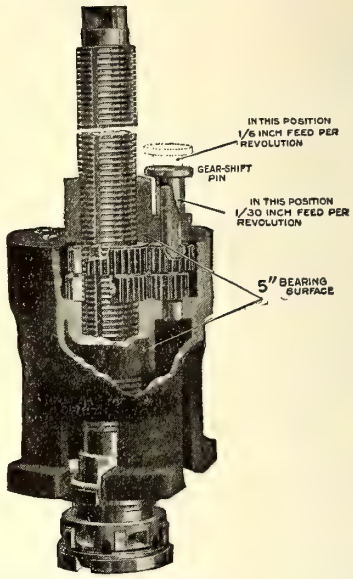
The Light Flashes Like the Spark Plug In This Engine Model.

most popular type can be clearly and effectively illustrated. It clearly shows the intake stroke, compression stroke, explosion stroke and exhaust stroke. It illustrates valve action, cam action, and timing-gear action. It also shows the principles of the ignition system. It demonstrates clearly the following parts in their true relationship: Cylinder, piston, crank shaft, valves, gas intake port, exhaust port, water jacket, water inlet, water outlet, timing gears, valve-lifting cams and fly-wheel. The spark plug is represented by a small incandescent bulb *which flashes at the beginning of each explosion stroke,* thus producing a most realistic effect. The model is made entirely of metal and stands 15 inches high.

AN IMPROVED CYLINDER REBORER.

The new cylinder reboring tool, here illustrated, enables anyone to rebore cylinders in their own garages, or it can be used on the farm to rebore cylinders of any tractor, truck or passenger car.

About 10 to 18 minutes is all the time required to rebore a cylinder with this tool, and do a better, truer job than you can possibly do by lapping in by hand. Lapping in pistons takes from 2½ to 3 hours per cylinder and the result is not a first-class mechanical job in any case.



Improved Cylinder Reborer for Autoists.

With a universal cylinder reboring tool any ordinary mechanic in your shop can rebore the cylinders of any motor, either detachable head or closed end cylinders, and do a perfect job—make a correct fit on every cylinder, regardless of the oversize of piston to be used. One operation for each cylinder is all that is necessary.

You can take out 31 one-thousandths of an inch or 1 one-thousandth of an inch in one cut. Any workman can operate it.

ELECTRIC HEATER FOR AUTO ENGINE.

This heater fills a need long felt by nearly every automobile owner for a simple, economical and effective method of keeping his automobile engine and carburetor warm during the frosty days of winter. It is the ideal method of keeping the engine warm while the car stands in the garage. Thus, on cold mornings no difficulty will be experienced when starting the engine, as the temperature of the engine will always be well above that of the outside air.

It is ruggedly built and practically indestructible. The heating unit is protected by a strong perforated sheet metal guard wound entirely around the heater. A rigid metal hook allows the heater to be placed anywhere under the hood. The flexible cord is long and the plug can be attached to any lamp socket. Altogether it is a well-built heater with no delicate parts to get out of order. The heater is placed where it it will do the most good at least cost.



Perpetual Motion Contest Awards

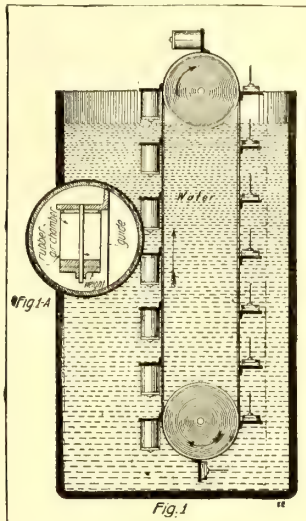
THE "Perpetual Motion" Prize Contest, which was publisht in the November issue, was a howling success, and we received enough letters to keep the Board of Judges busy for several long evenings. All the answers to the perpetual motion contest, were examined by the following Board of Judges: Professor John J. Furia, Instructor of Physics, New York University; H. Gernsback, Editor of ELECTRICAL EXPERIMENTER and RADIO AMATEUR NEWS; and H. W. Secor, Associate Editor of the ELECTRICAL EXPERIMENTER.

Up to the time of the closing of the contest, January 15th, the editors had received 2,596 letters attempting to explain why the three perpetual motion schemes here illustrated, and described in full detail in the November issue, would or would not work.

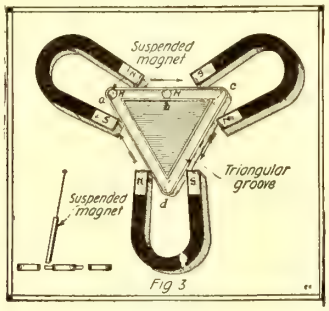
We have been so favorably imprest by the first two letters here publisht, those from Messrs. Ralph A. Wood and B. O. Burgin, that we have decided to pay each of them a $10.00 CASH PRIZE, instead of awarding but one $10.00 prize.

Mr. Burgin carries off the honors for the best technical answer as to why the three suggested perpetual motion schemes would not work, while the palm for the most humorous and technically correct solution goes to Mr. Ralph Wood. And we were certainly pleased to hear from the girls! Forty-four of the 2,596 answers received were from the "fair sex." The best solution received from the ladies was submitted by Hannah Dvorcef, of Montpelier, Vt. Her explanation of the perpetual motion schemes is publisht herewith. The judges have furthermore decided to give this contestant, as well as Mr. R. Hope, aged thirteen, who submitted the best solution for contestants, fifteen years or under, one year's subscription to the ELECTRICAL EXPERIMENTER. To Mr. Loy Coak of Jackson, Mich., whose answer is reprinted verbatim, a consolation prize of one genuine United States Steel engraving of Washington (a 1-cent stamp) has been awarded!

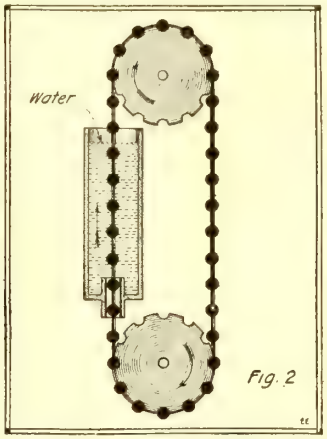
Several other very good solutions to the perpetual motion contest problems are publisht herewith, also. At an early date, we may have the pleasure of announcing another contest along similar lines, and we take this occasion to thank heartily all those who took an interest in this contest, and wish them better luck next time!



The Expansive Rubber Chambers Have Weights Fitted to Them, Which Weights Cause These Chambers to Collapse as They Descend Down Through the Water on One Side of the Belt; While as They Start to Ascend on the Up Side of the Belt, the Chambers Open up and Present a Considerable Amount of Buoyancy. Imagine What a Tremendous Amount of Buoyancy a Series of These Air Chambers Will Give!



A Magnetic Pendulum Arranged in the Manner Shown, so That a Suspended Magnet Reacts in a Field Created by Three Horseshoe Magnets. The Lower End of the Suspended Magnet Runs in a Triangular Groove as Shown. Apparently, the Pendulum Magnet Should Keep on Rotating Around the Groove, and in the Direction of the Arrows Perpetually! Is It So?



Another Water Power Perpetual Motion Idea Which Is Out of the Ordinary Class. This Promising Design of "Everlasting Motion" Machine Utilizes a Series of Hollow Balls Mounted on a Continuous Belt. Gravity Helps the Downward Motion of the Balls on the Right Side, While as Soon as They Enter the Water Chamber at the Left There Is Realized a Considerable Amount of Buoyancy Created by the Long Series of Hollow Balls Which Are Pushed Upward by the Water.

PRIZE WINNER $10.00.

Wal, wal, wal! What wont ye city fellers git up next? So ye've bin an invented perp-e-tual motion?

Now that there dingus in figger 1, she looks slick, gosh a'mighty, if she'd do what ye say I'd hitch one t'the old saw-mill an I'd have all my cord wood sawed up in no time. But say Gents, she sorter reminds me o' one a them there gold-bricks. Looks durn purty on th'outside, but cut her open an she's bogus inside. Jest ye take a nother slant at that wha'cha-call-it. How in thunder be them buckets a goin t'close up? I cant see no air vent t'let the air out when she gits t'the top, an if ye do have a air vent, an all th'air is squoze out when she tips over and goes down, how t'blazes be ye goin' t'git 'em filled up again down t'the bottom, 'cept with water, then whar's this here "buoyancy" gone to.

'S no use Gents I aint goin t'buy one 'till ye git her fixt bettern that.

There, Gents, ye take that there riggin No. 2 an she's a good-un, if she'll work. I'd have one o'them put in t'run the cream separator with but fur one thing. I'm afeered I'd do more work pumpin water t'keep that there stand pipe full, than I'd have to t'jest turn the old separator by hand as we'uns allus did. Why by Heck, Gents, ye see she'd be jest sure t'back fire an run tuther way till all the duned H_2O in that there tank run out, an then I'd have t'pump her up agin, every time she run out. So I guess I'll jest let that there new-fangled-she-bang alone, she'd make me work too hard.

What's that there contraption ye got the "Fig. 3" marked on, Gents? She looks like the old "YD" "Yankee Division" brand, but say, Gents, that rig aint no bettern yur other two.

Ye know Gents, when that there swingin "N" pole gits snuggled up t'that there "S" pole on one o'them there magnets, she'll git so affectionate and stuck on that there "S" pole, she jest wont do no wanderin on. It'll be a case o'love at first sight or mootual-attraction, an if any o'them other "N" poles has anything t'say, it'll jest be t'push her up tighter t'the old "S" pole. Then ye'll have to come along and shove her off, an t'keep her on the go I'm afeered ye'll find it too much work fur the price.

'S no use Gents, I'm real superstitious bout this here perp-e-tual motion. I've allus had th'idea 'at that there ain't no such animal, so I'm some sure it'll take more'n some purty pictures t'change them ideas.

When ye see a feller tryin t'lift himself by his boot-straps, try him, Gents, per'aps ye'll be able t'sell him one o'them there jiggers.

I am, Gents,

Your 's'pectfully,

RALPH A. WOOD,

97 Bartlett Ave., Arlington, Mass.

PRIZE $10.00.

The devices described on page 649 of the November number of ELECTRICAL EXPERIMENTER will not work as perpetual motion machines for the following reasons:

Scheme 1. Since the pockets are air tight, no air can enter or leave them. If the pockets are empty, as on the right, they will still be empty on the left, even though the weights are not supported by the brackets, because no air can enter. If, on the other hand, they possess air, as on the left, they will still possess the same air on the right, even though the weight is on the top, because the air cannot get out. In either case the buoyant effect will be the same on each side. Any compression of the air due to water pressure would be the same on both sides and, therefore, would not modify the action.

Scheme 2. The fallacy of this scheme lies in the fact that there will always be a ball entering the tube at the bottom of the tank which has a downward pressure on it due to the entire depth of water but no upward pressure because no water is under it. It is easily shown by principles of hydrostatics that no matter how many balls are used or how high the tank may be the downward pressure on the ball just entering would be greater than the buoyancy on all the others.

Scheme 3. The difficulty with this scheme is that it is assumed that the north pole of the suspended magnet will, during parts of its motion, move away from a south and toward a north pole. Suppose, for example, it were moving past "b" toward the right-hand magnet. Even tho its momentum carried it past S of the right-hand magnet (which is improbable) it would have to stop at "c" and would then move back toward S rather than toward N which repels it.

Very sincerely yours,

B. O. BURGIN,

Instructor of Physics, Albany High School, Albany, N. Y.

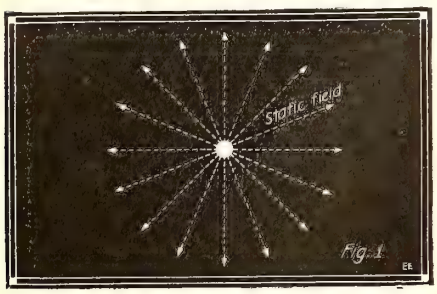
The other answers received to the Perpetual Motion Contest Problems printed in the continuation are equally interesting.

(*Continued on page* 1059)

The New Theory of Electrical Mass

By ROGERS D. RUSK, M.A.

THE idea that the mass or weight of a body is due to electricity and nothing else is rather surprising at first and yet this new theory is one that is quite steadily gaining ground. Electricity explains many things because it

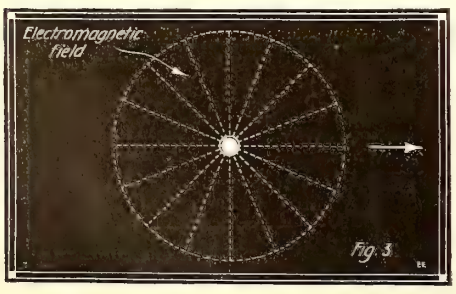


An Electron At Rest Has Only a Static Field and Its Weight Is Very Minute.

is one of the most fundamental quantities in the universe, and if matter is electrical in nature, as there now seems to be no doubt, then the properties of matter must in some way be electrical phenomena. This may seem to be a startling conclusion, and yet it is no more startling than the experiments by which it has been suggested.

When the notion of electrical mass or weight was first proposed a few years ago it was a very hazy and abstract notion. Today it has not only become more precise and practical, but it is of such far-reaching importance that it underlies all science and forms the basis for a complete electrical theory of matter. At the very start let us remember that the two words *mass* and *weight* have very much the same meaning except that the mass of a body or the quantity of matter in a body is always constant while the exact weight of a body may be slightly different at different points on the earth's surface where the attraction of gravity does not have the same value. For this reason we shall use the word *mass* to indicate that property of a body which causes it to have weight or to resist motion. The idea that mass is electrical in nature is a heavy blow struck at old-fashioned science which thought matter, electricity and energy and many other things were all separate and distinct quantities instead of being fundamentally interrelated, if not one and the same.

When it was discovered that all atoms of matter contain electrons, which are nothing more than minute electrical charges, scientists immediately began to wonder where atoms get their mass, and *if a particle of electricity could have mass.*



The Field About a Slowly Moving Charge or One at Rest Is Symmetrical.

In answering this question there are three possible theories; first, that the weight is totally electrical; second, that it is partly due to electricity and partly due to some non-electrical material which we will indicate by the word mechanical; third, that it is totally mechanical. The latter view is not tenable now because we know the electrical charges in an atom exert some effect on the mass so that the choice narrows down to the first two theories.

WHY ELECTRICITY RESISTS MOTION.

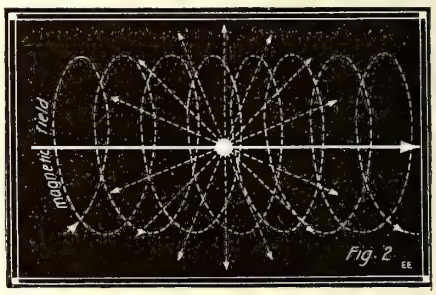
The first thing to consider is the way in which these electrons in an atom influence the mass of the atom, and it is easily explained. *The mass of a body is its power to resist motion.* Now a unit electric charge or electron also has the power to resist motion hence it has a certain amount of mass. Just why an electric charge resists motion is of fundamental importance. When at rest an electric charge has only an electric field as shown in Fig. 1. When the charge is in motion it has not only an electrical field as shown, but also a magnetic field as in Fig. 2. This field represents a certain amount of energy and the energy taken to set the charge in motion was the energy taken to create the magnetic field. In other words, in order to overcome the resistance of the charge to being set in motion, a certain amount of energy had to be used up in creating the magnetic field. This quantity is a measure of the electrical mass of the charge. Such a resistance with ordinary charges at ordinary speeds is a very small quantity and does not explain the notion that all mass is electrical.

It was at this time that J. J. Thomson, the electron wizard, suggested from mathematical considerations that in the case of very high velocities, approaching the velocity of light, the charge having the greater velocity would have the greater mass. This was a startling suggestion that the mass of an electrical charge would depend on how fast it was moving, but shortly it was able to be proved by experiment. It was a fortunate thing that radium had just been found to emit electrons at high speeds, and Thomson, Kaufmann and others experimenting with these high speed electrons found out that it was true that the faster-moving particles had the greater masses. As these electrons contained no mechanical matter at all, *it was evident that their mass was all electrical.* Hence it is plain that as all atoms contain electrons that part of the mass of the atom is electrical. The next question is: What is the rest of the mass of the atom due to?

According to the modern electrical theory of matter, *all atoms are composed of NEGATIVE electrons and POSITIVE particles and nothing more.* The electrons are unit charges of electricity only, but the exact nature of the positive particle has never been discovered so that there are two views concerning it which may be held. First, it seems logical to suspect that it may be similar to the negative particle and consist of nothing more than electricity. On the other hand, we cannot prove it yet, and it may have some mechanical matter in addition to its electrical charge. If the first is true then all the mass of an atom is due to electricity, but if the latter is true then part of the mass is due to something else which we may call mechanical matter and concerning which we know absolutely nothing.

HOW SPEED AFFECTS MASS.

At present experiments point strongly to the probability that all mass is electrical, and that the positive particle is similar in that respect to the negative particle, being different from it only in sign. That the



The Weight (Inertia) of a Moving Electron Is Greater Than One at Rest Because of the Magnetic Field Generated by the Motion.

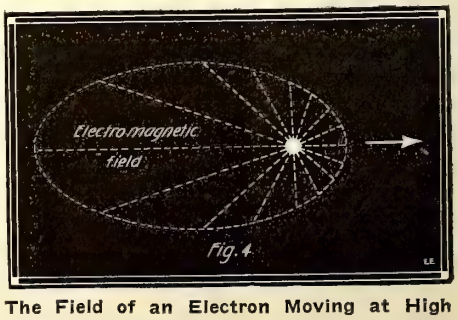
whole mass may be electrical will be more evident from the following explanation as to how an electric charge may have a very appreciable mass at high speeds when it has a very inappreciable mass at low speeds. This is the reason:

If we first consider a small metal sphere which is uncharged, then we say it has no field and there are no lines of force about. But suppose that all at once the sphere receives a charge, then an electric field is set up about the ball. This electric field is not established instantaneously but grows, so to speak, out from the charged sphere at approximately the speed of light. When the sphere is set in moderate motion, the sphere keeps its field in front of it as well as behind, but when it moves at high speeds, approaching that of light, it is not able to build its field in front of it before it has past on to another point, so that the field is distorted and drags out behind. As the resistance to motion of an electric charge depends on its field, the more the field is enlarged by distortion the more mass the charge will have. It is evident, however, that this only occurs at high speeds, and it is very easily understood by reference to the diagrams.

PICTURING ELECTRICAL MASS.

Fig. 3 shows a stationary or slowly moving charge with the usual symmetrical field. Fig. 4 shows a charge moving at a very high speed in the direction of the arrow and the distortion of the field that is produced. The charge could not build its field in front of it fast enough, and the field behind lags and is distorted because it does not disappear instantaneously after the charge has

(*Continued on page* 1079)



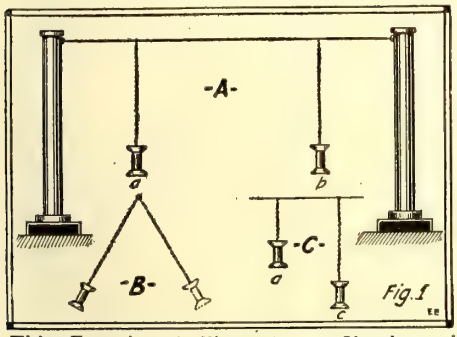
The Field of an Electron Moving at High Speed Is Distorted and the Mass Increases With the Speed.

Experiments in Physics

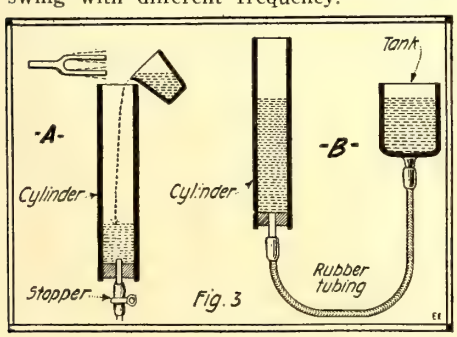
By JOHN J. FURIA, A. M.
DEPARTMENT OF PHYSICS, N. Y. UNIVERSITY

NO. 5 RESONANCE AND TUNING.

FOR the first experiment stretch a string about two feet long between two rigid supports, make two pendulums of the same length (about 12 inches) by attaching a spool to a string, as shown, and then attach the improvised pendulums to the stretched string about six inches from the supports, (see Fig. 1) making sure that the lengths of the pendulums remain equal. When both pendulums are at rest, start one swinging by displacing it perpendicular to the stretched string, to which they are attached. It will be noticed that if for example *a* is the one made to swing its swings will gradually die down and simultaneously *b* will commence to swing of itself. Finally a point will be reached when *a* comes to a standstill and *b* has a maximum swing. Then *b's* swings will gradually die down and *a* will swing again. The process will continue almost indefinitely. Remove one of the pendulums from the string support, and in its place put a similar pendulum, the length of which is considerably greater (about 18 inches) (see Fig. 1-C). Now start *a* swinging again. *A* will be found to swing almost indefinitely, while *c* remains practically at rest. Start *c* swinging with *a* at rest. *C* will be found to swing almost indefinitely, while *a* remains at rest. If the two pendulums of unequal length are allowed to swing by supporting them by hand, it will be found that the period of swing is different, whereas the period of swing of the two pendulums of equal length will be found to be equal. This is equivalent to saying that the equal length pendulums swing with the same frequency, and the pendulums of unequal length swing with different frequency.



This Experiment Illustrates a Simple and Very Striking Phenomena in Tuning. It Comprises Two Spools or Weights Supported from Strings, as Shown. With Equal Strings, Swinging A Will Cause B to Start Swinging, After Which This Will Die Down and A, Which Has Come To Rest, Will Start Swinging Again, Etc.



Even Water May Be Made Resonant or Subject to Sound Wave Effects, as Here Shown, and at A the Natural Period of Vibration of the Air Changes as More Water is Poured From the Beaker at the Top. If One Blows Across the Mouth of the Cylinder the Air Column Will Respond and Give a Clear Note.

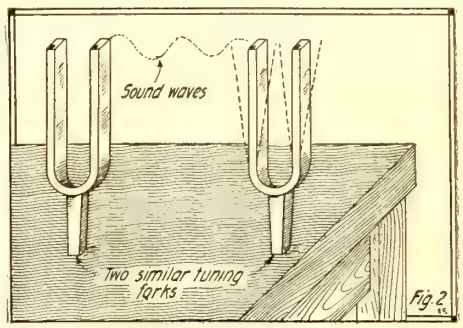
Tune two strings of a stringed instrument (mandolin, violin, guitar, banjo, ukelele, etc.) to the same pitch*. Start one of the strings vibrating by plucking it. The other will be found to vibrate. Raise the dampers of the piano strings (push down loud pedal) and sing a strong clear note near the piano. The piano will be found to continue sounding the same note after the voice is silent, i.e., the strings corresponding to that note have been set in vibration by the voice note. Set a tuning fork in vibration by striking it. Place the bottom of the fork on the table and the sound will increase in intensity. If now another tuning fork of the same pitch is placed with its bottom on the table and the first taken away, the note will still be heard clearly, i. e., the second fork is now vibrating. Fig. 2. (This experiment can be performed fairly well using table forks instead of the tuning forks). If in part one of this experiment, the two strings are not tuned, and they are not at the same pitch, plucking the first string will not set the second vibrating. If in part two, the damper is removed from only one note of the piano and a note of different pitch is sung, the piano string will not be set into vibration. If in part three, the two tuning (or table) forks are not of the same pitch, the second fork will not be set into vibration by the first. The reader should note the similarity between the three parts of this experiment with each other and also with experiment one of this lesson.

If water is gradually poured into a tall cylinder (See Fig. 3-A) a sound of definite pitch is heard. As more and more water is poured in the pitch of the sound becomes higher and higher. Note that as more and more water is poured in, the air column, the vibration of which causes the sound, becomes smaller and smaller. The air column has a natural period of vibration, i. e., a definite frequency, and responds to any noise in the vicinity which contains a component vibration of the same frequency. If one blows across the mouth of the cylinder, the column will respond and give a clear note for any definite length of air. (The noise produced in blowing containing a component corresponding to the natural frequency of the column). Set a tuning fork in vibration above the cylinder as in Fig. 3-A, at the same time gradually pouring water. A point will be found where the sound of the tuning fork is greatly increased in volume. The column at this point is vibrating with the same frequency as the fork. If more water is poured in another point will be found (if the cylinder is long enough), etc. If two are performing the experiment, a better procedure to follow is for one to hold the fork in position while the other can let the water out slowly thru the stopcock (Fig. A), beginning with the cylinder full. If measurements are desired and the *resonant* column is to be measured, more exact points can be located, using the set-up in Fig. 3-B, where a slight motion of the tank will raise or lower the level of the water in the cylinder the desired amount.

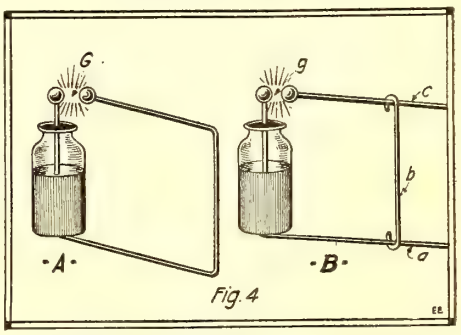
Let A and B in figure 4 represent two Leyden jars of approximately equal capacities. A thick conductor (wire) joins the outer coating of A with its inner coating thru the spark gap G. B has its outer coating joined with the inner thru conductors *a, b,* and *c,* and spark gap *g,* this gap being very small, say 1/32 inch, while G is about ⅛ inch. The two Leyden jars are insulated from each other and placed 6 or 8 inches apart. Charge A up by means of a Wimshurst static machine or by a spark coil. (Note that the size of the conductor for B can be varied by sliding *b* back and forth.) With the two circuits in parallel, a position will be found for *b* such that whenever jar A discharges thru the gap G, jar B will discharge thru the gap *g,* in spite of the fact that no energy is fed into B. If the jars have exactly the same capacity the position of *b* will be such as to make the dimensions of B's circuit equal to those of A's circuit. On changing the position of *b* the sparks will cease to form at *g.* Just as in the previous experiments whenever the natural period of an oscillator is the same as the natural period of a similar oscillator and one is set in vibration, whether it be mechanical, sound, or electrical, the first will cause the second to vibrate also. When the natural period of one is different from the period of the one that is vibrating (or from a component) the second does not vibrate. Varying the frequency of one object to make it equal to that of the object that is vibrating in order that the vibrating object will cause one at rest to vibrate is called *tuning,* and the vibration of one caused by the other is called *sympathetic vibration.* Small vibrations of one may cause large vibrations of the other object. Let us review some examples. The two objects are said to be in *resonance.* The weak old man who rings the old church bell, times his pulls on the rope so

(*Continued on page* 1079)

*Note that the pitch of a note is an indication of the frequency of vibration.



One of the Most Interesting Physical Experiments With Which All Students of Physics Should Be Familiar—That of the Two Tuning Forks, Whereby Sound Waves Set Up by Striking One of the Tuning Forks, Causes the Second Fork to Start Vibrating. This Holds True Only When the Two Forks Are In Resonance or of the Same Pitch.



An Experiment Illustrating in a Vivid Manner the Fundamental Tuning Principle as Followed in Wireless Stations. If the Charged Leyden Jar A is Discharged, and Providing the Length of Copper Wire is the Same in the Circuit at B, Then a Spark Will Simultaneously Occur at the Small Gap "g", at Fig. B. This Secondary Circuit Can Be Tuned by Sliding the Wire B Along the Parallel Conductors A and C.

Practical Chemical Experiments

By PROF. FLOYD L. DARROW

ALCOHOL.

THE government ban upon the manufacture and sale of alcohol together with the consequent widespread use of poisonous wood alcohol in beverages, medicines and extracts makes a chemical knowledge of this subject of very great interest and importance. Even for industrial and educational purposes alcohol cannot now be purchased without the filing of a government bond and for the amateur chemist its purchase is absolutely prohibited.

Therefore the preparation of alcohol in the home laboratory for actual use in experiments becomes a matter of considerable importance. *Such preparation, too, is not illegal.*

PREPARATION OF ETHYL ALCOHOL.

Ethyl alcohol, or ordinary alcohol, also called spirits of wine and grain alcohol, is best made from molasses. Procure a large bottle, holding from 2 to 4 quarts, and pour into it 1 volume of molasses to 6 volumes of water. In a teacup make a thin paste of two yeast cakes and a little luke-warm water. Pour the paste into the molasses and shake the mixture thoroly. In order to determine the nature of the gas given off during the process arrange a small bottle containing a little limewater as shown in illustration 1. Now set the apparatus and contents in a warm place and allow the fermentation to proceed for about a week. Very shortly myriads of small bubbles will be seen to rise thru the mixture of molasses and yeast. As this gas bubbles thru the limewater the latter will become turbid, thus proving that carbon dioxid is one product of the fermentation. The alcohol of course remains in the bottle.

The chemical changes taking place in fermentation are these: The cane sugar in the molasses under the influence of the ferments or enzymes as they are called takes on a molecule of water and breaks up into two other sugars called glucose and fructose. These sugars are then fermented to alcohol and carbon dioxid. The equations for the reactions are:

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6$$

Glucose Fructose

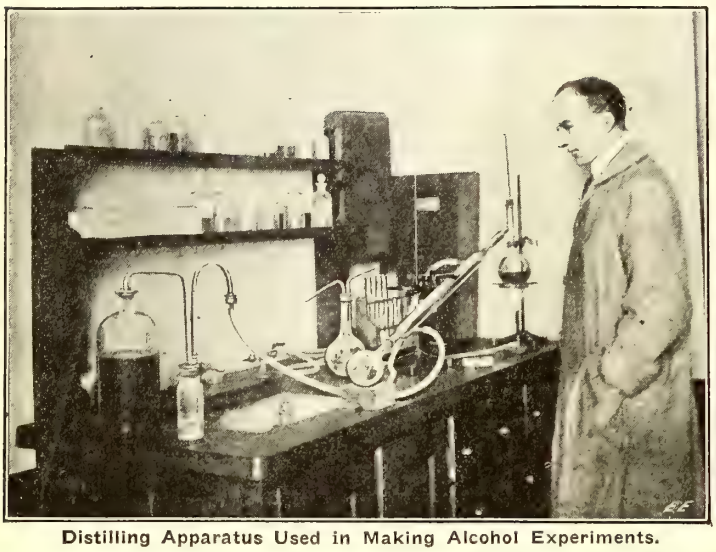
$$C_6H_{12}O_6 = 2C_2H_5OH + 2CO_2$$

DISTILLATION OF ALCOHOL.

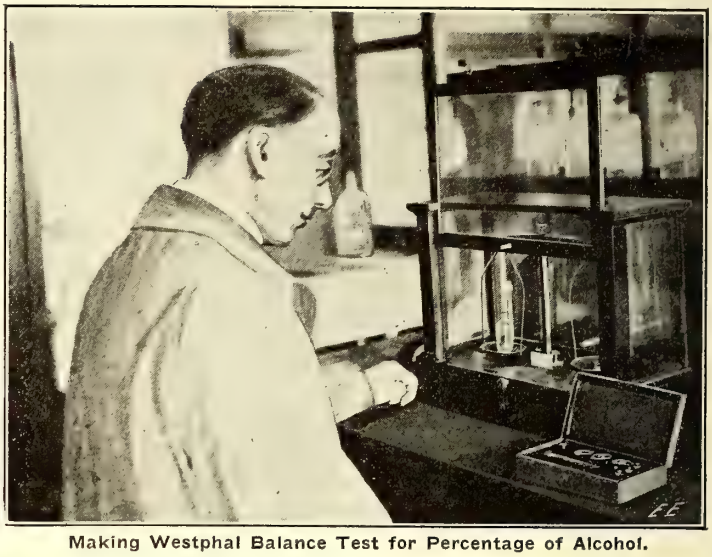
At the end of a week, or when the bubbles cease, arrange a boiling flask and condenser as shown in illustration 2. Siphon, or carefully pour off, enough of the fermented liquid to half fill the boiling flask. See Fig. 2. Insert in the neck of the flask a one-holed stopper and thermometer with the bulb just below the delivery tube. Regulate the flow of water thru the jacket of the condenser to a small steady stream and light the Bunsen burner. Bring the contents of the flask to boiling and note the temperature. This will be about the boiling point of alcohol and at first a distillate rich in alcohol and containing little water will pass over. Keep the flame down so as to prevent frothing and continue the distillation until a temperature of 99 degrees Centigrade is reached. As the temperature rises more water and less alcohol passes over.

Now pour the distillate into a large stoppered bottle and repeat the process with successive portions of the fermented liquid, until it has all been distilled.

But the first distillate will contain a large percentage of water and this must be removed. To do this rinse out the boiling flask and place in it a number of lumps of quicklime. Fill the flask half full of the first distillate and distil again, placing the second distillate in a glass stoppered bottle. Clean out the retort and repeat with another portion, continuing to do so until the first distillate has all been redistilled. The quicklime unites chemically with the water and the second product is very largely alcohol.



Distilling Apparatus Used in Making Alcohol Experiments.



Making Westphal Balance Test for Percentage of Alcohol.

New Chemistry Series

The publishers have great pleasure in announcing that they have arranged for a new series of EXPERIMENTAL CHEMISTRY papers, to be prepared by Prof. Floyd L. Darrow, Instructor in Chemistry and Physics at The Polytechnic Preparatory Country Day School, Brooklyn, N. Y. Prof. Darrow is the author of numerous articles and books on the subjects of Chemistry and Physics, and possesses a clear and very interesting style of writing on these topics, which we feel sure our readers will find a real treat.



Welsbach Mantle Test for Alcohol; the Mantle Lights if Over 12 Per Cent. is Present.

TESTS FOR ETHYL ALCOHOL.

To detect the presence of alcohol in beverages, medicines and extracts has always been a matter of commercial and chemical importance, but now with prohibition in force it is very much more so and it is also very interesting work.

First note the odor of the alcohol. Then place a little on a watch glass and apply a match. Try its solvent power on a bit of camphor gum or a crystal of iodin. Place a little of the alcohol with an equal quantity of acetic acid in a test tube and add a few drops of concentrated sulfuric acid. Heat gently and note the pleasant, ethereal, fruit-like odor of ethyl acetat, a substance which is much used in artificial flavoring compounds. What happens is this:

$$C_2H_5OH + H(C_2H_3O_2) = C_2H_5.C_2H_3O_2 + H_2O$$

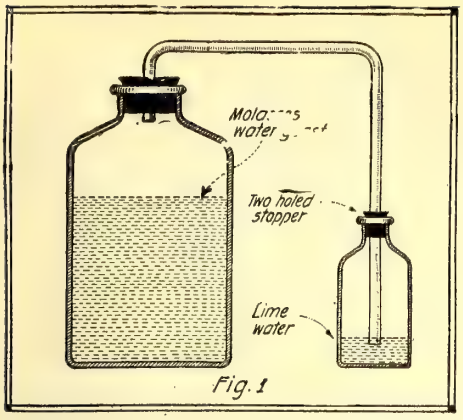
The sulfuric acid is used to absorb the water formed.

IODOFORM TEST.

A very delicate test for ethyl alcohol is the iodoform test. To a dilute solution of the alcohol in a test tube add a little sodium hydroxid solution and then iodin, crystal by crystal, and gently warm. Stop the addition of iodin short of a permanent brown color. Slowly a yellow precipitate of iodoform will separate and its characteristic odor will be obtained. Even tho no precipitate forms the odor will be present. This test can be applied to medicines and extracts, but it is best to distil a small portion and test the distillate.

AN ALCOHOL MEDICINE TESTER.

To one end of an 8-inch length of glass



Simple Apparatus Set Up for Carrying on the Fermentation of Molasses in Making Ethyl Alcohol.

tubing of proper diameter fit a Welsbach gas burner and mantle. Push the other end thru a one-holed stopper. In a flask place two or three tablespoonfuls of the liquid to be tested and insert the stopper and burner. Upon heating the flask gently, if alcohol is present in amounts larger than 12 per cent, the mantle will glow brightly when lighted.

TO DETERMINE PERCENTAGE OF ALCOHOL.

Arrange distilling apparatus as shown in diagram 3. For this distillation the delivery tube of the boiling flask may be bent in the flame of a Bunsen burner fitted with a fish tail tip.

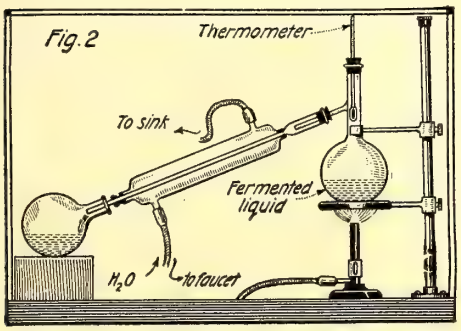
Measure into a graduate exactly 100 cc. of the medicine, beverage or extract to be tested and transfer it to the boiling flask. Rinse out the graduate with 50 cc. of water and add it to the flask. Introduce a small piece of leather to prevent frothing, and being sure that all connections are tight, distil off into a graduated cylinder about 90 cc. Then add enough distilled water to bring the contents to the 100 cc. mark. We have now practically a mixture of alcohol and water of the same volume as the original volume of liquid taken, and containing all the alcohol in the sample.

To find the percentage of alcohol we must know the specific gravity of the mixture to at least 4 decimal places. To determine this there are two principal methods. One is by use of a Westphal balance and the other by means of a pynknometer.

WESTPHAL BALANCE METHOD.

The balance is shown in Fig. 4. The plummet is first suspended in air from the hook at the end of the bar and by means of the leveling screw at the bottom the bar is brought into a horizontal position. There are nine divisions on the bar and with the balance are four sizes of "rider" weights.

Now suspend the plummet in the mixture of alcohol and water which you have distilled over and place weights on the balance arm until it is exactly horizontal.



Apparatus Set Up for the Distillation of Alcohol in the Laboratory.

Then suppose the largest weight stands at 9, the next size also on 9, the third weight on 2 and the smallest on 4. Such being the case the specific gravity is .9924.

Then to get the percentage of alcohol look in a table of alcohol percentages and opposite the specific gravity found will be the percentage both by volume and by weight.

THE PYNKNOMETER METHOD.

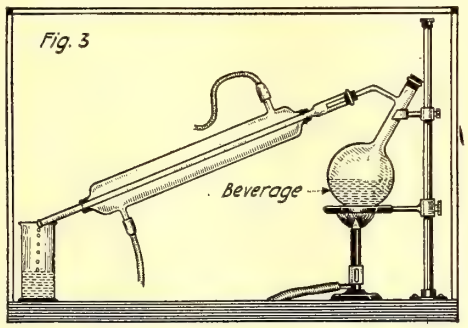
A pynknometer is a small specific gravity bottle holding exactly 25 cc. or grams of water at a definite temperature, and carrying in the stopper a small thermometer for regulating this temperature.

The bottle is weighed on an analytical balance empty and dry. It is then filled to the top of the overflow tube with the liquid to be tested, the stopper inserted and the cap fitted on the overflow tube, see Fig. 5. After wiping dry, the bottle and contents are weighed and from this weight is subtracted the weight of the empty bottle. If the temperature has been regulated to 15.6 degrees centigrade, this difference will be the weight of exactly 25 cc. of the liquid. Therefore, the specific gravity is found by dividing this difference by 25 after which the percentage of alcohol is determined as before by reference to the tables.

It will be found very interesting work to determine the percentages of alcohol in drugs, etc.

WOOD OR METHYL ALCOHOL.

Wood alcohol, obtained in the destructive distillation of wood as a by-product in the manufacture of charcoal, has always been used as a substitute for ethyl alcohol and



Special Distilling Apparatus for Determining Per Cent. of Alcohol.

now with prohibition this use has become alarmingly widespread. Therefore, to be able to detect its presence is of great importance. The formula of methyl alcohol is CH_3OH, while that of ethyl alcohol is C_2H_5OH, the two differing only by a CH_2 group. It is very frequently found in Jamaica ginger, lemon extract, peppermint, "hot drops," liniment, bitters, toilet waters, spirits of camphor and cheap whiskey.

TEST FOR METHYL ALCOHOL.

Cut a 3-foot length of No. 14 copper wire and starting about 10 inches from one end wind the wire as closely as possible about a lead pencil stopping 10 inches from the opposite end. Bring the first end thru the coil and twist the two ends together to make a handle. See Fig. 6.

To learn the test, make a solution of one part of methyl alcohol to six parts of water and pour 10 cc. into a test tube placed in a bottle of cold water to keep it cool. Now heat the copper coil in the upper hot oxidizing portion of the Bunsen flame to a dull red and quickly plunge into the contents of the test tube. Repeat the operation six times. The copper oxid formed in the Bunsen flame oxidizes the alcohol to formaldehyd which is left in the solution.

Then to confirm the presence of formaldehyd and therefore of methyl alcohol apply the following test: Add one or two

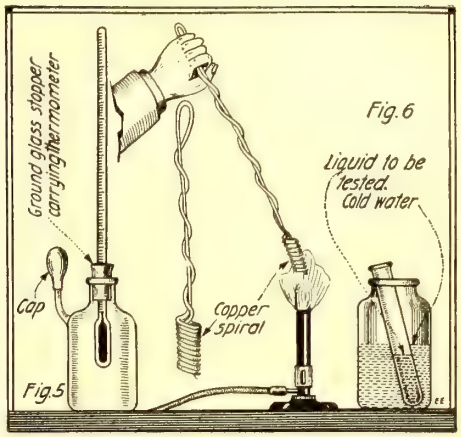


Fig. 5. The Pynknometer for Determining Specific Gravity of Alcohol. Fig. 6. Apparatus Used in Testing for Presence of Wood Alcohol.

drops of the above solution to 10 cc. of milk and mix well. In another test tube put 4 cc. of a solution containing twenty-five volumes of concentrated sulphuric acid to one volume of ferric chloride solution. Now very carefully pour the milk down the side of the second test tube, inclining the tube so that the milk shall rest on the surface of the acid. In the presence of formaldehyd a violet ring will be formed at the contact of the two liquids. This is a very delicate test, and if much formaldehyd is present, use more milk. Now test beverages, extracts, witch-hazel, etc., for wood alcohol. It is always best to make the formaldehyd test before testing for alcohol so as to be sure that formaldehyd is not already present. In highly colored or flavored extracts, it is frequently better to distil off a small portion and test the distillate.

TEST FOR METHYL ALCOHOL IN PRESENCE OF ETHYL ALCOHOL.

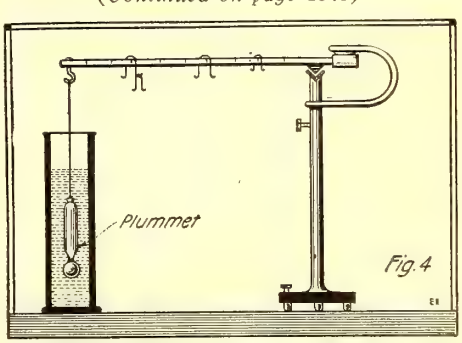
Denatured alcohol contains about 10 per cent of wood alcohol to render it unfit for use in beverages. The two are also frequently found together in extracts, etc.

In the presence of ethyl alcohol oxidize the alcohols with a hot copper coil as before, but before making the formaldehyd test, boil the solution in the test tube very gently until the odor of acetaldehyd has disappeared. Acetaldehyd is formed by the oxidation of ethyl alcohol just as formaldehyd results from the oxidation of methyl alcohol. It has a pungent, ethereal and suffocating odor which will not escape detection. After satisfying yourself of the absence of acetaldehyd proceed with the formaldehyd test as before.

PREPARATION OF METHYL SALICYLATE OR OIL OF WINTERGREEN.

In a test tube put a small pinch of salicylic acid. Add a drop of methyl alcohol and about twenty drops of concentrated sulfuric acid. Warm the mixture very gently and shake the test tube as you do so. The odor of oil of wintergreen is at once apparent.

(*Continued on page* 1046)

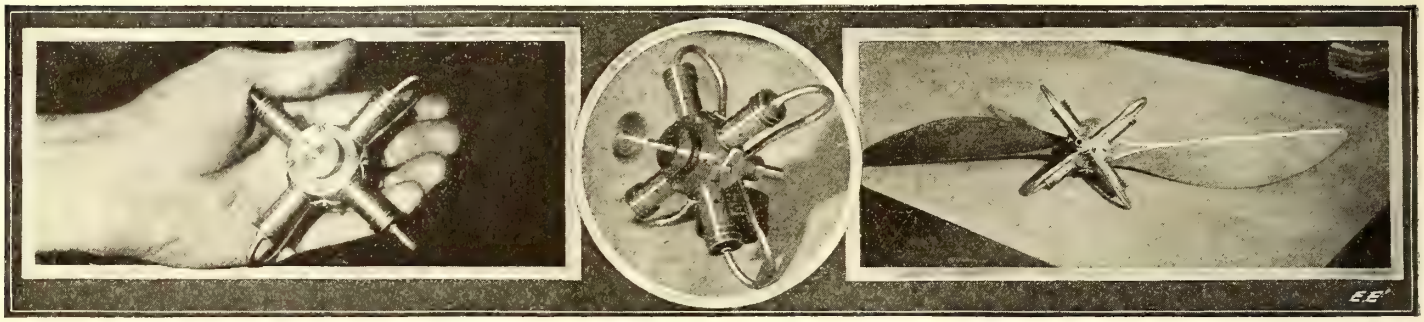


The Westphal Balance for Determining Specific Gravity of Alcohol.

THE CONSTRUCTOR

Rotary Motor for Model Airplanes

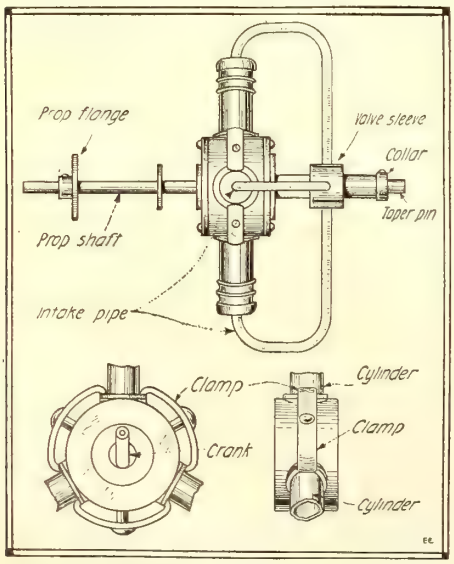
By WILLIAM J. BEACH



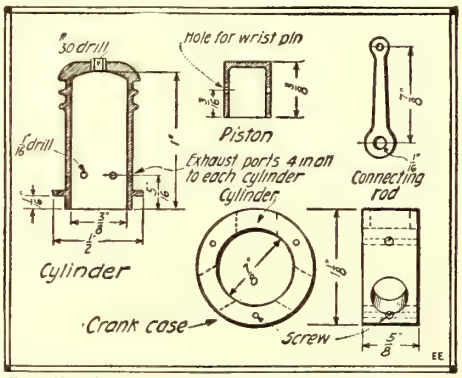
TO the constructor of model airplanes no feature of the work is such a drawback as the power plant. The use of rubber strands is in no way suitable for reproduction or scale model work; such a method of propulsion necessitates a long and out of proportion fuselage and further does not permit the wings or planes to be placed in correct position. When we say that rubber provides a maximum of power for weight, we have explained all its virtues; hence, we find ourselves turning to the use of miniature engines, the power for which may be obtained from several sources such as flash steam, carbonic acid gas, liquid carbonic acid, or comprest air, preferably the latter, since it is the simplest and least expensive method.

The following describes a motor which is a perfect mechanism and which will spin around and *drone* like a "Gnome" or "Clerget" and give a maximum of efficiency if the most suitable propeller or tractor screw is fitted to it.

The cylinders are machined from ½-inch cold rolled steel, being reamed and polished to the last degree of smoothness—the pistons may be made from either brass or aluminum (preferably the latter). Naturally the pistons must be a perfect fit which is accomplisht by a lapping process. The exhaust ports are drilled in the cylinders before the lapping and polishing takes place. The connecting rods are made from brass 1/16-inch thick. The crankcase is made from aluminum, the front and back being made from brass.



View of Completed Comprest Air, Model Airplane Engine.



Detail of Model Engine Cylinder and Connecting Rod.

The propeller shaft is made from a piece of cold rolled steel ½-inch in diameter and soldered to the front plate.

The valve sleeve is turned from ¾-inch C. R. steel and the valve and crankshaft are made from a No. 5 taper pin.

The intake pipes are from brass ⅛-inch outside diameter.

To make a clean bend in the pipes, heat the same red hot, and instantly dip in water when the brass will readily bend around any suitable mandrel. The clips holding the cylinder to the crankcase are from spring steel. No. 2-56 screws are employed thruout for holding all parts together.

This engine may be timed to run clockwise, or anti-clock-wise, which is governed by the position of the slot in the taper pin, which in either case should be vertical with the crank throw and so set that the pistons will have a fraction of a lead, or in other words air may be communicated to the cylinders a little before the pistons reach dead top center.

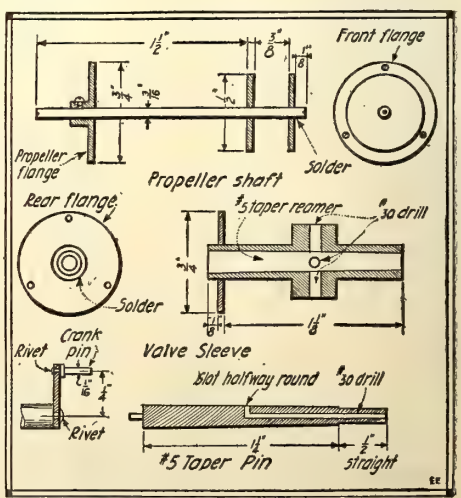
When soldering the intake pipes to the valve sleeve, care must be taken not to allow any solder to adhere to the taper pin and thus freeze it to the sleeve.

In building the engine, all parts as far as practicable should be turned between centers. For instance, the crankcase and front and rear flanges should be all turned together on a mandrel made specially to receive the three parts at the same time.

When completed the engine should be submerged in oil and then taken out and placed in the lathe and run in until it may be spun freely with the fingers. This engine when completed weighs under three ounces and will turn a 12-inch to 14-inch propeller nicely.

In the use of comprest air motors for model airplane work, the tank or air reservoir should be made as light as possible, and given diameter in preference to length. A proper construction must be followed out or disastrous results will ensue. A tank should be around 30 inches long by 4 inches in diameter and made from 5 mil phosphor bronze 6 inches wide and riveted every ¾ inch, likewise the domed ends. The entire tank should be wound with the finest gage piano wire at the rate of eight turns to the inch. Having wound the tank with the wire this should then have the soldering iron wiped straight along it at three points around the tank to prevent the wire from slipping when expansion takes place.

The matter of a well constructed tank is of the utmost importance—the writer knows!

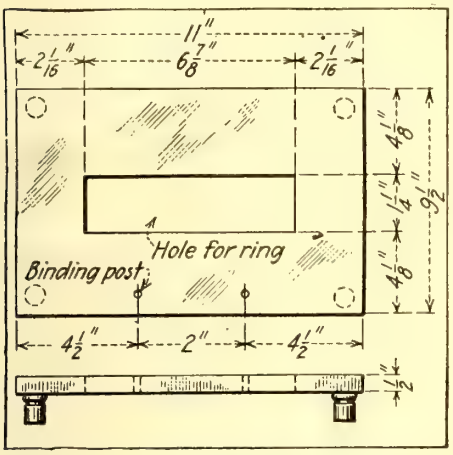


Detail of Propeller Shaft and Flanges.

Building a Tangent Galvanometer

HEREWITH I present drawings and specifications for building a tangent galvanometer, which nearly all amateur experimenters will find useful and which will measure an electric current from .088 to 1.375 amperes accurately, if the dimensions are carefully followed. No nails, iron or steel screws should be used.

From a piece of white wood cut out a



Above There is Shown a Sketch of Wooden or Fiber Base for the Tangent Galvanometer.

ring ⅝ inch thick by 9 inches inside diameter by 10½ inches outside diameter. Next cut two rings from the same kind of wood, whose inside diameters are 9 inches, outside diameters 11 inches and ¼ inch thick. Glue them on both sides of the first ring to hold the wire in place. When the glue is dry, wind eight turns of No. 16 D.C.C. magnet wire on the middle ring and twist the two ends together so that when assembled they will come under the base to the binding posts. A keyhole saw can be used to cut the rings. Two pieces of wood 11 inches by ⅝ inch wide and ¼ inch thick are screwed on both sides of the completed ring in the center, as shown in the drawing, and exactly in the center of the two pieces a groove is cut to fit the compass, which should be no smaller than 1¼ inches in diameter. Use only brass screws.

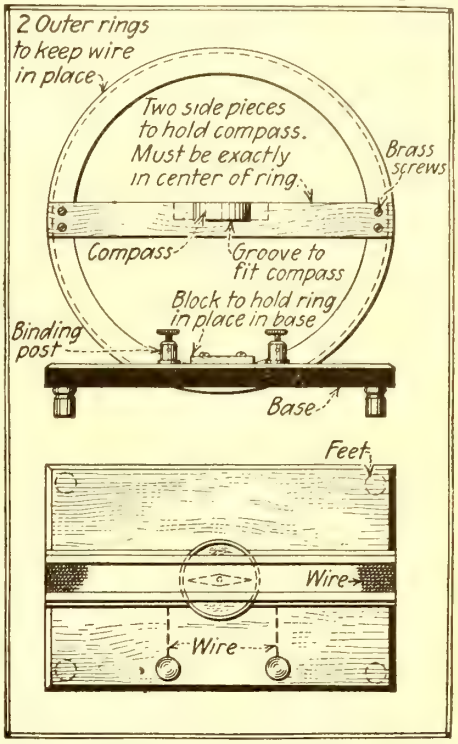
The base is made from a piece of wood ½ inch thick by 9½ inches wide and 11 inches long. Cut in it a hole 1¼ inches wide, 6⅞ inches long for the ring with the coil to fit in.

When finished, drill two holes for the binding posts, as shown, and insert four Moore glass push-pins to be used as feet, because the ring will come below the bottom of the base. Sandpaper it and give one or two coats of varnish or shellac, which will add greatly to the appearance of the instrument. A small block is fastened over the ring where it passes into the base to hold it stationary.

To use the galvanometer, remove all magnets, iron or steel, away from it, and turn the galvanometer so that the needle when pointing *North* is exactly in the center line of the coil. The deflection caused by an electric current going thru it is equal to a certain fraction of an ampere, as will be noted in the following table:

Angle	Current
10 degrees	.088 Amp.
20 "	.182 "
30 "	.289 "
40 "	.420 "
45 "	.500 "
50 "	.600 "
60 "	.865 "
70 "	1.375 "

The table here given will only be suitable for places east and north of Chicago, since the earth's force acting on the magnetic needle varies at different places. For positions west and south of Chicago, the values obtained must be multiplied by 1.3.



Side and Top View of the Tangent Galvanometer, Which is of Use to Every Experimenter.

Contributed by JOHN DZUGAN.

Simple Microphotographic Apparatus

HEREWITH is a microphotographic apparatus which I constructed recently, while employed in a hospital laboratory. Photographs were necessary in the study of an extremely important pathological lesion. No microphotograph apparatus being available, I hastily constructed, or in other words, assembled, the following apparatus:

1 4"x3" Premo camera.

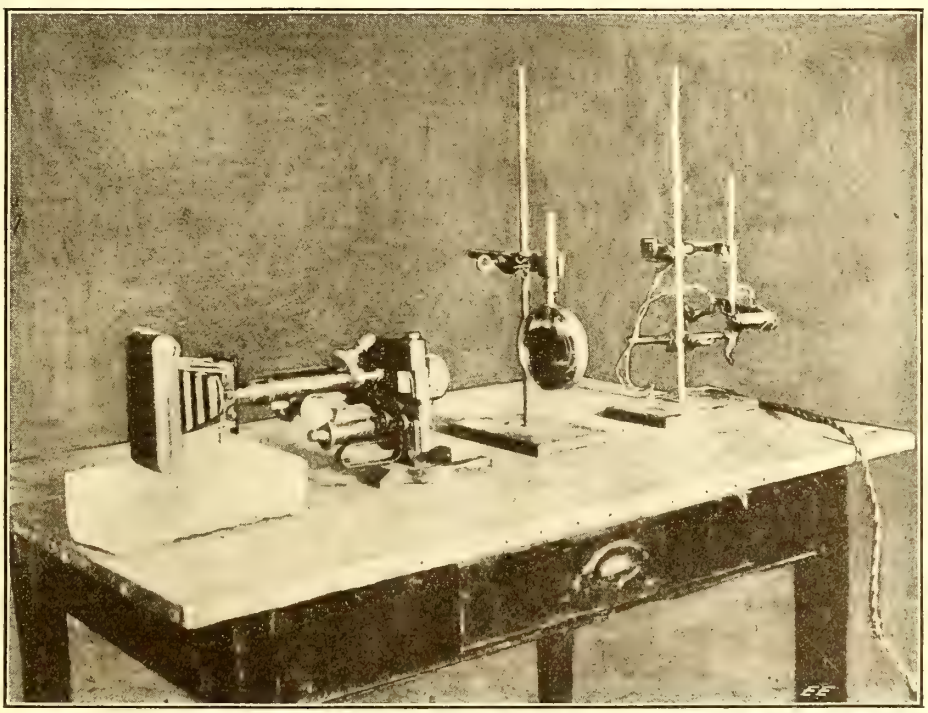
1 Standard high power microscope.

1 Condensing lens (a large reading glass being employed, supported by a ring-stand).

1 Arc, constructed of a ring-stand.

1 Adjustable resistance, which was made of common bale wire.

The pictures taken were extremely satisfying.



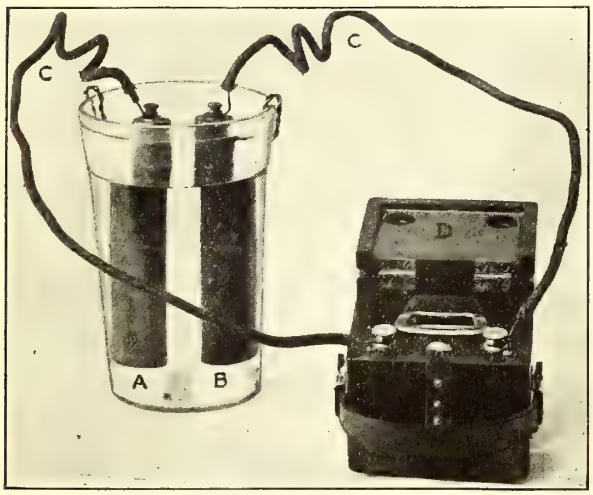
The Microphotographic Apparatus Here Illustrated, Comprises a Few Readily Procurable Apparata and Will do Very Good Work Indeed. A Camera, a Microscope, a Large Reading Glass and an Arc Light, Constitutes the Apparatus Required.

Operation:—No lenses were used in the camera. The ocular of the microscope was introduced directly into the lens places on the camera. The arc being started, a slide introduced on 'scope stand, and condenser being focused accurately on slide, it was then necessary to introduce a ground glass in place of adapter in camera and adjustments made for focus with micrometer adjustment of microscope. When the object was seen with sufficient distinctness on a ground glass, a sensitized plate was introduced. The exposure of the plate was controlled by a sheet of black paper between the condenser (reading glass) and the stand of the microscope. The plates were exposed 5 seconds and developed in the usual way. Positives were then printed and when colored with Eastman's water colors gave really extraordinary results. Considering the simple and inexpensive apparatus employed and the short time required to set up the instruments, the results obtained were fine indeed. Experimenters in general will find this branch of science most interesting and instructive.

Contributed by WARNER N. CROSBY.

Electricity from the Thermo Cell

NOT long ago scientists and inventors alike predicted the generation of electricity direct from heat (combustion of coal, etc.) as a means of putting the steam engine into the "scrap pile." But tho the thermo-couple generating method is worth mentioning, did it prove successful? Having many drawbacks, and owing to the great loss of energy, hardly two per cent of heat are transformed into electricity.



A Very Interesting Thermo Cell With Which Some Little Known Experiments Can Be Made. By Heating One of the Carbons A or B and Plunging it Into the Electrolyte, a Current is Produced; But if Both Carbons are Heated to the Same Temperature and Plunged Into the Liquid, no Current is Indicated on the Galvanometer.

One day while experimenting on thermo-electricity, I was lead to believe, by so proving, that electricity can be generated by two conductors immersed in the water, provided there be a difference in temperature between the carbons and the water.

The discovery of this thermo-cell, which I will make clearly understood, is far more powerful than a thermo-couple.

The photo shows the thermo-cell in its simplest form, with its various details, easily within the reach of every experimenter. A and B are two dry battery carbons immersed in a vessel of water, connected by the conductors C, to the galvanometer D, by which a closed circuit is made. Now by removing carbon A, heat it merely by holding it in the hand, plunge it back into the liquid, and have the remainder of the vessel the same degree of temperature as that within the room; you will note an electric current passing from B thru the liquid to A and outer circuit, back to B.

By heating one of the carbons to about 200 degrees Fah., I was able to obtain as much as .50 of a volt. The amperage is fairly large, usually as large as in a voltaic cell, but the great resistance of water does not permit it to flow thru the circuit.

The flow of the electric current continues as long as there is a difference in temperature between the carbon or carbons and the surrounding water.

In the place of carbons, any conductors can be substituted; metals will do as good. I have employed a shunted 563 ohm Weston galvanometer in my experiments, but a voltmeter capable of measuring an hundredth part of a volt, will answer as well.

As we know that even the heat of the hands is enough to manifest an electric current, then the thermo-cell ought to be more interesting than a thermo-couple, and beside there is a possibility of its becoming a success in the near future, if fundamental improvements are possible, so as to employ a different liquid better adapted for the purpose than acidulated water. Otherwise, as far as I have gone, the thermo-cell will remain as merely an interesting experiment, and more important for explaining its effect on metal construction.

Contributed by VINCENT POMPI.

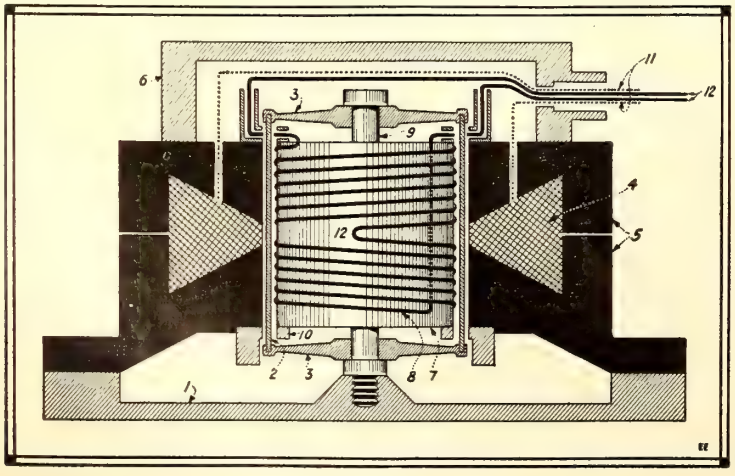
The Fessenden Oscillator

By E. T. JONES

THE field magnet of the Fessenden sound oscillator consists of two steel recest rings clampt together with a coil of wire in the space formed by the recesses. When a direct current passes thru the coil of wire, the inner surface of one ring becomes a North pole and the other a South pole.

The core consists of a steel cylinder, upon which are wound the proper number of turns of wire and rings for rigidly

(*Continued on page* 1090)



No. 1, Diafram 30 Inches in Diameter. 2, Movable Conductor (Copper Tube). 3, Flexible Discs, Holding "2" to Axis "9". 4, Field Coil. 5, Iron Field Magnet. 6, Oscillator frame. 7, Armature, Iron Core. 8, Armature Winding (Winding Reversed at "12"). 9, Rod (Imparting Motion to Diafram). 10, Ring, Preventing Side Motion and Supporting Core. 11, D.C. Field Windings. 12, A.C. Armature Windings.

AN ELECTRIC OVEN EASILY CONSTRUCTED.

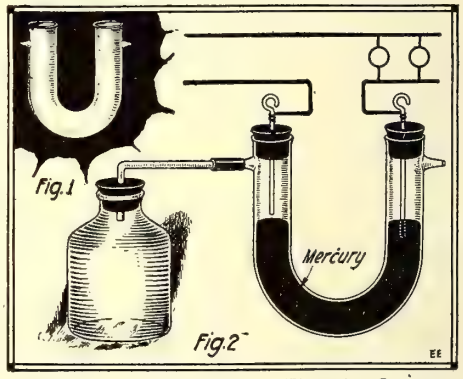
SINCE so many boys and young men are equipping their own laboratories and workshops, it is scarcely necessary to mention the great need of an electric warming oven in any chemical laboratory. Many of us have doubtless realized this need of an oven which would maintain a temperature of 100° C. without attention.

The oven should be protected from excessive loss of heat by some heat-insulating cover. An excellent method of accomplishing this is to cut pieces of felt the proper size and glue them to the sides, top, bottom and door of the oven. One layer of felt is good; two layers are more satisfactory. Two layers of felt with a layer of straw-board between gives fine results.

The heating element is simply two carbon filament lamps mounted in sockets on or near the bottom of the oven. If the heat insulation is very good one 32c.p. carbon lamp will be sufficient.

For the regulator a very small U-tube (Fig. 1) must be procured. This may be bought from any chemists' supply store for twenty to thirty cents. By means of a small piece of glass tubing which has been heated and bent to a right-angle connect a two-ounce bottle or better test-tube to one of the side tubes of the U. A rubber stopper and bit of rubber tubing will solve it.

Thru another rubber stopper placed in the open end of the U-tube a stout copper wire is inserted and extended half way down the tube as shown in Fig. 2. All of the joints and connections on this side of the U must be absolutely air-tight.



To Make a Satisfactory Electric Oven, a Metal Cracker Box is Used. You Will Need a First Class Electric Heat Regulator and the One Here Illustrated Has Proven Very Satisfactory for Such Purposes in the Laboratory.

Thru the other side of the tube mercury is poured until it touches the copper wire. A second piece of copper wire is placed in this side and run well under the surface of the mercury. The mercury-tube together with the attached bottle is set up at the back of the furnace where it will be out of the way. The two copper wires are connected in series with the lamp or lamps just as any other switch would be connected. Connection is made to any lamp socket by means of flexible wires and a plug.

Finally the current is turned on and the temperature is watched. Soon the air in the bottle will begin to expand. The mercury will be deprest and the circuit broken. After the furnace has cooled a little the air will contract, the mercury will rise and the lamps will be turned on again. If the temperature is not high enough when this occurs the wire should be lowered a short distance at a time until the desired temperature is reached. Should much sparking occur at the break, a drop or two of oil should be placed on the surface of the mercury.

One of these automatic regulators, built by the writer, gave excellent regulation while in daily use for several months.

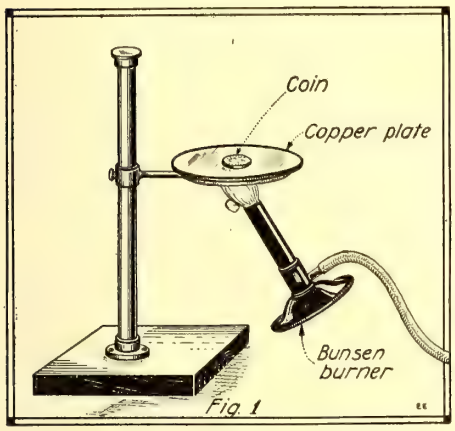
Contributed by
DAVID CLARKE COX, M.A.

Experiments in Thermography

By THOMAS W. BENSON

AS the name would imply, these are experiments in "firewriting." As a matter of fact they demonstrate the effect of heat radiations on a surface to alter or control the tendency of vapor to condense on that surface.

A very simple experiment can be made



Novel Experiment in Thermography—a Silver Coin Is Placed on a Polished Copper Plate and Heated. After Cooling and by Breathing on the Plate, the Image of the Coin Will Be Clearly Seen.

by placing a silver coin on a polished copper plate and passing a spirit lamp or Bunsen burner under it to slightly heat the plate and then allowing it to cool. On examination, the plate, if not heated too much, will show no marks on the surface. However the surface of the plate where the coin rested has been affected in some way that alters its tendency to condense moisture. By breathing on the plate the impression of the coin will be seen clearly defined in drops of watery vapor.

Exposing the plate to vapors of iodine or mercury will have the same effect and make the outline more permanent.

To obtain a good image, the coin or other substance must be of a different material from the plate. Thus should a penny and a nickel be put on the plate and heated, only the nickel would be reproduced in the condensed vapor.

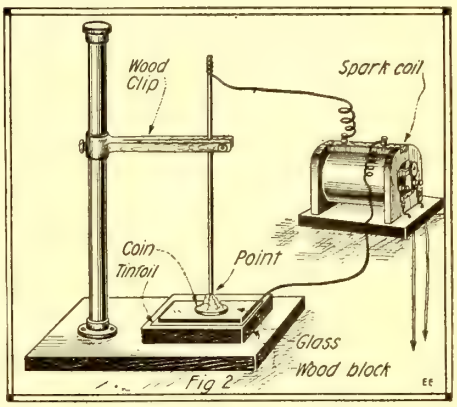
Take a glass plate and lay it on a sheet of tinfoil or other conductor. Place a coin or other metal object in the centre of the glass plate. Connect the tinfoil to one terminal of a spark coil or static machine and bring a wire from the other terminal close to the coin and permit sparks to jump for a few seconds. Remove the coin quickly and breathe on the surface of the glass, when the impression of the coin will become visible.

If several plates of glass are superposed, a coin laid on the top plate and sparks passed to the coin a similar impression will be found on the top surface of each plate when breathed upon.

Another method of obtaining the same result is to place a mirror in the sun with a coin laid on the surface for several days. On removing the coin carefully and breathing on the mirror a fairly clear outline of the coin will be reproduced.

A rather mystifying experiment in thermography can be performed as follows: Take a sheet of copper and amalgamate by rubbing with nitrate of mercury to give a brilliant reflecting surface. A sheet of printed paper is laid face down on the copper and pressed into close contact with several thicknesses of paper and a weight. Place the whole on a warm surface for a half-hour.

On removing the paper no change will be noticed on the amalgamated surface. However it has been affected in some manner by the dark and light areas of the paper. This effect is made visible by exposing the plate to mercury vapor which will condense on the parts of the plate for-



A Spark Coil Is Used to Conduct This Experiment With. A Coin Is Placed On a Glass Plate, As Shown. Removing the Coin and Breathing On the Glass Brings Out the Image of the Coin.

merly in contact with the white area of the paper. Then by exposing to iodine vapor the parts will be blackened where the mercury did not condense, thus giving a clear reproduction of the printing.

These are but a few of the many experiments possible, for by trying various substances and materials strange and unexpected results will be obtained that may find a practical application.

Making an Electrical Swing

By Prof. LINDLEY L. PYLE

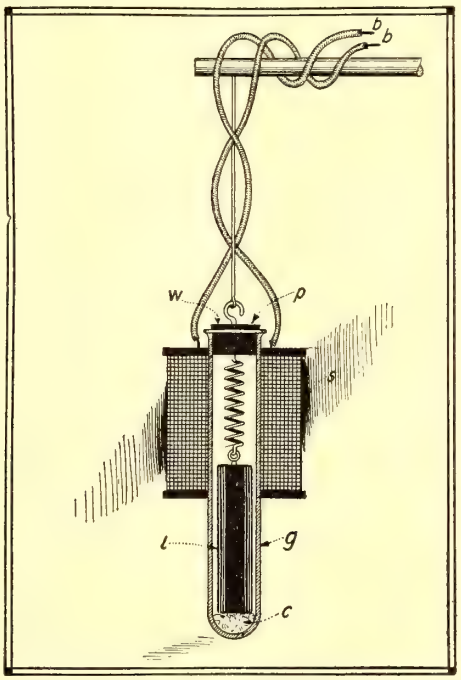
EVERY one is familiar with the method of "working up" in a swing. Any boy may construct an "electrical swing" that may be made to "work up" by the mere tapping of a distant key. Obtain a four-inch length of quarter-inch glass tubing (inside diameter) sealed off at one end. (A small test tube will do.) Pack a piece of cotton into the bottom. Find a piece of soft iron half as long as the glass tube and about three-sixteenths of an inch in diameter. (A bundle of iron wires cut to the proper length will be satisfactory.) Suspend the piece of iron from a coiled spring attached to a cork thrust into the top of the glass tube. Details may be seen in the accompanying drawing. The spring may be home-made, wound of No. 30 brass, steel, or German silver wire, such that when unloaded it is about one inch in length and when loaded with the iron it elongates just enough to allow the iron to rest upon the cotton cushion.

Next wind five layers of No. 24 insulated copper wire upon the upper half of the glass tube, allowing two or three feet for the free ends of the wire.

Fasten a string (or thread) a foot long to the upper end of the coiled spring (which is thrust thru the cork), and suspend the whole device to swing as a pendulum.

Wind the free ends of the solenoid winding *loosely* around the supporting string and support, and then extend them to a tapping key and a couple of fresh dry cells in series.

Start the apparatus to swinging gently by a touch of the finger. Close the key every



An Interesting Electrical Device, Called a "Swing" and Which Resembles In Its Action the Common Swing. (g) Glass Tube; (i) Soft Iron; (c) Cotton Cushion; (s) Solenoid; (p) Cork Plug; (w), Sealing Wax; (b, b) To Be Connected to Two Dry Cells and Key.

time the device swings thru its lowest (or bottom) position, both "coming" and "going." The magnetic field set up by the momentary current thru the solenoid lifts the iron at the middle of the swing and the release of the key allows the iron to drop at the ends of the swing, and the apparatus "works up" beautifully into vigorous motion. The best way to learn the proper moment to work the key is for the operator to stand up in a rope swing and watch while he "works up," for the position in his to-and-fro travel at which he *lifts his own body* by his leg action.

Violent oscillations of the electrical swing may be quickly cut down to *moderate* oscillations by the proper manipulation of the key. The operator should also study the key action for this case by watching his own body while making his rope swing "die down" quickly by forced body action.

By giving the transparent walls of the glass tube an exterior coat of black paint the apparatus may be made to appear very mysterious to an audience, especially if the wiring and key be concealed.

The reader is of course aware that the tension in the coiled spring makes it easier, so to speak, for the magnetic field to bring about the lifting of the iron core. The glass tube is sealed at the bottom in order that upon the descent of the iron core it (the iron) may not drop past its normal position and interfere with the proper action of the device; also oscillations of the piece of iron are prevented.

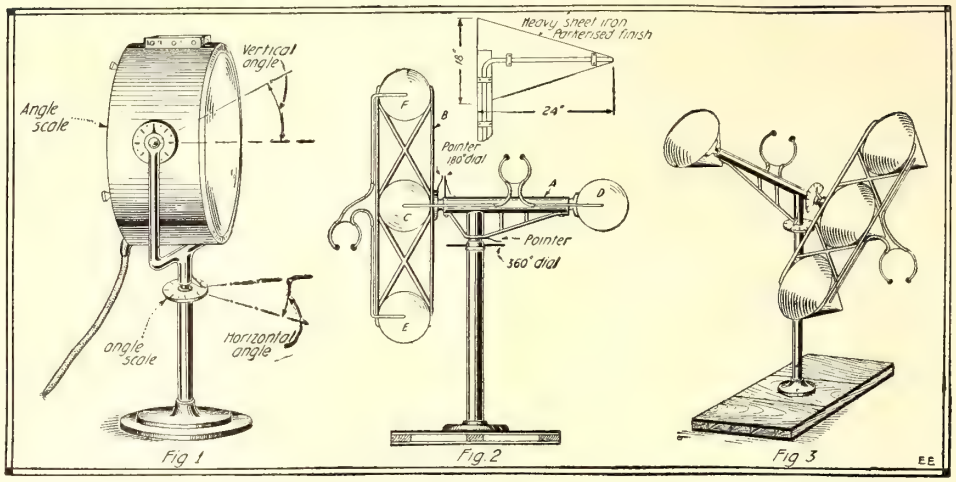
Readers interested in the mechanics of "working up" in a swing may find excellent discussions in *Science* for July 4, July 18, and August 8, 1919.

The Horn Type Sound Locator

By CHARLES K. FANKHAUSER, JR.

THE following article is a description and explanation of the principles of operation of the type of sound locator widely used by the British anti-aircraft forces for the location of enemy aircraft at night. Several advantages are claimed for it over the paraboloid type, the chief ones being portability and greater accuracy.

Until the invention of sound locators the crew of an anti-aircraft searchlight had to depend solely upon their ears to tell the general location of an enemy plane at night. This method was very unsatisfactory and necessitated the searching of a large area of the sky. Then came the horn type of sound locator.



The Above Drawing Will be of Interest to "Boy Scout" and Other Military Organizations in That It Shows the Details of the Horn Type of Sound Locator Employed by the Allies for Spotting Enemy Air-Craft at Night. When the Spotter, who Listens for the Sound, Reads the Direction of the Enemy on the Dials, He Informs the Searchlight Operator of These Readings, and the Latter Instantly Swings the Beam of Light in the Indicated Direction of the Enemy, Without Wasting Time in Sweeping the Skies With It.

First, let us consider the theory of locating sound. When one hears a sound there is generally no difficulty in telling whether it is to the right, left, in front or behind. Suppose the source of sound to be directly in front. Then, assuming of course that there is no wind, the sound waves will reach both ears at the same instant, equalizing the amount of sound recorded by each ear. But if the source of sound is at a flank of the observer, the paths over which the sound waves must travel to reach the ears would be of different lengths, so that the sound waves would reach the ear on that side before reaching the ear on the farther side. Hence, sound waves reaching both ears at the same instant would be *out of phase;* that is, the crest of the wave would reach one ear slightly in advance of the other.

As the ears of a human being are only a few inches apart, this difference in phase is very slight. Let us imagine, then, that we have two ears, placed four feet apart. Then, if the source of sound is at a flank, there is a much greater difference in the length of the sound paths, and therefore a corresponding increase in the difference in phase. This would make it much easier to determine the position of the source of sound. That is exactly the result accomplished by the sound locator. In the place of ears, four large, conical horns are placed on pivoted arms, A and B, Fig. 2. The two horns, C and D, on the horizontal arm, are spaced four feet apart and connected by means of rubber tubing to a headset having rubber ear pieces. The other two horns, E and F, on the vertical arm, are arranged in the same manner.

Three observers, one for each pair of horns and one to read the direction dials (these will be explained later), are required to operate the instrument. A plane approaches. The locator is pointed in the general direction of the sound. The observer using the horizontal pair of horns, dons his headset. If the sound is louder in his right than in his left ear, he knows that the locator is pointed too far to the left. Moving it alternately right and left, he finds a point at which the sound seems to be the same in both ears. He then knows that the source of sound is directly in front of him, and calls, "on target." Holding his horns stationary, he notes that the sound is increasing in volume in his left ear, hence the plane is moving toward his left. Moving the horns when necessary, he strives to keep the sound centered. In the same manner, the second observer located the position of the plane with the horns on the vertical bar, thereby getting the location of the plane in relation to its elevation. These horns on the vertical bar swing horizontally with every movement of the horizontal bar, so are always pointing toward the plane.

Mounted on the pivot of the horizontal bar, and remaining always stationary, is a circular dial divided around its circumference into 360°. The zero mark is alway pointed to the north. When the horizontal bar is moved a pointer on it indicates the number of degrees from zero, or north, the horns are pointing. A second dial, consisting of half a circle and marked off in divisions of 0° to 180°, is used in conjunction with the horns on the vertical bar to indicate the elevation of the plane; that is, the angle formed with the ground by a straight line to the plane. Thus, if the plane were directly overhead the pointer would indicate 90° on the vertical dial. Corresponding dials on the searchlight are adjusted to coincide with these.

The third observer reads the dials on the locator. Both listeners having reported "on target," the third man reads, let us say, 20° on the horizontal and 75° on the vertical dial. These numbers he phones or calls to the man at the control wheel of the searchlight, who at once sets the light at 20° from zero and elevates it 75°. Were the sound locator absolutely accurate, the beam of the searchlight would now fall directly upon the plane. There are, however, always some variations, due to wind and speed of the plane, but this method is far more accurate than the ear alone.

Time Saving Wire Tables

This table when used to ascertain just how much wire is necessary to wind certain coils of various lengths and widths with various sizes and kinds of wire will be found to be extremely valuable.

Size B & S Gauge	Enameled	Turns per Inch: Single Cotton Covered	Double Cotton Covered	Single Silk Covered	Double Silk Cover
20	29	25	23	27	26
21	32	28	26	31	29
22	36	31	28	34	32
23	41	34	31	38	36
24	43	37	33	42	39
25	51	41	36	47	43
26	56	43	39	52	46
27	64	49	42	57	52
28	71	54	45	63	56
29	79	58	48	70	62
30	88	64	56	77	67
31	100	69	57	85	72
32	112	75	60	93	78
33	134	81	64	102	84
34	140	87	66	112	91
35	156	94	73	120	97
36	173	101	78	130	104
37	201	108	84	141	110
38	225	115	89	151	117
39	256	122	95	163	123
40	288	130	102	179	129

In calculating the size of tuning coils, loose couplers, choke coils, electro-magnets, etc., one of the most important factors which has always to be known, is the turns per inch of the various forms of insulated copper magnet wire, and the accompanying tables should prove of extreme value to all readers who are anxious to design or calculate any such windings as these.

For average calculations the turns of magnet wire per square inch of cross section of winding, such as in electro-magnets, solenoids, etc., can be found by *squaring* the turns per inch as given in the table at the left. The table below is a very useful one and one which has not been publisht before, so far as we know. This table gives the feet of wire per inch of winding, for cores of various diameters.

Contributed by E. T. JONES.

Turns per Inch	Feet of Wire: 20	24	28	32	36	40	45	50	55	60	65	70	75	80	90	100	Diam. of Core
	5	6	7	8	9	10	11	12	14	15	16	18	19	20	22	25	1
	7	8	9	10	12	13	15	17	18	20	22	23	25	27	30	33	1¼
	8	9	11	12	14	16	18	20	22	24	26	26	30	32	36	40	1½
	9	11	13	15	17	18	21	23	25	27	29	31	33	36	41	46	1¾
	11	13	15	17	19	21	24	26	29	31	34	37	39	42	47	52	2
	13	16	19	21	24	27	30	33	37	40	43	47	50	53	60	67	2½
	16	19	22	25	28	31	35	39	43	47	51	55	59	63	71	79	3
	19	22	26	29	33	37	41	46	50	55	59	64	69	73	82	92	3½
	21	25	29	33	38	42	47	52	67	63	68	73	79	84	94	105	4
	27	32	37	43	48	53	60	66	73	80	87	93	100	107	120	.....	5
	31	38	44	50	56	63	71	79	86	94	102	110	118	126	.....	.....	6
	37	44	51	59	66	75	85	92	101	110	119	128	138	.....	.....	.....	7
	43	51	60	69	77	86	96	107	118	129	139	150	.....	.....	.....	.....	8
	47	56	66	75	85	94	103	118	129	141	153	.....	.....	.....	.....	.....	9
	52	63	73	84	94	105	118	131	143	157	.....	.....	.....	.....	.....	.....	10

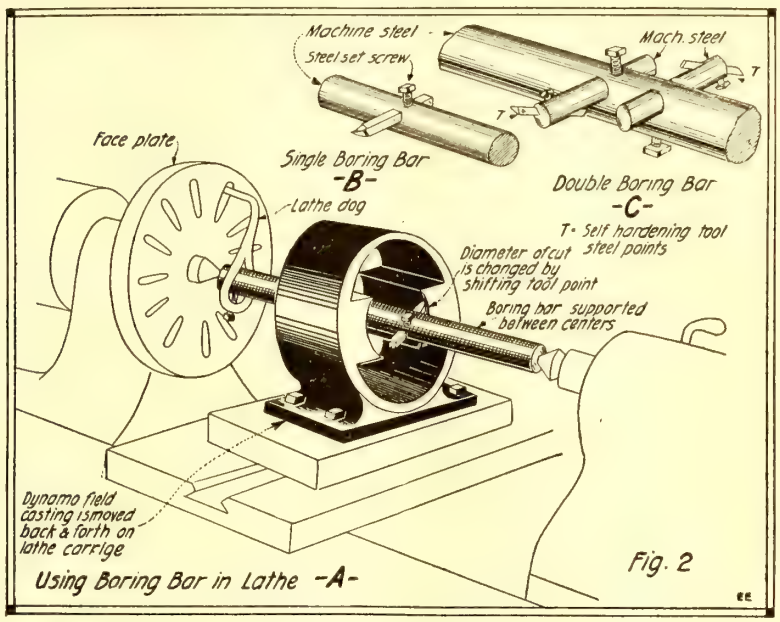
The Electrical Machinist

By H. WINFIELD SECOR

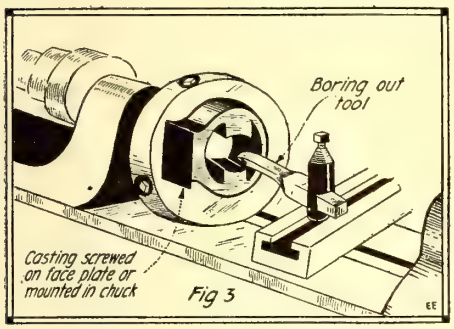
NO. 4—MACHINING FIELD CASTINGS.

ONE of the principal problems met with in Electrical Machine work is the machining of motor and dynamo field castings and field poles. This paper deals with some of the more common methods of finishing up field castings, as well as separate pole-pieces. At Fig. 1 several interesting wrinkles are illustrated, which will save much time and labor. At A and B are shown two simple and effective ways of boring out the pole-faces of small dynamo or motor castings. In many small size machines, similar to these types, the cast iron or malleable iron members are left unfinished with respect to the inside pole-faces surrounding the armature.

However, it is very imperative that the air-gap be left very small in all dynamos and motors and never more so than in the small battery voltage machines. Therefore, it becomes necessary in order to realize the highest electrical efficiency from the machine (which is occasioned by minimizing



Boring Out Dynamo and Motor Field Castings With a Boring Bar, Rigged Up in the Lathe.



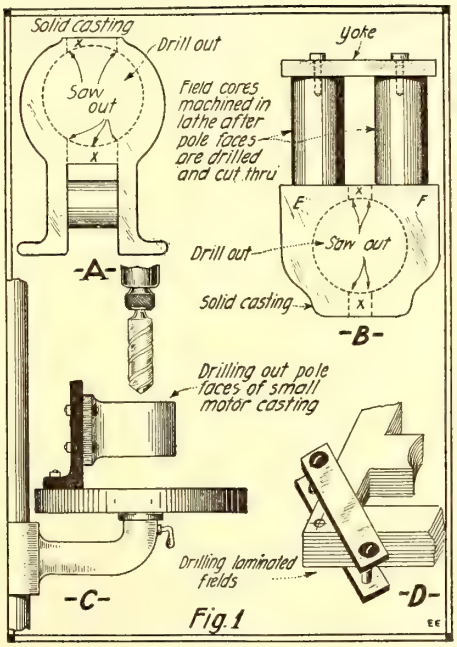
Mounting Field Castings on Face-Plate or Chuck of Lathe and Boring Out Pole-Pieces With Boring Out Tool.

the thickness of the air-gap between the field and armature) by accurately machining or boring out the pole-faces.

Of course, the two pole-faces such as shown in the design at Fig. 1-A and 1-B have to be separated at the points marked XX, but it is best to cast this part of the frame in one continuous ring. If this is done and where the casting is drilled out or bored out on the lathe, it will be found much more rigid and suitable for carrying out this operation than if the pole-pieces are left open at the points XX. When the polar bore has been finished to the proper diameter then the sections XX in the casting can be cut away with a hack-saw and filed smooth. The casting shown at Fig. B is made in one piece, excepting the yoke. It is not necessary to machine the magnet cores, but if it is desired to turn them off in a lathe, this can be done after the polar bore has been either drilled or tooled out to the proper size, and the two pole-pieces E and F are cut apart at XX.

It is usual to mount small field castings on the carriage of a lathe or else on the lathe bed in any way convenient, so that the casting is held solidly—but as shown at Fig. 1-C such castings can also be held for drilling vertically on a right angle bracket on a drill press table. Of course, the point to watch in any of these operations is, primarily, to see that the polar bore *is made parallel with the base* and bearing supports. The base of the motor is usually machined on a *milling machine* or *shaper*, as nearly parallel as possible with the axis of the unfinished polar bore, and thus this becomes the controlling factor in aligning the casting for any further machine operations.

At Fig. 1-D a handy wrinkle is shown for drilling laminated sheet steel transformer or field cores, which involves the use of iron clamp members which are put under compression by means of bolts in the manner shown. It should be mentioned at this juncture that on small castings such as those described above, it is rarely practicable to attempt the drilling out of such

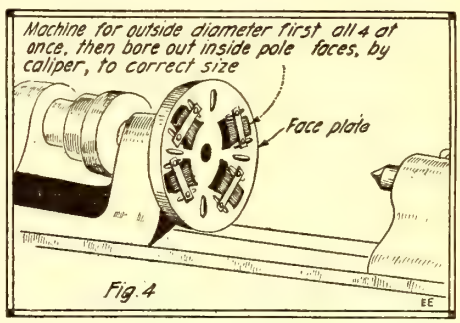


Tricks in Casting and Machining Dynamo and Motor Castings.

thin portions as the pole-pieces with a large drill, say of about 1¼ inches or greater diameter. The easiest and most sure way to do this is to drill around the outline of the polar bore, as laid out with dividers on the surface of the iron after it has been rubbed with chalk, with a small drill about ⅛ inch in diameter on small castings, and of greater diameter on larger castings.

The inner face of the pole-piece should then be carefully filed to the correct diameter and a smooth finish given with a file, using a coarse file for roughing out, and a fine file for finishing the surface. A half round file is best suited to this work.

Another very good method for boring out the pole-pieces in such small castings is to drill, say a one-half inch hole thru the center of the casting on the polar axis and then to mount the casting on a face-plate in the lathe; then with a boring out tool proceed to machine out the iron until it is of the proper diameter. The connecting parts of the casting at XX are then



Machining Separate Pole-Pieces of Electrical Machinery. The Pole-Pieces May be Secured to a Face-Plate and "Turned" Inside and Out to the Correct Diameters.

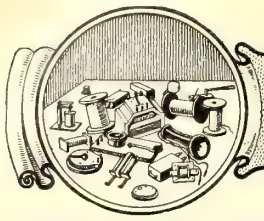
cut away with a hack-saw along the dotted lines as shown.

USING THE BORING BAR FOR FIELD CASTINGS.

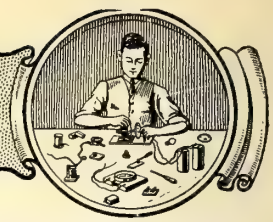
At Fig. 2 the application of the boring bar to the machining of dynamo and motor field castings is shown. This bar is usually made from a piece of steel either cold rolled or what is commonly known as *machinery steel* stock; this latter is a mild homogeneous grade of steel which can be readily worked. There are two kinds of boring bars in general use on light machine work, and these are shown at Fig. 2-B and 2-C, respectively.

That shown at B has one tool point inserted in the bar, while C has two revolving tool heads and carries two tool-steel cutting points. The single point boring bar is shown in operation turning out the polar bore of a two-pole field casting at Fig. 2-A. If the boring bar is to be made in the shop, it should have two center holes drilled accurately in either end, and in about the center a round hole of suitable

(*Continued on page* 1078)



HOW-TO-MAKE-IT

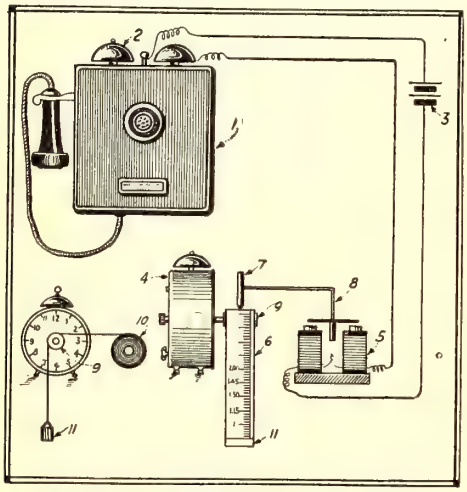


This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

A TELEPHONE "CALL RECORDER."

The parts used are as follows: 1 is an ordinary house telephone, or the gong box on the private phone. 2 is a breaker between the gong and tapper. When the bell rings the tapper is drawn over to the bell, closing the circuit. 3 is a battery of dry-



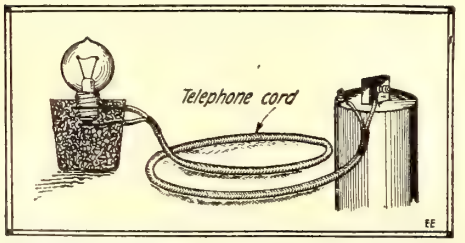
A Home-Made Telephone Call Recorder Which Anyone Can Construct From An Alarm Clock and a Telegraph Sounder, Together With Some Paper Tape.

cells. 4 is an alarm clock with the hands removed. 5 is a telegraphic sounder, or a vibrating bell adapted for the purpose. 6 is a paper tape, about one inch wide, passing over 9, a wooden spool or spindle. 7 is a soft pencil fastened to the sounder by wire No. 8. 10 is spindle with reserve tape on it. 11 is a weight to hold tape tightly to the spindle.

Contributed by HOWELL W. MILLER.

LAMP SOCKET FROM CORK.

I herewith submit a novel idea to your "How to Make It" Department. A is a cork in which a hole is bored part way thru to admit the bulb, B, which is connected by a telephone cord to the battery. The pins at one end of the double cord are



Why Worry About the High Cost of Lamp Sockets, When You Can Make a First Class One for Miniature Lamps by Cutting a Hole for the Lamp Base in an Ordinary Cork as Shown?

inserted, one at the bottom of the hole and the other at the side and a little higher. These make contact to the lamp base.

Contributed by AN EXPERIMENTER.

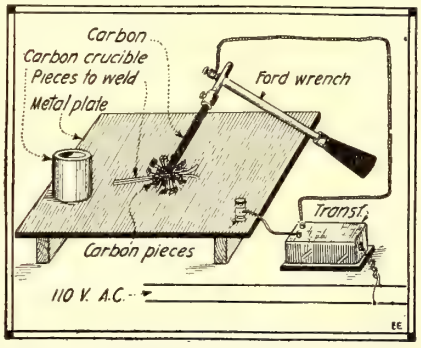
SECOND PRIZE, $2.00

WELDER AND ELECTRIC FURNACE COMBINED.

The most important factor in the construction of this welder and electric furnace is its cheapness, owing to the fact that it can be made from odds and ends.

The following materials are needed: A common Ford wrench, a ⅝ inch soft core carbon, plate of metal (copper, iron or galvanized iron sheeting), a small piece of plate carbon about 2x4 inches, or some carbon rods pounded into small bits. A piece of flexible heavy wire is used in connecting up the device. A complete diagram of how this is assembled is shown in the accompanying diagram. By using the transformer (several of which have been described in the previous numbers of the ELECTRICAL EXPERIMENTER), or by using a rheostat composed of water electrolyte or a coil of wire, the welder will work satisfactorily. The transformer used must be wound as a *welding transformer*, to give a low voltage, high amperage current. A transformer capable of giving fifty volts, twenty-five to thirty amperes A. C., at the secondary will work very well. The flexible wire running to the wrench can be either soldered or fastened by a fixt binding post.

In working it, I was able to weld nails, wires, plates of different kinds of metal, like copper, brass, iron, tin, etc. I also



Electric Welder and Furnace Combined—This Stunt Should Prove of Interest to Automobile Owners. As is Well Known, the Electric Arc Produces a Very Intense Heat and This Outfit if Properly Operated With a Suitable Size Transformer From the Alternating Current Supply Circuit, Will Work Very Smoothly and Satisfactorily.

mended small cracks or holes in motors, pulleys and vises, besides mending kitchen and household utensils that were made of metal, such as pots, pans, et cetera.

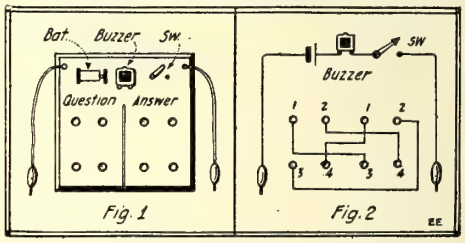
In using the welder for melting and casting small articles, I used a home-made carbon crucible. My crucible was two inches long, and one-half inch in diameter. I bored a 1-inch hole, 1⅝ inches deep, in the carbon rod. I melted and cast small articles out of tin, copper, brass, aluminum, etc. The moulds that I made for the melted metal to run into were made of plaster of Paris. Use heavy dark glasses when operating the outfit, because the light is hard on the eyes.

Contributed by LEONARD E. ARKE.

THIRD PRIZE, $1.00

AN ELECTRICAL QUESTION ANSWERER.

Here is a toy which will interest every one, besides being instructive. The illustration shows the idea so well that only a little description is necessary. The idea is that the person desiring to get the answer to one of the "questions," plugs in the hole at that question, and in the "Answer" section plugs in anywhere until the buzzer rings. This indicates the right answer and the answer at the hole where the plug was in, is the answer to the question. This is



Here is a Clever Electric "Question and Answer" Board Which will Provide Hours of Amusement to Both Young and Old During the Winter Evenings.

very interesting to children. The operation is easily understood. For a model, four questions were taken so as not to have a large and complicated wiring diagram. The diagram is shown in Fig. 2. But the wires to the answers are distributed haphazard, so there will be quite a lot of excitement finding the answer. A switch should be provided so as to cut the circuit when the answer is put away.

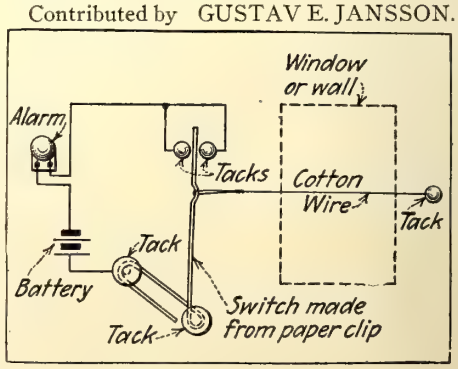
Contributed by PHILIP A. WALL.

FIRE AND BURGLAR ALARM.

The accompanying sketch shows a signal device made from a paper clip, some tacks and a piece of cotton wire. The thread stretched across a window will prevent anyone from entering as you will note that any movement of wire will close the contact.

The contact can also be used to give fire signals as it easily burns off, and thus makes contact, ringing the bell.

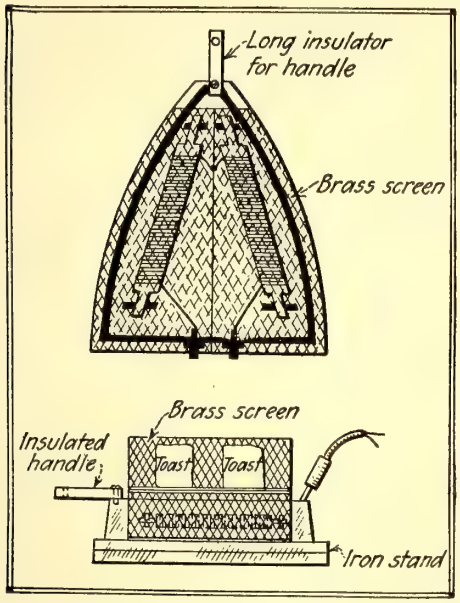
Contributed by GUSTAV E. JANSSON.



The Simplest Fire and Burglar Alarm We Have Yet Seen! It is Made From a Paper Clip and a Piece of Cotton Thread Which Holds One End of the Clip in Free Suspension. If the Thread is Run Into by a Burglar, the Contact is Closed, While a Fire will Burn the Thread, Thus Allowing the Contacts to Close.

A SIMPLY CONSTRUCTED ELECTRICAL STOVE.

An electrical stove can be made from a hot point iron in a few minutes. First



Home-Made Electric Toaster and Stove—an Electric Sad-Iron Forms the Basis of the Structure.

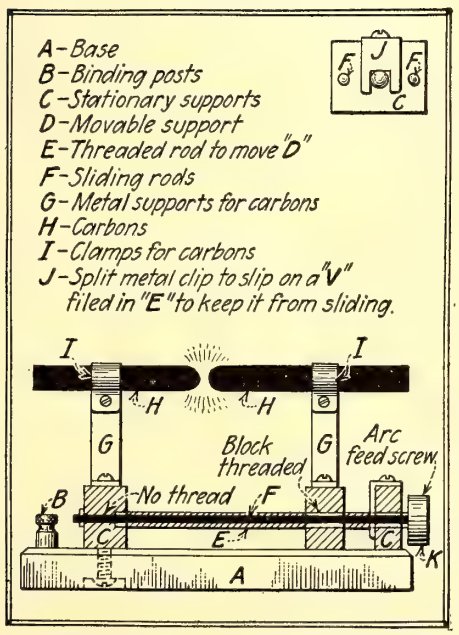
take the cover off and then remove the asbestos. From some brass screen fashion a grid of convenient shape and height so as to cover the iron. When one needs hot water, a flat-top screen is best, and for toast use the triangular shape, with a small place to hold bread. This can be replaced in sad iron in a few minutes.

Contributed by GEO. Y. MATSUMOTO.

AN EFFICIENT HAND-FEED ARC LAMP.

An efficient arc lamp can be easily constructed as per the accompanying sketch. No fixt dimensions are given because Amateur Mechanics usually change them to suit their material on hand anyway. I have operated one like this with a Nichrome wire resistance for some time, and it has given very satisfactory results. One carbon support only, D, is made movable by means of adjustment or feed screw K.

Contributed by ROBERT WOOD.



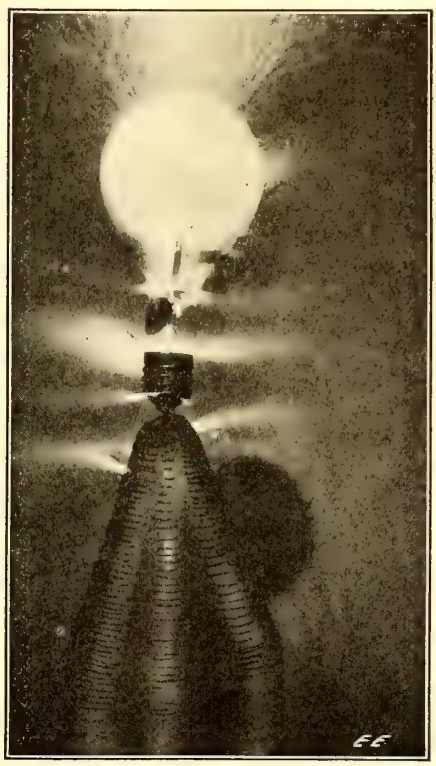
A Simple and Efficient Hand-Feed Arc Lamp.

LIGHTING 250 WATT LAMP ON 200,000 VOLT OUDIN COIL.

The photograph herewith shows a very interesting experiment conducted by the contributor, Edward E. Slyn, in which a 250 watt Mazda tungsten lamp was illuminated by placing the metal base in contact with the charged ball terminal of a powerful 200,000 volt Oudin coil.

Some of the most interesting and entrancing experiments in the whole realm of electricity can be conducted only by the use of this high-frequency air core transformer. Anyone possessing a wireless transmitter can easily rig up a high frequency coil which will produce sparks of quite an appreciable length. With a 1/4 K.W. step-up radio transformer, or with a 6 to 8 inch spark coil, it is possible to produce high frequency sparks 8 to 12 inches in length, when the condenser and spark gap in the circuit are properly attuned.

It might be interesting in this connection, to state that Dr. Tesla has said, the only difference between the *Oudin* coil and his own air-core high frequency transformer,

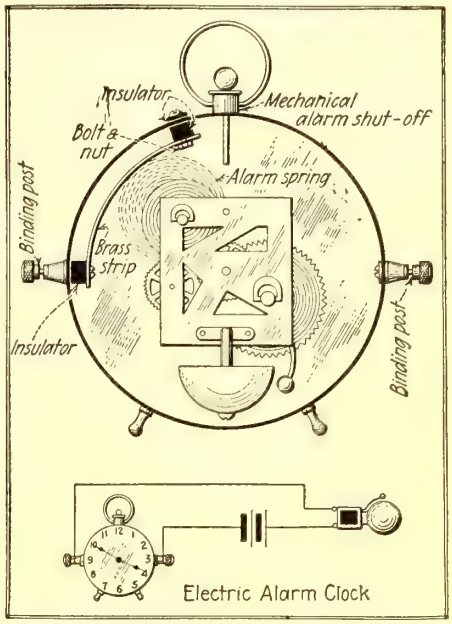


Many Spectacular and Beautiful Effects Are Obtainable When a Large Incandescent Lamp Is Lighted by an Oudin Coil. This Experiment Shows a 250 Watt Lamp Being Illuminated on a 200,000 Volt Oudin Coil by a Unipolar Discharge.

known as the *Tesla* coil, is that Oudin, while experimenting with some of Tesla's high frequency transformers, simply changed the connections around, and from this fact sprung what is known to the present electrical fraternity as the *Oudin coil,* which is ostensibly nothing more nor less than a Tesla transformer with one end of the secondary connected to the primary. Moreover, as Dr. Tesla had pointed out, his early experiments and notes, covered all such experiments as this, long before Oudin had happened to try it out. It is also of interest to mention that all of the kick-coil high frequency apparatus now on the market and used for the purpose of exciting so-called violet ray tubes, etc., including what is known as the *Collins-Sanchez* high frequency kick-coil set, are all primarily based on, and follow the specifications laid down by Dr. Tesla, in his high frequency coil apparatus, described and illustrated in the May, 1919, issue.

ELECTRIC ALARM CLOCK.

As the spring of the alarm clock expands, it makes contact with the brass strip, thus causing the electric bell circuit



A Sure-Fire Electric Alarm Clock. The Expanding Spring Closes the Electric Bell Circuit.

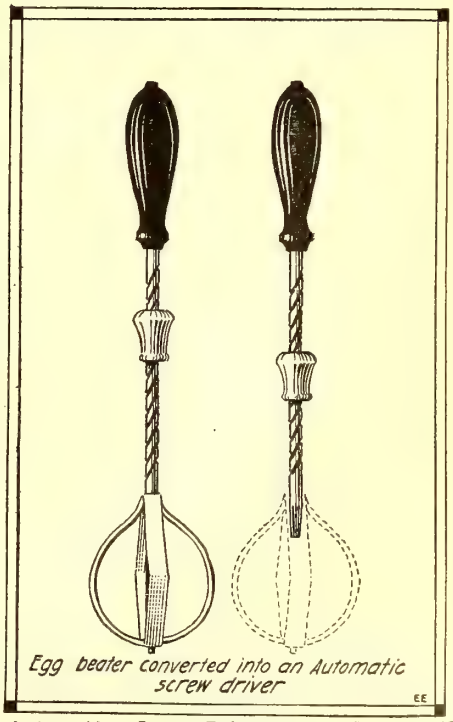
to be closed, or which can be used to operate the "alarm shocker" described sometime ago in the "E. E.," where the woodenhead sleeper is awakened by receiving a firm and sure electric shock thru two pieces of tinfoil laid under the sheet, and which connect to the secondary of a medical coil.

Contributed by IRVEN ELDRIDGE.

AUTOMATIC SCREW-DRIVER FOR TEN CENTS.

While working in the machine shop I had to insert a large number of screws. Not having an automatic screw-driver at hand I devised the one shown. Take off the bottom part and file to a point, that's all there is to making an automatic screw-driver out of an egg beater. You can get the egg-beater shown at any 5 and 10-cent store.

Contributed by JOHN JAMES.

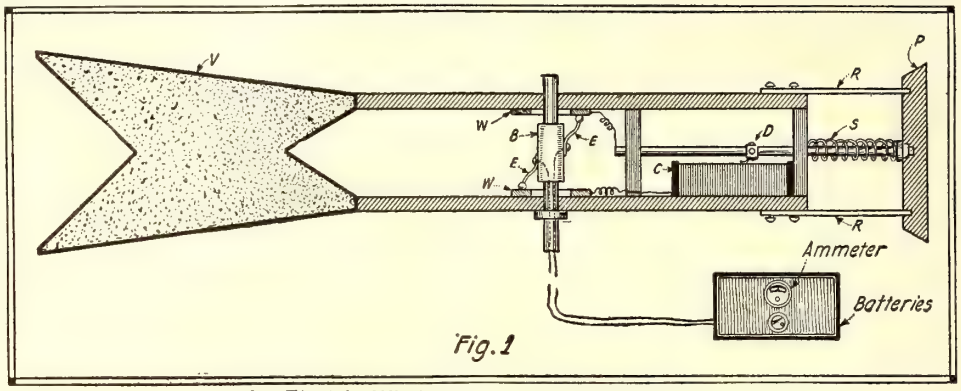


Automatic Screw-Driver Made From a 10 Cent Egg Beater.



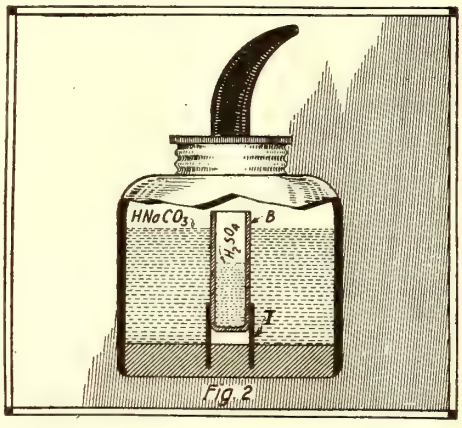
Three Successful Wrinkles

The first is a simply made anemometer (wind-gage), the construction of which is evident from the drawing, Fig. 1. P is a small pan about a foot in diameter; S is a coil spring which holds the pan as far out as the wind pressure will allow. The spring contact D presses on the resistance coil C, thus regulating the current. A small board B holds two spring contacts E, which press on the washers W. The wires run down the inside of the pipe X and are connected to an ammeter and switch. A paper scale may be fastened to the ammeter and the instrument calibrated by comparison with a standard instrument.



An Electric Windgage of Very Clever Design.

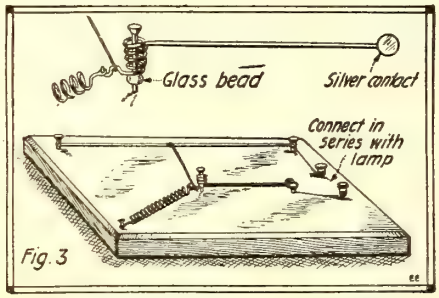
The *fire-extinguisher*, Fig. 2, can be easily made from a large oil can. A tube T is found, into which the bottle B may be inserted. This tube must be fastened to the bottom of the oil can in some manner. I used wax in the one I built. The bottle must be adjusted so that it will extend almost to the top of the can. The pressure is so great that all joints must be soldered. When ready to try the fire-extinguisher fill the can with a solution of sodium bicarbonate and the bottle with sulfuric acid, being careful not to mix them. Screw the top on tightly and the extinguisher is ready to use. When it is inverted the action of the acid on the sodium bi-carbonate generates carbon dioxide and the pressure of the gas forces the water out. This device will shoot at least 15 feet. If you wish some fun exchange a prepared can for somebody's oil can. After which you want to make yourself "scarce."



Fire Extinguisher of the Sulphuric Acid and Bicarbonate Type. Caution!

The construction of the *lamp flasher*, Fig. 3, requires no description. When the current passes thru the wire it expands slightly and allows the spring to separate the contacts C. As the instrument has quite a little resistance, more current must be used. This is for battery lamps only.

Contributed by
J. DURWARD MINER, JR.



Lamp Flasher of Simple Construction.

Analyzing Water

The following are a few tests which can be applied to drinking water. The apparatus can usually be found around the laboratory.

1—Clean carefully, dry, and weigh a porcelain evaporating dish.

Evaporate in this dish 1000 c.c. of water, over a water bath (which can be made from an old tin cover) and be sure that the last traces of moisture have been expelled, by heating two or three minutes after the dish appears to be dry. Weigh again and the difference between the first and second weighing, in centigrams, multiplied by ten is the number of milligrams per liter of total solids. Do not condemn the water solely for this reason unless it contains more than *four or five hundred milligrams of solids per liter.*

Apply hydrochloric acid to a portion of this residue, and if it effervesces, a carbonat is present, probably calcium.

2—To another sample of the water, add a few drops of silver nitrat solution. If a white precipitat, that is very evident, appears, the water probably contains sewerage, unless it is near a salt district, and it should be regarded with suspicion.

3—The presence of iron is determined by running hydrogen sulfid thru a sample of the water for a few minutes and if the water turns very brown, iron is probably present.

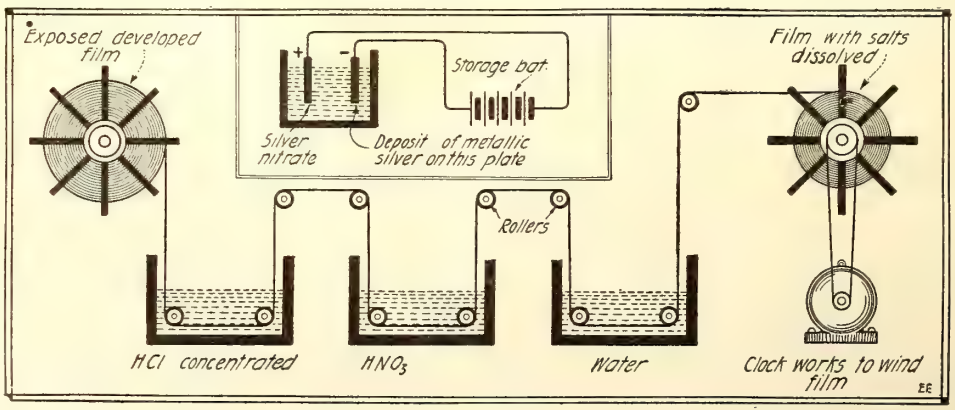
4—The amount of soap used before a permanent lather is formed on a sample of the water is a fairly good indicator of the hardness of the water.

5—Take half a test-tube of water and half a test-tube of distilled water. Add the same number of drops of potassium permanganat solution to each. Boil, and the difference in color is an estimate of the amount of vegetable matter present.

Contributed by PHILIP H. VIVIAN.

HOW TO RECOVER SILVER FROM FILMS.

The photographic film is first run thru hydrochloric acid. After the film is run thru the HCl very slowly it dips into the container containing the nitric acid, of course taking some of the HCl with it. These acids will dissolve any metals such as gold and platinum but leave silver in the form of a precipitate of silver chloride.



An Easy Way to Prospect "Pay-dirt" Right Here in Your Laboratory.

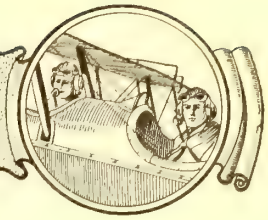
The acids are now mixed together very carefully, whence the silver salts will fall to the bottom of the container.

The solution is now filtered and the silver salts recovered from the filter paper and dissolved in an excess of ammonium hydroxide.

The solution thus obtained is now subjected to an electrolytic process whence the silver salts is deposited in its pure state, viz. metallic silver. Contributed by J. H. KRAUS.



RADIO DEPARTMENT

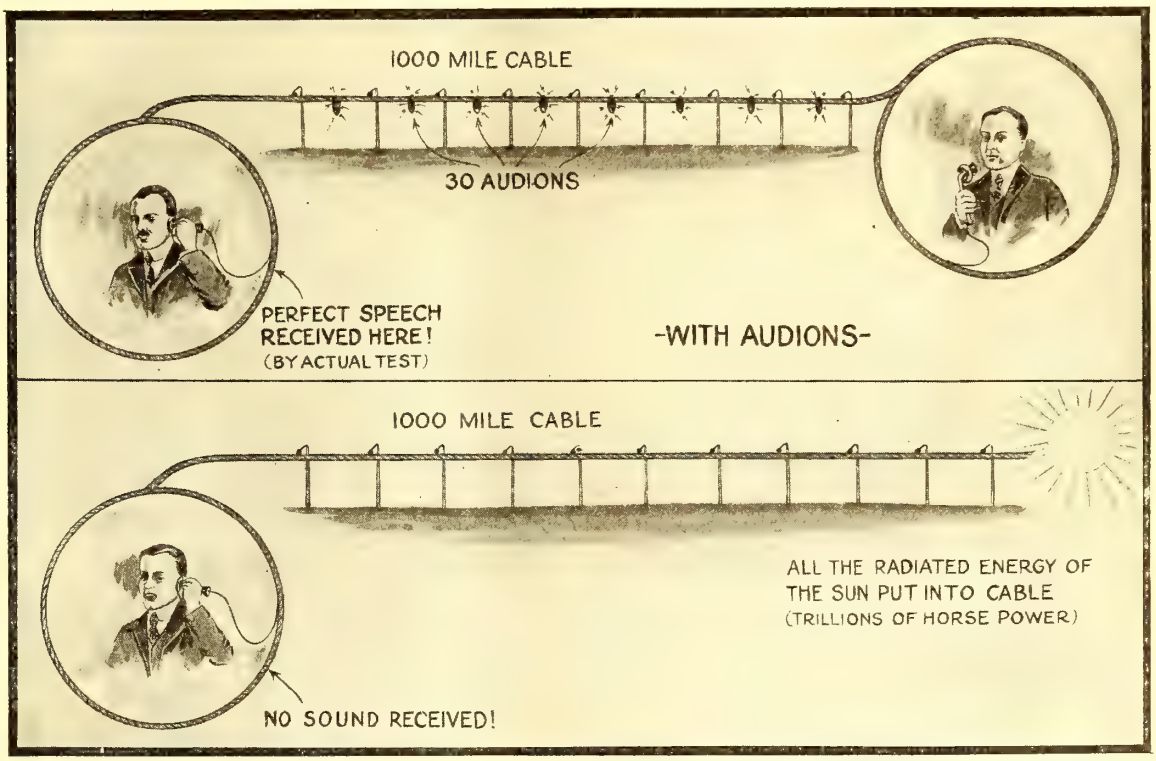


Audions Stronger Than Sun!

Thirty Audions Amplify Voice Stronger Than Sun's Total Radiated Energy

THE Audion, as we all know today has proved to be the real "dark horse" in the Radio game, if ever there was any! A simple little glass bulb containing a filament, grid and wing, which Dr. Lee de Forest started playing around with less than a score of years ago, and which at first looked more like a scientific or laboratory toy than anything else for many years, has rapidly come to the front, particularly during the progress of the World War, and now stands in the very front rank of Radio devices. It has not only threatened, but has actually surplanted in several instances the usual electro-dynamic and other standard forms of radio equipment, not only for receiving but for transmitting wireless telegraphic signals and telephonic speech.

Who Would Believe That 30 Audions Would Amplify the Human Voice So As To Give It Greater Strength For Transmitting Speech Over a Long Telephone Line, Than If All the Power Radiated By the Sun Could Be Applied in the Form of Telephone Waves To One End of the Circuit? It Has Been Computed In Connection With Actual Tests With This Number of Audions On a 1,000 Mile Circuit, That No Sound Would Be Heard at the Other End If All of the Power Radiated by the Sun Was Used in Place of the Audions. The Total Amplification Due to the 30 Audions Is Equal to 10^{50}.



Several hundred audion bulbs connected together in a bank enabled the U. S. Naval radio experts at Arlington, several years ago, to hurl the spoken word across the Atlantic from that station to the Eiffel tower radio station at Paris, France. The words spoken at the government high-power station in Arlington were also picked up in Honolulu, T. H., and practically every radio station of any size on the North American continent, as well as several South American stations picked up the radio-telephonic messages spoken into the microphone at Arlington. All of which goes to show what a wonderful device the present day development of the audion really is.

Glancing at the accompanying illustration we are astounded to learn that thirty audions, connected to a telephone cable 1,000 miles in length, are able to amplify perfectly the spoken word, and produce such a tremendous amplification of the voice that the total amplifying power resultant is greater than that which would be produced if all the power radiated by the sun could be applied in the form of a telephonic current!

The following report by a leading American telephone expert, and which report constitutes a portion of an affidavit regarding the applications of audion repeaters and amplifiers on long distance telephone cable, proves highly interesting; in fact, startling!

MR. O. B. BLACKWELL, BEING DULY SWORN, DEPOSES AND SAYS "that he is Transmission Development Engineer of the American Telephone and Telegraph Company having charge, among other things, of the development of telephone repeaters and amplifiers and has been engaged in telephone engineering for a period of thirteen years. That he is familiar with the history and development of telephone repeaters, and that to the best of his knowledge and belief there was no mechanical repeater capable of meeting the requirements for a telephone repeater or amplifier in actual telephone lines produced prior to the *Shreeve Repeater,* developed by Herbert E. Shreeve, of the Western Electric Company, which was first put into operation on a commercial line in August, 1904.

"That any repeater or amplifier which produced distortion of the speech currents is to that extent unfitted for use in tandem operation, because *the distortion is cumulative* in the successive repeaters; and that mechanical amplifiers generally and even the Shreeve repeater to some extent, produce distortion.

"That the *Audion amplifiers* used by the American Telephone and Telegraph Company are practically distortionless, and are commercially used in tandem operation in regular installations, and were so used in the first transcontinental line, which would have been impossible without the use of the tandem arrangement. That by actual trial over cable circuits approximately one thousand miles in length, it has been found that as many as *thirty* of these audion amplifiers can be connected in tandem and produce excellent speech at the receiving end of the line.

"That computation shows the attenuation of a cable circuit of this length to be so enormous that, if all the power radiated by the sun could be applied in the form of telephone waves to one end of the line without destruction of the apparatus, the energy received at the other end would be insufficient to produce audible speech without the use of amplifiers, whereas with the amplifiers used as above described, the relatively minute energy of ordinary telephone speech currents at the transmitting end produced speech in the receiver at the opposite end which was both loud and clear, and the amplification due to such a tandem arrangement of tubes being of the order of 10^{50} or 100,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000."

Vacuum Tube Circuits

By PIERRE H. BOUCHERON, Ensign, U. S. N. R. F.

Just What Each Circuit is Best Adapted for and What is Necessary to Make it Function

THERE is no question about it, the Vacuum Tube, usually abbreviated "VT," and sometimes called the Audion, the Electron Relay, the Vacuum Valve, the Oscillion, etc., is the most marvelous invention which has been added to the Radio art since Marconi's first "V" message flashed across the Atlantic back in 1898. It is at once capable of performing more electrical "stunts" than any other instrument of its kind, not only in radio science but in general electricity as well. The VT may be employed as a detector, amplifier, rectifier, or generator of high frequency oscillations, suitable for either undamped *Radio-telegraphy* or *Telephony.*

There are, of course, a multiplicity of circuits which will perform any of these conditions, some with better success than others, and all of which may be said to depend upon various operating conditions such as the characteristics of individual tubes, proper balancing of coupling circuits, wavelengths, etc. It is, therefore, the purpose of the accompanying diagrams to give some standard hook-ups which have been found generally successful, do not involve too complicated and expensive apparatus, and thus are not beyond the capability of the average experimenter.

NO. 1—THE TWO-ELECTRODE FLEMING VALVE.

The original *Fleming Valve* consisted of but two elements; that is, the *filament* and the *plate,* as compared to the present-day VT, which consists of three: the *filament,* the *plate* and the *grid.* Fig. 1 shows a two-electrode VT detector circuit. Altho this form of the vacuum tube is practically obsolete, it is given here as it may suggest possible interesting experiments which may be performed in this connection by using an ordinary electric light bulb, the outside surface of the glass of which has been surrounded by a metal band and used as the plate. Incoming damped signals may thus be rectified and intercepted in the telephones. In general practise, however, the two-element valve has not been found very sensitive to the reception of radio signals, and has therefore been replaced by the three-element tube, which permits, by the addition of the *grid control member,* of much more uniform and sensitive operation. So much for the two-element VT.

NO. 2—THREE-ELECTRODE "VT" CURRENT-ELECTRON FLOW.

This diagram shows just what relation the *electrons* emitted by the filament bear to the direction of the "B" battery plate current flow. To some experimenters it is not always quite clear why the electron flow should be directly opposite to the current flow. Before the advent of the electron theory it was arbitrarily assumed by investigators that the electric current traveled from *positive* to *negative,* but now it is found that the electric current is in reality a movement of negative electrons and *that they travel from the NEGATIVE to the POSITIVE side of a circuit.* Thus the direction of electronic flow is exactly *opposite* to the current flow, a fact that should always be borne in mind when experimenting with VT circuits.

NO. 3—GRAPHIC ACTION OF THE "VT" AS A DETECTOR.

Fig. 3 shows a graphic record of just what is assumed to happen in a VT detector circuit employing a grid condenser when the antenna picks up high frequency oscillations from a distant transmitter. Each wave train (A) causes the grid to increase its negative charge because some of the negative electrons are attracted to it and therefore the average potential of the grid falls in a manner shown in (B). The fact that the grid becomes negatively charged causes a partial or total stopping of the electron flow from filament to plate, thus causing a *decrease* in the plate current. At the end of the incoming wave train, however, this negative charge leaks thru the grid condenser and thus the plate current rises to its original strength as shown in (C). This is where the so-called "grid leak" makes its presence desirable by permitting the above mentioned negative charge to leak thru quickly. A grid leak may have a resistance of from a half to two megohms and need be nothing more than a lead pencil line drawn between the connections of the grid condenser. The result of the above action is that a *pulsating, unidirectional current* is imprest on the telephones, the character of which is similar to that shown in (D).

In February "Radio Amateur News"

The Armstrong Super-Autodyne
By H. W. Houck, A.M.I.R.E.

Modified Government Receptor.
By J. Stanley Brown

The Priess Loop Set—Part 3
By Walter J. Henry

Radio Telephone Communication to and from Trains.
By J. J. Graf

Banked Winding and How It Is Done.
By H. C. Silent

A New Type of Condenser for Selective Tuning.
By E. M. Sargent

A New Receiving System.
By Edward T. Jones

Junior Radio Section.

NO. 4—PLAIN DETECTOR CIRCUIT.

This circuit is the most commonly used and is usually the first one attempted by amateurs when first initiated into the mysteries and wonders of the VT. It is simple, inexpensive and will give excellent results for *damped* (spark) wave reception. The primary and secondary of the loose coupler may be wound for the efficient reception of waves ranging from 200 to 2,500 meters; the first wave for amateur work and the last one for reception of time signals from "NAA" (Arlington). The variable condenser V.C. may be of the standard .0005 mfd. maximum capacity, while the grid condenser should be preferably of the fixt type, about .0001 mfd. The grid leak as explained before may be made by inserting a piece of paper across the grid condenser contacts, upon which has been drawn a heavy lead pencil line; the heavier the line the lower the resistance, which latter should be about one megohm (one-million ohms). This lead pencil grid leak may also be placed in the circuit indicated by the dotted lines with equally good results. Try both ways.

As there are several types of bulbs each requiring different filament and plate voltages, care must be taken to secure the proper voltages for both. Some bulbs require but four volts for the filament or "A" battery, but the majority require six volts. The same applies to the plate or "B" batteries which range from 20 to 80 volts. The "A" battery current should be made variable by means of a small battery rheostat, while the "B" battery should also be variable, but preferably by means of a selector switch tapping individual cells. The "A" cells should be of the storage battery 40 to 60 ampere-hour type, 4 to 6 volts. The "B" cells should be small pocket flashlight batteries grouped together and conveniently boxed. The head telephones give best results when from two to three thousand ohms resistance in series, and the bridging condenser B. C. may be of the small fixt type similar to the grid condenser, and have approximately .0005 mfd. capacity.

NO. 5—THE HETERODYNE OR "BEAT" CIRCUIT.

This application of the VT is used extensively by the Army and Navy, particularly for the reception of undamped waves of high wave lengths. In this case an oscillating VT circuit is coupled to the antenna inductance and its capacity and inductance adjusted to generate oscillations of, let us assume in this case, 50,000 cycles; while the antenna oscillations received from the distant transmitter may correspond to 49,000 cycles. These two frequencies will therefore meet in the receiving circuit and interact upon each other with the result that there will be produced in the detecting system the difference between these two frequencies, i. e., 1,000 cycles, known as the "beat" note, which will of course be quite audible in the telephones.

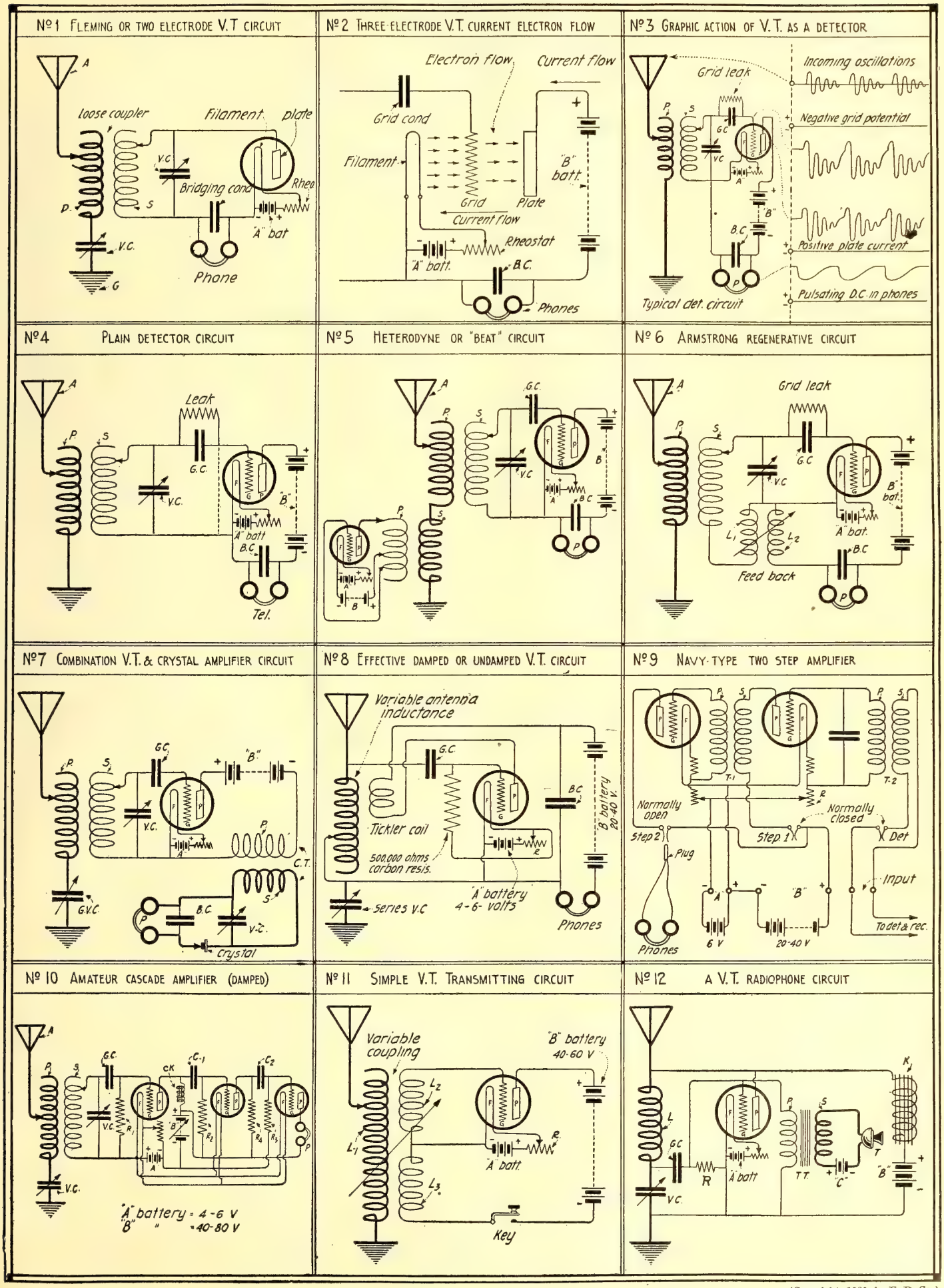
This circuit, on account of its flexibility, produces extreme selectivity and ease of controlling the note received in the telephones. Various forms of *heterodyne* reception are now being employed in this country making it possible to copy European undamped stations while in the immediate vicinity of a local high power undamped transmitter in constant operation. If long wave reception is attempted with this circuit, the inductances involved must be great enough to tune to long waves; that is, at a receiving range up to 20,000 meters, which will cover practically all undamped long distance stations. In this connection very inexpensive compact and efficient inductances which may be employed are the so-called "honeycomb" type, now in general use everywhere and which may be had to cover any desired wavelength.

NO. 6—THE REGENERATIVE "VT" CIRCUIT.

A simple and unique application of the amplifying action of the VT is used in this circuit which was devised by Major E. H. Armstrong, and modifications of which have been used extensively. The efficient performance of this circuit depends upon the proper degree of coupling between L1 and L2, which inductively couples the grid and plate circuit. It is

(*Continued on page* 1084)

Vacuum Tube Circuits



(Copyright, 1920, by E. P. Co.)

(Full explanation on opposite page.)

Radio Telephony and the Airplane

By WILLIAM C. MUNDT

LATE INSTRUCTOR, U. S. A. ADVANCED SCHOOL FOR RADIO TELEPHONE OFFICERS, GERSTNER FIELD, LA.

EX-LIEUTENANT DOYLE'S article on "Radio Problems in Aviation" in the October issue brought to mind the possibilities of the interest of the readers of the ELECTRICAL EXPERIMENTER to some information gleaned by the writer, not from books, but from actual experience at one of the large aviation fields.

As Lieut. Doyle stated, directional effect of both transmitted and received signals is the all important factor in airplane radio. It might be of interest to show by diagrams a few of the types of antenna tried out with their limitations. Figures 1 thru 5 are *fixt type* antennae, while 6 and 7 are *trailing-type*. The latter was finally adopted as the most practical for radio telephony on the airplane.

In all these types, the metal parts of the plane were bonded, and with the engine formed the *counterpoise* or ground.

Referring to Fig. 1 the three wires extended from the "cabane" struts on top of the upper wing. This type showed maximum radiation but since directional effect is desired to the rear it was undesirable. There were also very weak received signals by a plane equipt with a receiving set traveling alongside of transmitting plane, showing poor transmitting-range.

Fig. 2 is the same in type as 1, using however one wire. This reduced the capacity, but showed very little change in radiation; the directional effects were the same as 1, with the same limitations.

Figs. 3 and 4 both gave directional effect to the rear, but wavelength was so low as well as capacity that received signals would come in very weak. In Fig. 3 the one side of the triangle extended from "cabane" struts on upper wing to insulator attached to vertical stabilizer. The same with Fig. 4.

Fig. 5 used five wires extending backward as in Figs. 3 and 4 and gave the best radiation of any of the fixt type antennae but with the least positive directional effect.

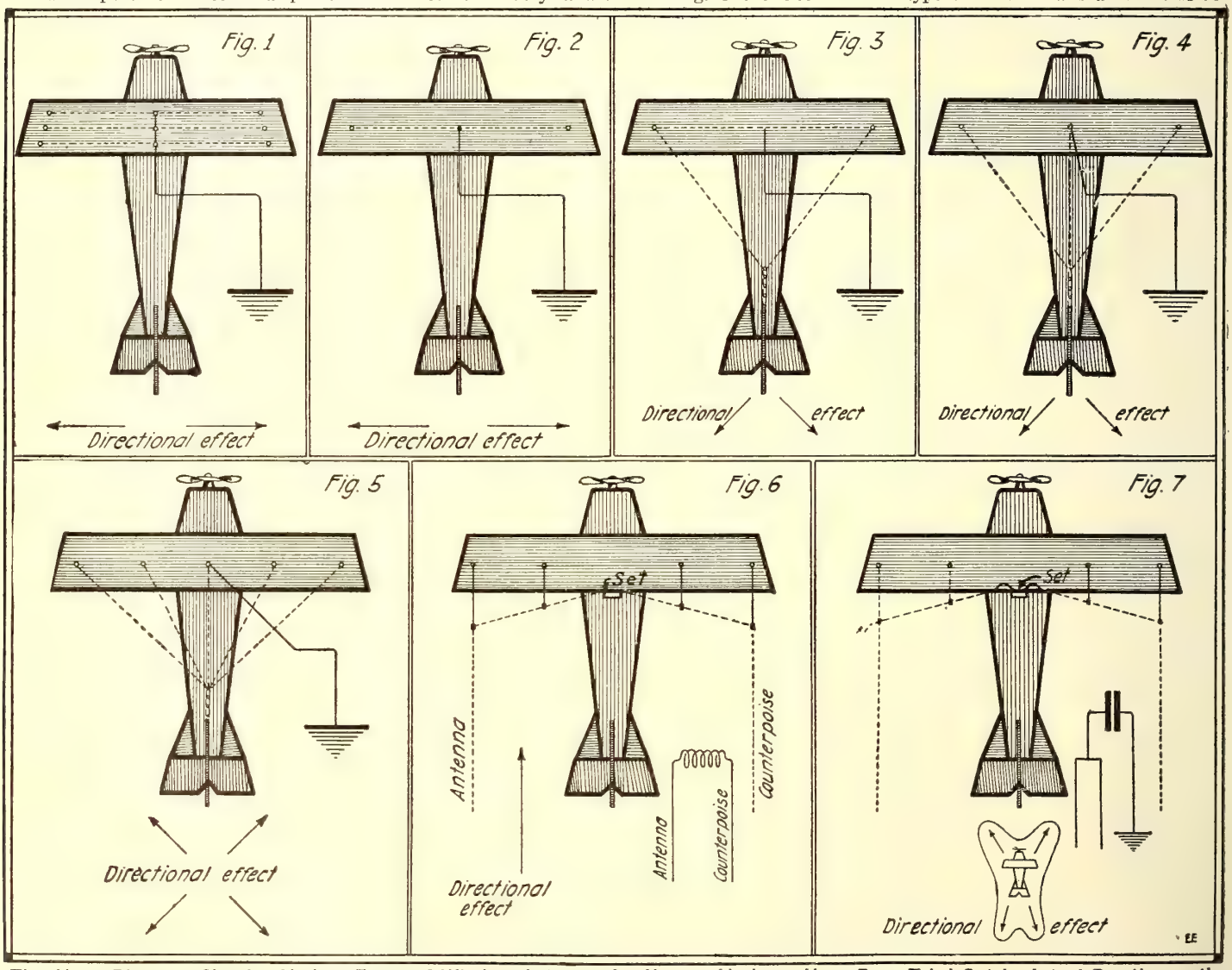
We next took up the trailing-type antenna. Fig. 6 design comprised one wire as antenna and the other trailer as counterpoise, both wires extending about 200 feet to the rear. The directional effect was good but the wavelength and radiation was poor.

Fig. 7 illustrates the *Trailing-Type* antenna which was finally accepted as the best for training purposes, until a better one might be devised, tested-out and adopted. The directional effect was about perfect for inter-plane communication or "voice-controlled squadron formation flying." The long trailing wires were 200 feet of single strand No. 20 bare copper wire and were easily broken if caught in another plane, causing little trouble thereby.

This type of antenna was used exclusively for both transmitting and receiving but had this disadvantage. In a formation of say seven planes there would be one commander, with transmitting set, and the other six would be equipt with receivers only. All of them using the long trailers in changing positions they were continually breaking off parts of the antenna, causing the pilot more trouble in tuning-in the commander's signals.

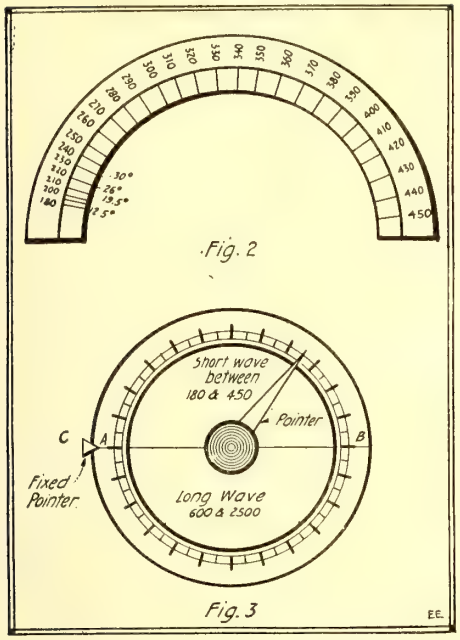
The "DOUBLE-W" antenna was then evolved which is Fig. 2 in Lieutenant Doyle's article with this difference; the trailing wires are but 35 feet long, and

(*Continued on page* 1088)



The Above Diagrams Showing Various Forms of Wireless Antennae for Use on Airplanes Have Been Tried Out in Actual Practice as the Author Points Out. These Should Prove Very Interesting to All of Us, Especially in the Directional Results Obtained.

Making a Wave Meter Direct Reading



This Shows How the Wave Length Scales Are Made and How They Are Applied to the Variable Condenser of the Wave Meter so as to Make it "Direct Reading."

LAY out a semi-circle of which the radius is the same as the semicircular scale on wave meter condenser. Next, consult the graph that accompanies the wave meter.

Suppose that curve for wave length is as in Fig. 1. If we take 180 meters as a starting point, we see that the corresponding value on the "degrees on condenser" scale is 12.5° (12½°). Then by means of a protractor locate the point on the laid-out semicircle at 12.5°. Opposite this point, mark "180 meters". In the same manner 190 meters will be found to have a corresponding value of 14.5°. By use of the protractor mark off point on the semicircle at 14.5°; this point is marked 190 meters, Continue this method of calibration until all the wave lengths have their relative positions marked off on the scale. The finished scale should resemble Fig. 2. Intermediate wave lengths like 295m. and 305m., etc., can be found and located, thus making a much finer calibration.

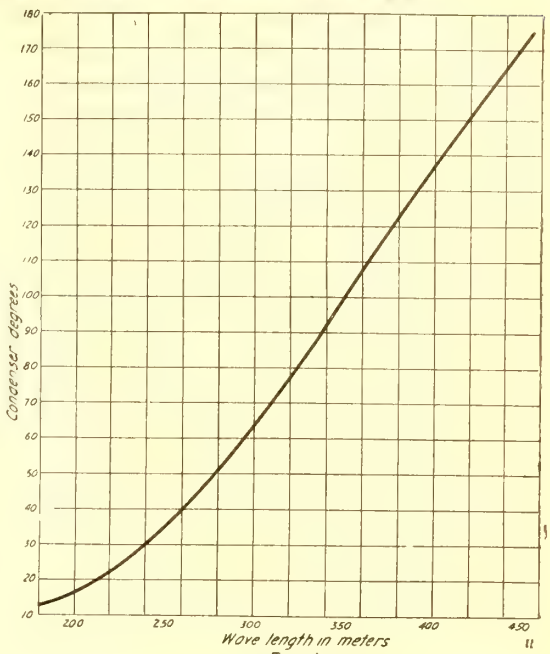
If the protractor is not handy, the points indicating the various wave lengths can be located by dividers.

The completed scale like Fig. 2 should be attached to the wave meter's condenser in such a way that its points corresponding to 0° and 180°, coincide exactly with the same marks on the condenser.

The amateur who uses this form of a wave meter will find it extremely handy and helpful where several wave lengths must be measured in a short time.

If the scale showing the wave lengths is made so that the degrees on the condenser can be read at the same time as the wave length, the accuracy of the calibration can readily be seen. By comparing the wave length read for a particular setting with that on the graph, a close check can be made.

Suppose that the wave meter has one inductance for short waves, and another for long. In such a case (if there is no binding posts on the top of the variable condenser) lay out a circle. Calibrate one-half of it for short waves and the other half for long waves. (See Fig. 3). Place the dial on the variable condenser as in Fig. 3.



This Graph Shows the Wave Meter Readings Plotted in Conjunction with the Successive Values of the Variable Condenser Scale. Instead of Reading the Wave Length Indirectly from Such a Chart, It Is Easier to Make Direct Reading W. L. Scales as Shown at Left.

In order to do the calibration quickly it would be well to tabulate the wave lengths and their corresponding values as follows:

W. L.	C.	W. L.	C.
180	12.5	320	77.5
190	14.5	330	85.
200	19.5	340	92.
210	16.5	350	99.
220	22.5	360	107.
230	26.	370	114.
240	30.	380	122.
260	39.5	390	130.
270	45.5	400	137.
280	51.	410	144.
290	57.5	420	151.
300	64.	430	158.
310	70.5	440	166.
		450	172.

If short waves lengths are to be read, set the dial so that its dividing diameter is opposite a stationary pointer (C) at (position A) which is the position when the 0° and 180° on the scales coincide. While the dial remains fixt in this position, short waves are read. If the inductance for long waves is used, rotate the dial until point B (Fig. 3) is opposite stationary pointer (C). Then read off long wave lengths.

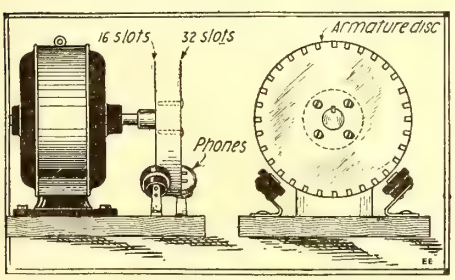
If binding posts are on the top of the condenser use two concentric calibrated semicircles to accomplish the above.

Contributed by WENDELL KING.

A Small Radio Frequency Alternator

This little machine was designed to meet the need of some device that would successfully imitate wireless signals, and keep on doing it without attention.

The materials required are a small motor, two old armature punchings about 3 inches in diameter and two 'phones; single or double pole, 75 or 1,000 ohms, it does not seem to make any difference in the way they work. The two punchings are mounted on the motor shaft about ¾-inch apart, or far enough not to allow both disks to affect the same 'phone. The disks should not have an equal number of slots, for if they were, both would yield the same tone.



The Above Illustration Shows a Simple and Very Efficient Design for a Small High Frequency Alternating Current Generator. This Machine Is an Excellent One for Supplying the Necessary High Frequency Current in Learning the Radio Code Signals.

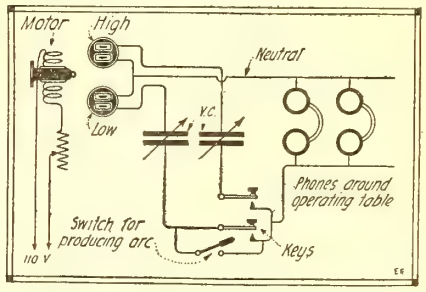
The 'phones should be so mounted as to have the revolving disks clear their pole pieces by about 1/32-inch. If it is desired the position of the 'phones can be made adjustable, thus allowing a variation in sound intensity without the use of a variable condenser.

The hook-up is shown in the drawing; this, of course, can be varied to suit individual tastes. The object of the two tones is to give practice in reading thru interference and to imitate arc stations. To produce the sound of an arc station one tone should be going all the time, the other should have a higher frequency and should be tuned in a little louder with the condensers, this louder circuit being broken up by the key. A speed regulator should be placed in series with the motor, so the speed can be adjusted to where the best note is heard in the 'phones.

A small machine similar to the one here described has been in use for teaching codes at a local high school and has given good service.

The necessary iron armature disks for building the rotor of this small high frequency alternator can be procured in most cases from some local electric repair shop. They can also be purchased from builders of small dynamos or motors or again, they can be cut out from some soft sheet iron or even from tin, but unless the tin is quite heavy several thicknesses of it should be used for each disk.

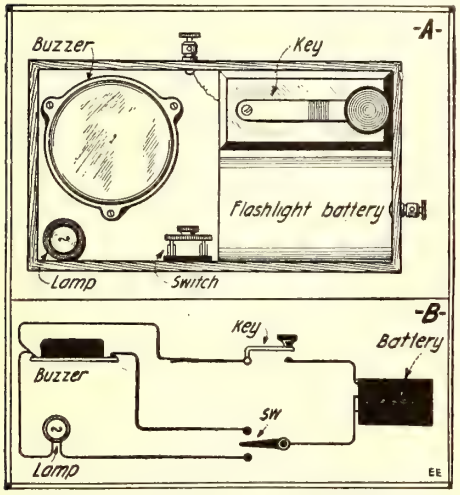
Contributed by R. H. OWEN.



Herewith Is the Hook-up for the High Frequency Telephone Generator Shown at the Left. This Scheme Has Been Used for Teaching Codes in a High School Radio Class and Should Prove Useful to Amateur and Professional Alike.

A POCKET "CODE" PRACTICE SET.

This set is completely enclosed in a box made of ⅛-inch cigar-box wood, and measuring 2¼x4¾x1⅜ inches, inside dimensions. Fig. 1, A, shows the arrangement of the key, battery, buzzer, lamp and switch in the box. The battery is one cell of a large-size flashlight battery. The lamp is 1.5 volts and is held in place by the connecting wires soldered to it. The key is mounted on a block of wood about ⅞ inch thick. The buzzer may be made to give a high note by gluing a piece of wood between the armature and contact spring. Fig. 1, B, shows connections. A lid may be made from ⅛ inch wood and fitted to the box. A copy of the codes is pasted on the inside of the lid. Binding posts are provided for connecting an outside battery in



Here's a Handy Pocket "Code" Learning Instrument Made from a Buzzer, Lamp, Switch, Key and Battery.

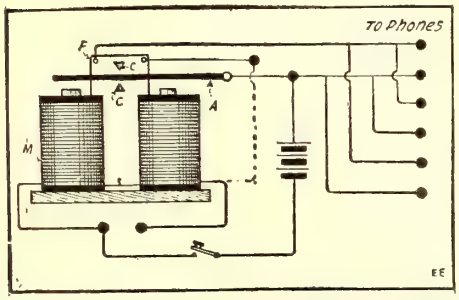
multiple with a flashlight battery so as to conserve its strength wherever possible.

Contributed by HORACE R. BROKAW.

CONVERTING RELAY INTO A BUZZER.

When using a buzzer for radio code practice I found it desirable to adjust the buzzer to give a very high frequency note, and when looking around for something better I found that by a simple expedient an old relay could be made into a first-class buzzer.

All that is necessary to construct this buzzer is to connect one of the electro-mag-



Circuit Connections for Converting Relay Into a Buzzer for Radio or Other Purposes.

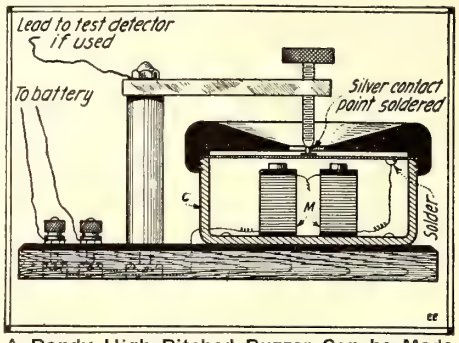
net terminals to the frame of the relay. If a temporary job is desired these connections may be made by means of the outside binding posts. It is also necessary to see that the uninsulated adjusting screw is on the side of the armature nearest the magnets. In other words, it is necessary to insulate the armature from the frame when the magnets "kill it."

By placing this buzzer on a base with a key and three pairs of binding posts for 'phones it makes a fine code practice set for embryo wireless operators.

Contributed by E. V. SHERMAN.

MAKING A BUZZER FROM A WATCHCASE RECEIVER.

This buzzer is made from a small watchcase telephone receiver, a piece of hard rubber for a base, and a piece of copper

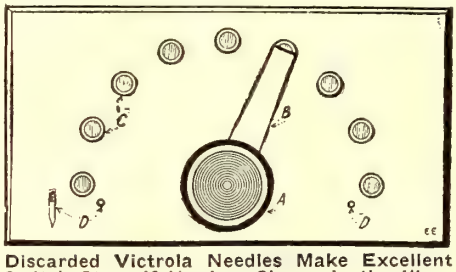


A Dandy High Pitched Buzzer Can be Made from a Watch Case Receiver.

tubing about two inches long, some copper wire of about the same length, and two 8-32 machine screws, one about two and one-half inches long. A hexagon nut is placed at the upper end, which may be used to attach a wire to, leading from the detector; the other screw is about one inch long and fitted with a hard rubber knob. This is put on top to prevent a shock. At the other end is a fine silver wire, which makes contact with the small silver disk soldered or riveted onto the diafram. However, the drawing is self-explanatory. This buzzer gives forth a sound like a real radio signal. Contributed by ROY HILER.

VICTROLA NEEDLES AS SWITCH STOPS.

The illustration herewith shows how pins for switches can be made from old Victrola needles. As the needles are sharp they may



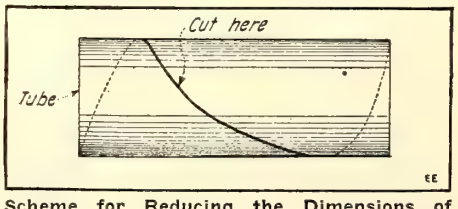
Discarded Victrola Needles Make Excellent Switch Stops if Used as Shown in the Illustration.

be easily driven in wood. For hard rubber or bakelite a small hole should be drilled and the needles driven in the hole.

Contributed by HUBERT CHIDDIX.

TO REDUCE DIMENSIONS OF PAPER TUBES.

A very successful way to reduce paper tubes, is to make a circular cut around the tube with a knife as shown in the illustration, and shrink it upon the form tightly on which it is to be mounted and mark where the tube overlaps itself, and then take it off the form and cut out the piece. Then take a piece of heavy paper and paint it with glue on one side, then put the tube back on the form and wrap it carefully with the paper, being careful to keep the diameter of the tube even, and

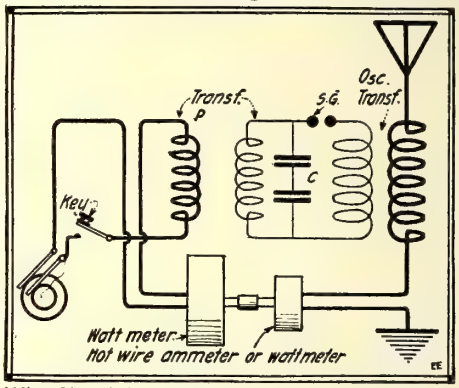


Scheme for Reducing the Dimensions of Paper Tubes. A Hint of Value to the Radio Amateur.

then set it away to dry. After the tube is dry it will be found to be as strong as ever. Contributed by HOWARD KING.

WHY NOT A RADIO "EFFICIENCY METER"?

Talking about "CONTESTS," WELL—I am about to spring one which I am sure if put to the test thru your magazine would create a lot of brain racking and exciting moments for the thousands of readers of the "E.E." I'll bet there will be a lot of valuable information spilled in the answering. I have studied the thing out myself, and as yet am a bit off on the correct solution as to its VALUE in practical work, the ratio between the transfer of energy in a radio transmitter not being any too well understood, I am at a loss to arrive at a decisive end. It may lead up to something good—as *two heads* are better than *one*. Here's the idea—mainly: (THE QUESTION WHETHER OR NOT IT IS POSSIBLE TO CONSTRUCT A METER WHICH WILL GIVE US A CORRECT READING IN PROFICIENCY) as here shown in the diagram—roughly, the hotwire ammeter would be coupled by an insulating shaft to the watt-



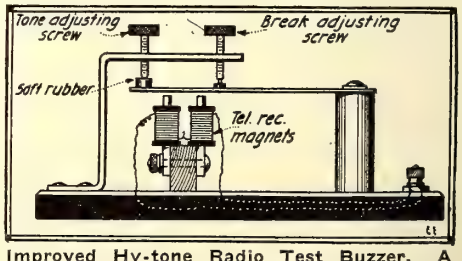
Why Not Join the Primary and Aerial Oscillating Circuit Meters Together, and Produce a Direct Reading "Efficiency" Meter?

meter—one bucking the other in such a way that a true reading of the efficiency of transferred energy from the *input of the transformer* to that of the *output (into the antenna)*. If seem as tho such a meter, if correctly proportioned could be built, as it is seen that if the set was overloaded the radiation would not be as great, therefore, the meter would show as the power was reduced; with more radiation given to the open circuit, then a greater efficiency would be indicated thru the meter. I am sure that this will create a lot of interest. Let's hear from the radio experts.

Contributed by E. T. JONES.

AN IMPROVED HY-TONE RADIO BUZZER.

A very satisfactory high frequency buzzer, which can be adjusted to give almost



Improved Hy-tone Radio Test Buzzer. A Very High Pitched Note Can be Obtained by Making the Armature of Spring Steel.

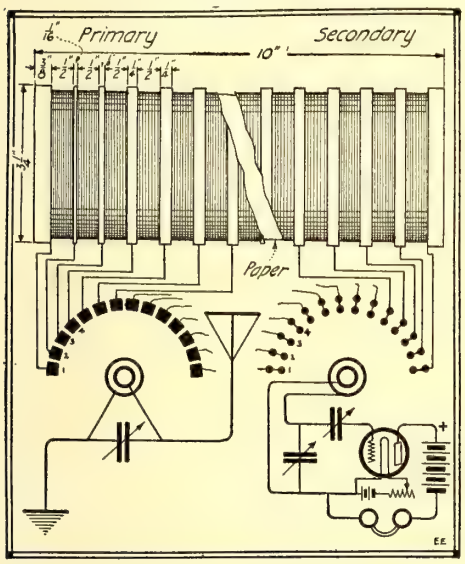
any tone and which can be made either very loud or very weak, can be easily constructed as delineated by the accompanying diagram. The coils are connected as in all standard buzzers. If deemed advisable, three posts may be connected in order to make two ready at all times to connect across the break. One of the wires is connected to the vibrator and the other to the binding post. Another wire connects the binding post with the brass "L" arm, which supports the adjusting screws. This post and the wire from the vibrator are the ones which connect to the break.

Contributed by ROBERT W. HART.

An Improved Loose Coupler

By FRANK H. BROOME, B. Sc.

MOST amateurs usually have trouble with the sliding secondary of their loose couplers, especially if they are home-made. When the coupler is mounted in a cabinet, this trouble is multiplied by the necessity of gears, pulleys, levers or other means of moving the secondary. The coupler described below has no moving secondary and will not only give the range of coupling that the common type of coupler will give but also variometer coupling, in that it is possible to reverse the windings with respect to each other.



An Interesting Type of Loose-Coupler in Which the Secondary Winding is Wound Over the Primary Winding and by the Clever Design of the Switches, the Coupling Can be Changed Without Moving Either of the Windings.

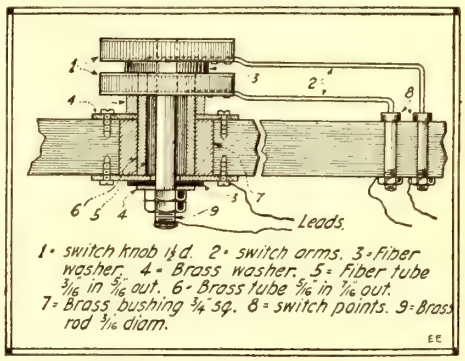
Only one tube is needed, that being about 3¼ inches in diameter and ten inches long. Starting ⅜ inch from one end of the tube, wind No. 26 B. & S., S. C. C. magnet wire for a length of ½ inch, take off a tap, leave a space of 1/16 inch and wind another ½ inch of wire, take off a second tap, leave ⅛ inch and wind a third ½ inch of wire, take off a third tap. Leave a space of ¼ inch here and wind the rest of the tube with ½-inch widths of wire with ¼ inch between each, taking off taps at each space.

Now shellac the tube and wrap on five thicknesses of good stout paper and shellac again. The primary is then wound on the tube in the same manner as the secondary but using No. 22 B. & S., S. C. C. magnet wire. The secondary taps are taken thru the inside of the tube and the primary taps are taken off the outside.

The secret of the loose coupling of this coupler is in the switches. Two 14-point switches are required with two switch arms on each, insulated from each other. The ends and taps of both primary and secondary are brought out to the points of the two switches respectively, in the same order, the right end of both primary and secondary windings being on point No. 1. These points must be large enough for both switch arms to make contact on them or else two small points used for each point. This type of switch is used on some variometer couplers and its design is left to the maker, altho the principle of it is shown in the accompanying sketch.

The inside switch arm is connected to the aerial and the outside one to the ground —primary winding. The two secondary switches are connected to the secondary apparatus in the same manner as the secondary terminals of any loose coupler.

To tune with this coupler, have the primary ground switch on the first point and adjust the aerial switch until enough inductance is in the primary circuit. Have the outside switch of the secondary on point No. 1 and adjust the inside switch until signals are clear and then move the two secondary switches together, keeping the same amount of wire in the secondary circuit. The two primary switches may also be moved together to change the coupling. By having the outside switch to the right of the inside switch on the primary and the *outside* switch to the left of the inside switch on the secondary, or vice versa, variometer effect is obtained.



Details of the Double-Pole Switch Used on the Loose-Coupler Here Described and Which Varies the Coupling by Connecting in Different Sections of the Windings.

As no tens and unit switches are used on this coupler, fine adjustment will have to be obtained by means of variable condensers across primary and secondary windings.

Details are given in the diagram, the primary switch having long switch points on the primary and two small points on the secondary.

The coupler may be either mounted in the receiving cabinet, in a separate cabinet or merely with ends and a front panel for the switches.

Getting Together on the Antenna

By E. T. JONES

SINCE the received current generally figures out something like three-trillionths of the radiated energy, there certainly must be room for improvement in connection with the receiving circuits and apparatus. It is the object of this article to point out as many features as will bring about in part or in full these requirements; if not now, probably in the near future.

The conservation of the received power is in fact more important than the radiated energy, as it is infinitesimally small and very easily wasted. Absolute connections, well soldered, and very low resistance wiring (high frequency resistance), induction in neighboring conductors, and an article dealing with the most efficient type of receiving aërial to be used are exceptionally scarce and I do think that it will be well read and put to practical use, especially among the Amateurs who are looking for economy and at the same time efficiency—with a capital E.

Everyone is aware of the fact that a good *sending* antenna is often a poor *receiving* antenna. Every antenna radiates energy to a greater or less degree. The energy in this case (receiving) is put into it by an electric wave (sent out from some other distant set) striking it; this energy is to be dissipated in some way, for example in a coupled circuit to create a telephonic sound, as we try to do *purely* in receiving. It will be noted that I state that the energy is to be used *purely* in some particular way. But a vibrating antenna tends to do both these things at once. Since the degree to which an antenna radiates can be controlled, and since we desire an antenna for reception which transfers as much as possible of the received energy over into the detector circuit, we must possess a type which radiates very little. Such an antenna of low vertical height and long horizontal length as described is recommended. Another advantage of long low antennæ for reception is that they intercept more wave front of the incoming wave, thereby being able to draw more energy and that practically *most of the long distance reception is done on those waves which are near the earth's surface.*

This antenna described below was but 20 feet high on one end and 6 feet on the other, being 120 feet long, and as will be noticed I received the same strength of signals on this antenna as was had with a former antenna, 70 feet high at one end and 25 feet at the farthest end, two phosphor bronze wires 200 feet long.

The antenna is composed of six strands of No. 24 D.C.C. magnet wire (with the insulation on), each strand being 120 feet long. They were first measured and then twisted together; further means of holding them together was furnished by wrapping a small piece of the same wire around the six lengths about every 5 feet, for the full length. The wire did not have any other metallic connection than that furnished at both ends; this was accomplished by first cleaning the insulation from each wire and then soldering the six together.

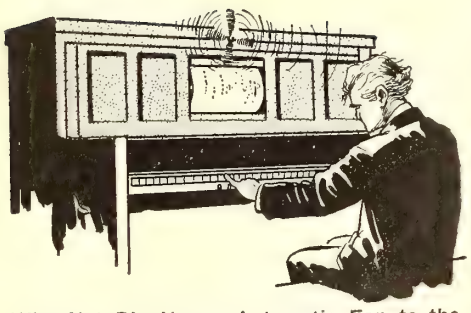
Since Radio Engineers have endorsed the winding of receiving transformers with *Litzendraht* or stranded cable to overcome the high frequency resistance and thereby get more energy to transfer to the detector circuit, why not begin with the antenna to overcome this fault, as I have done by making a Litzendraht antenna? This is given the most credit for the exceptional results obtained under tests.

For comparison sake, I had an antenna composed of the following: two phosphor bronze wires 200 feet long (fan shaped) stretched from a 70-foot pole declining to a fence 200 feet away which was about 25 feet high, (the break insulator at that end was so arranged as to allow the end of the aërial wire to be that distance from the ground, the remainder of the stretch being taken up with rope, down to a height of 6 feet). With this antenna I received a signal of 40 (audibility) from Swan Island which is exactly 900 miles from New Orleans. Owing to the fact that a severe storm blew my poles down, I was out of commission for about two weeks, at the end of which time I struck on the idea of using some No. 24 D.C.C. wire (which was all I had), in fact this was the main reason for using same, and naturally it required quite a few strands to give the desired tensile strength for that length (120 feet). Upon completion, this one wire

(*Continued on page* 1089)

What To Invent

By JAY G. HOBSON



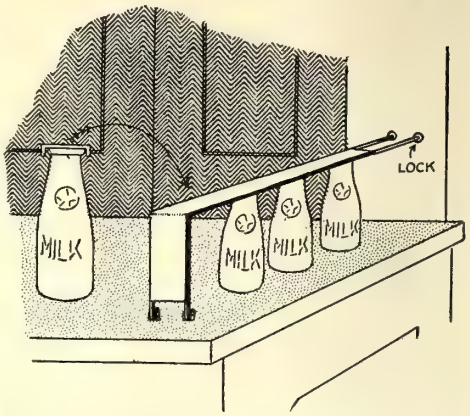
Why Not Rig Up an Automatic Fan to the Player Piano, So That in Warm Weather You Get Refreshed As Well As Inspired and Entertained.

AMONG the many readers of ELECTRICAL EXPERIMENTER magazine there are no doubt thousands mechanically inclined who would appreciate suggestions of practical inventions so that they could work out the mechanical details, obtain a patent and either sell or market their finished device for whatever remuneration they could obtain. In order to assist those desiring information along the above line the writer will endeavor to give one or more new and original ideas each month in this department.

The first idea that comes to mind was suggested the other day by observing a friend pumping a player piano in a very hot room. The perspiration caused by this exertion was very much in evidence. The operator could not keep cool and enjoy the music while playing the instrument. To overcome this annoyance my mind pictured a small fan directly over the spool box, where the music roll is secured. A fan so constructed that it would run when the player was operated and remain idle when no music was played. (See Fig. 1.)

A fan made to run from the vacuum that produces the player piano music. A small device of this nature if compactly made and reasonably priced would sell to practically all player piano owners. The manufacturers would probably install one on each instrument leaving the factory, for the added service it would render their customers. There are hundreds of thousands of player pianos already in use and American manufacturers are turning out over two hundred thousand yearly. The market for a successful invention of this kind is very large and the inventor who first brings forth one that is satisfactory should reap considerable money from it.

While reading the morning paper I ran across a little bit of news relating to the theft of milk in the bottles that is placed upon the house steps each morning by the hasty milkman. The item told of eight or ten places where milk had been stolen the morning before. The loss of milk at fifteen cents a quart soon amounts to a large figure. Finishing the news note I pictured a device that would prevent this loss and at the same time assure the housewife the milk would remain free from contamination until ready for use. The device would be so constructed from metal that it would hold one or more bottles securely. I have in mind a metal strip about one foot in length with "L" shaped under trackage to accommodate the neck of the bottle. It would be fastened to the door sufficiently high so the small children could not tamper with it. Two small holes would be bored thru the door thru which the automatic catch would lock the device after the milkman had placed the milk therein. Having the locking part inside the door would prevent the theft from the outside. An invention of this kind would meet with a hearty welcome at each home and sell by the thousands if made to sell at a popular price. Possibly the large milk companies would be glad to buy them and give them away as souvenirs to their customers. This article would not only be a money saver but a popular advertising novelty as well. (See Fig. 2.)



Ever Have Milk Bottles Stolen Before You Get to Them? Why Not Apply a Simple Grooved Lock Bar Like That Shown? It Locks When the Bottles Are Put in Place.

In the same paper I noticed the advertisement of a widely advertised hair tonic. The manufacturers instructed their customers to roll up a small piece of cotton, saturated in their remedy and draw this thru the parts in their hair, which would properly apply the liquid to the scalp. This method of application seemed very antiquated to me so I tried to picture or imagine a device in the form of a comb with little holes in the teeth leading back into the base where a long vial or tube-like arrangement would be connected with them and when filled with hair tonic would evenly and effectively apply the liquid to the hair and head. An invention of this description should find an immediate acceptance from some large hair tonic concern because it would assist the sale of their product. (See Fig. 3.)

During the cold season most everyone is troubled with their extremities suffering from lack of circulation. Their hands and feet are difficult to keep warm because they are the furthest from the source of heat and exposed to the rigor of winter. The hands particularly suffer on account of their inaction. Agents and salesmen who canvass from house to house taking their sample case with them must find it very hard to keep their hands warm because they must carry their wares by the handle of the case. This condition suggests a small device in the form of an electric battery, a resistance coil imbedded in the handle of the hand bag, a wire connection between them and a little switch secured near the lock of the case.

Just before the agent leaves one house to visit another he turns on the electric switch which connects the battery with the wire coil in the handle and this keeps the handle warm, which transmits the heat to his hand. (See Fig. 4.) A device of this construction should meet with welcome from thousands of travelers and people selling goods from house to house.

(*Copyright, 1920, by Jay G. Hobson.*)

This is the first of a series of articles by Mr. Hobson. The second will be publisht in the March issue.—EDITOR.

Thomas A. Edison

says of the
"ELECTRICAL EXPERIMENTER"

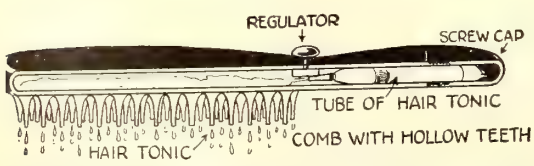
"A very remarkable publication that never fails to interest me. Yes, I do read it every month."

"The ELECTRICAL EXPERIMENTER is a most enterprising publication. It covers a wider field than any other magazine that I know of. I never fail to read it from cover to cover every month, and find the radio articles therein of particular interest."
DR. LEE DE FOREST,
Radio Engineer and Inventor.

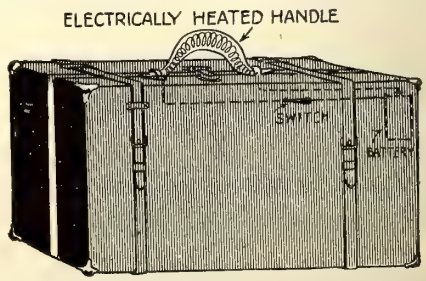
"You certainly know what magazine to buy when you go to the newsstand. The ELECTRICAL EXPERIMENTER always has something new to tell us. Every page contains something of interest, told in a clear and concise manner."
COL. L. R. KRUMM,
Chief Radio Inspector,
New York District.

"You have a most wonderfully instructive publication. Its text pages are a constant source of wonder to our people! Your advertising pages, too, present a wealth of information. We have nothing approaching your publication over here."
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The Inventor's Engineering Co.,
London, England.

"More thoro in its educational qualities than any other technical magazine publisht. It actually presents not only the marvels of modern invention, but also the fascinating romance of it, which furnishes its powerful public appeal."
RANDOLPH LEWIS,
Publicity Manager, Pathé Films.



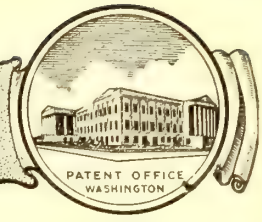
Why Monkey Around With Ding Dangled Hair Tonic Bottles and Fancy Squirt Guns for Applying the Tonic—Why Not Devise a Hollow Nozzle Brush Like That Shown and Give One to Each Purchaser of the Hair Tonic?



Agents and Others Who Have to Carry Suit or Display Cases in Cold Weather Should Find This Suggestion for An Electrically Heated Handle of Distinct Interest.



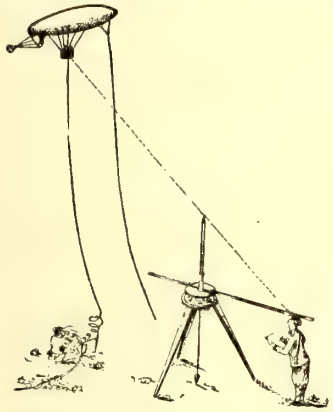
LATEST PATENTS



Range Finder.

(No. 1,317,670, issued to Ralph H. Upson.)

It is a known fact that a balloon will constantly shift and tilt from the horizontal, and hence corrections for range finding at some distant point must be made.

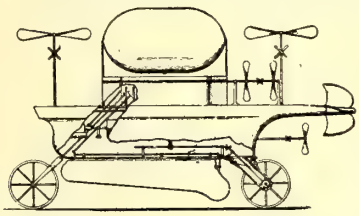


This will have to be taken simultaneously with the data as received by the observation balloon, inasmuch as the findings from the balloon falls under two heads, namely, the distance from the balloon to the distant point, and the angle which a line connecting the balloon with the distant point makes with some fixt base line. With this instrument both the angle of the balloon with any given base line and the distance to the balloon from a ground starting point are obtained at one and the same reading.

Airship Steering Idea.

(No. 1,317,910, issued to Quirino V. Distefano.)

This device relates to a method for simple and efficient means of steering airships and method for

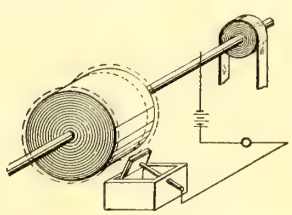


supporting rudders, etc. The drawings designate the body of the machine having a tapering end with the stabilizer mounted thereon. Propellers mounted in every conceivable manner are so arranged that their control is all maintained at one point. A system of cams, pinions and racks serve the purpose of swinging the rudder and steering or elevating the machine.

Balancing Rotors.

(No. 1,319,928, issued to Absolom M. Kennedy.)

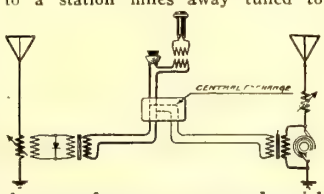
The method consists in spinning the object on an axle which is flexible enough for the object to describe a revolution on an axis of its own selection, thereby bringing the surface of the spinning body in contact with an electrolyte which coincides with the surface of revolution. The electrolyte is carried by a wick and contact is made thru a suitable electric circuit and when its most outstanding surface comes around it engages with the wick. In this way the mass of the rotor is allowed to alter electrolytically inasmuch as its bearings are suitably flexible. Also the parts which require alteration are announced by the flashing of a lamp or other similar indicator.



Wireless Telephone.

(No. 1,313,041, issued to E. F. W. Alexanderson.)

Amateurs and professional operators have always found that it is a tiresome operation and a seemingly unnecessary one to throw the switch over so that the station will be prepared to receive messages and then repeat the operation for sending. Mr. Alexanderson has here incorporated an idea in this recent patent whereby it is entirely unnecessary to use a switch to disconnect either transmitting or receiving apparatus. There are two aerials, placed far enough apart so that the signals of one will not affect those of the other, both tuned to a different frequency. When one aerial is sending to a station miles away tuned to

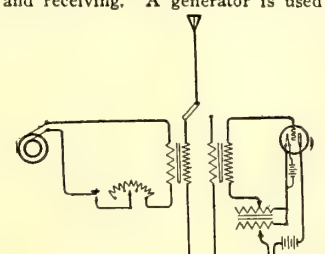


the same frequency, a second aerial is receiving from the distant station, which aerial is tuned to another frequency. Not alone is this a decided feature, but means are afforded whereby any house telephone can be used, thru the agency of a central exchange, for transmitting radio telephone signals, the results of which are identical to carrying on an ordinary telephone conversation without the necessity of change-over switches.

Wireless System.

(No. 1,320,140, issued to Earle C. Hanson.)

This invention relates to the wireless transmission of signals and the object is to provide a means whereby signals can be transmitted, utilizing exclusively "audio" frequencies. It employs transformers having iron cores. The system is claimed to absolutely eliminate all radio frequencies both in sending and receiving. A generator is used



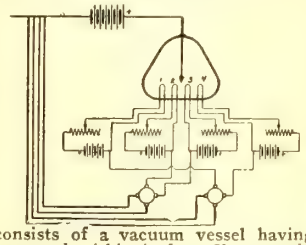
for transmission. This current generated passes thru the primary of an iron core transformer.

The secondary is connected to the aerial and ground, causing electrostatic changes of audio frequencies to be radiated. A vacuum bulb repeater is provided for receiving messages thru a similar transformer to that used in sending. One terminal of the secondary of the iron core transmitter connects to the grid of the vacuum tube, while the other terminal connects to a movable arm of an adjustable transformer also having an iron core. A slider connected to the secondary of this adjustable transformer goes to the phone circuit.

Electric Control Device.

(No. 1,318,196, issued to Theodore W. Case.)

This is a very novel device, and the plan of the inventor is to adopt the same to control or balance airplanes, boats, ships, moving vehicles, and in fact all those which need some stabilizing action. It



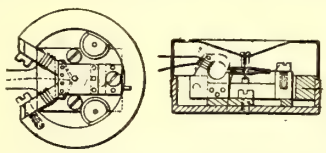
consists of a vacuum vessel having arranged within it four filaments in a circle. Hanging from the top is an unheated electrode, arranged so that it is free to move or swing due to the action of gravity, as the vacuum vessel is tilted or moved from its pre-determined position.

This movement of the unheated electrode causes it to assume a position nearer one or more of the heated electrodes and a greater amount of current will flow from it to the nearest heated electrode. In this way thru the selection of suitable relays various devices may be actuated so as to enable the vessel to remain on an even keel.

Telephone and Radio Receiver.

(No. 1,138,535, issued to Sidney G. Brown.)

This is a decidedly new form of a receiver using a vibrating reed member. It is claimed that maximum elasticity is obtained and that the speech is very clear, inasmuch as the magnetic field can be greatly increased. The reed is mounted in

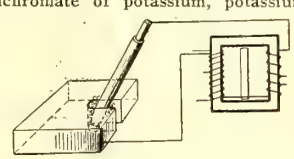


such a position that the magnetic effect of the permanent or electromagnet will affect the reed longitudinally, in this way exerting only a direct pull upon it from its point or base or support. The end of the reed is flattened and is in position so that any received current has a transverse action and affects the reed across the main field. Hence, the elasticity of the reed is independent of the magnetic field.

Arc Cutting Electrode.

(No. 1,321,309, issued to Claude J. Holslag.)

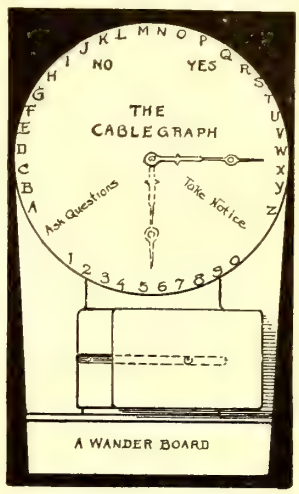
It has been a known fact that with an electrode containing some substance having an affinity for oxygen, such as magnesium, boron, etc., whereby the oxygen of the air or from the metal being welded is rapidly taken up, a strong weld is obtained. Hence, the inventor, working the other way around, has designed an electrode covered with a coating of some compound which will liberate oxygen under heat, such as asbestos impregnated with bichromate of potassium, potassium chlorate, etc. In this way oxygen is liberated and the arc forms an ideal cutting instrument.



Spirit Message Recorder.

(No. 1,322,727, issued to George F. Pearson.)

To the many devices which claim to receive and record spirit messages there is now added another by this recent patent. This idea consists of a dial arranged so that the letters and numbers are almost exactly the same, as in the modern Ouija Board. The letters are arranged on a circular disk in the center of which is a hand similar to the hand of a clock. At the lower end is a sliding base. This base connects directly thru a slot in the center with a rack and pinion, the actuating mechanism which turns the hand. It is only necessary for the operator to place his fingers on the sensitive key and the

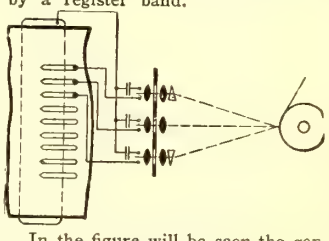


spirit (?) will cause the pointer to move to a figure or number in order to convey the message.

Electric Typewriter.

(No. 1,317,406, issued to W. Von Siemens.)

The invention is for improving the production of printed matter of good quality at very high speed with a typewriter. The type of the typewriter has been improved and type images are thrown by means of stationary templets onto a surface sensitive to light. The time which the image lasts is so minute that the tape need not be stopt at all. No jerks are produced by stopping the heavy paper carriage because of the tape moving continuously. In order that every image of a type may be produced at the correct moment, exposures may be controlled by a register band.



In the figure will be seen the general arrangement of spark gaps, lenses, and screen provided with the type material to be printed. The sensitive paper winds around a carriage. A register band operates spark gaps (by opening and closing a circuit thru contacts made by perforations in the tape, allowing brushes to close the circuit), from which is thrown by the lenses and prisms onto the moving light sensitive surface, an image of the type.



WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

We have not received any "Laboratory Photographs." So "go to it" and send us your photo, together with that of your laboratory. If they are particularly good we may list some new and bigger prizes. So get busy, Boys!!! It's up to you. Here's a way to earn some greatly wanted laboratory apparatus at no cost whatever. Don't be afraid to send in too many photos.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER— JOSEPH S. SMIGOSKI

MY "Electrical and Chemical Laboratory" consists of over 200 chemicals and almost as many solutions. (I could not get them all in the photo.) The electrical department has two complete switch-boards and one under construction. I also have a two-inch spark coil, as well as a wireless receiving and transmitting set.

There are several condensers, two D. C. generators and one A. C., also the 110-Volt A. C. house supply connected to the switch-boards. Two buzzers and three bells are connected to various parts of the house.

There are also two transformers, many different coils, an adjustable lamp bank, plenty of switches, and a lot more not shown in the photograph. Telephone and telegraph connections have been establisht between my friends' laboratories.—Joseph S. Smigoski, Gen. Del., Fort Sheridan, Ill.

HONORABLE MENTION—J. T. S. and A. J. REESE— $2.00 PRIZE

WE herewith present three flashlight photos of our "Experimental Laboratory."

In the first photograph may be seen our Chemical "Lab.," and electrical test-board controlled from the small switch-board observed in the upper right-hand corner of the picture. This switch-board is so wired that we can obtain two volts, twenty-four volts, fifty or one hundred and ten volts A.C., thru a rheostat and transformer of our own design. We also have in operation a telephone of our own make.

In the second photograph is shown our complete "Lab.," showing the electrical and chemical paraphernalia, which are nearly all of our own handiwork, including a bench lathe driven by a ½ H.P., A.C. motor, and a drill press also driven by a ½ H.P. motor.

The accompanying photograph also shows a 1/20 H.P. motor undergoing repairs under the supervision of A. J. Reese, while J. T. S. Reese is very busy finding the specific gravity of "aqua regia." We are also sending an odd photo of a motor built from a common iron wheel-barrow wheel, and a series of electro-magnets mounted around the iron tire. The rotary magnet coils and cores are mounted on the hub members and axle. The current thru the latter is interrupted by a commutator. We find much useful and interesting information in your magazine, which we read constantly.—J. T. S. Reese and A. J. Reese, 688 Carson St., Hazleton, Pa.



Science in Slang

By EMERSON EASTERLING

Electromagneti-potentiokinetics

THERE were a few of us young disciples of the vibratory-phenomena seated about the open fire that crackled out its glowing warmth upon the contented gathering. From subject to subject we wandered until:

"Say, Jazz," one of the circle spoke, "I can get most of the theoretical wires in the dynamo and motor straightened out in my head—but it don't seem quite that I am *all there* on the 'big know' about the matter. Put me wise, will yuh?"

"Yes," chirped up Punk thru a thick cloud of tobacco smoke, "Rip loose and feed the bunch up on some of this potentiokinetic and vice versa junk—I want a nice nap myself. Don't talk too loud, now."

"I know that the stuff works on the principle of that the wires on the armature whirling around in the magnetic field cut the lines of magnetic force and that the cutting causes an electric flow in the wires—but—but I have a lot of room under the old derby for some more of the *know*.''

This was from Bender, as he twisted a cord around his arm and untwisted the same.

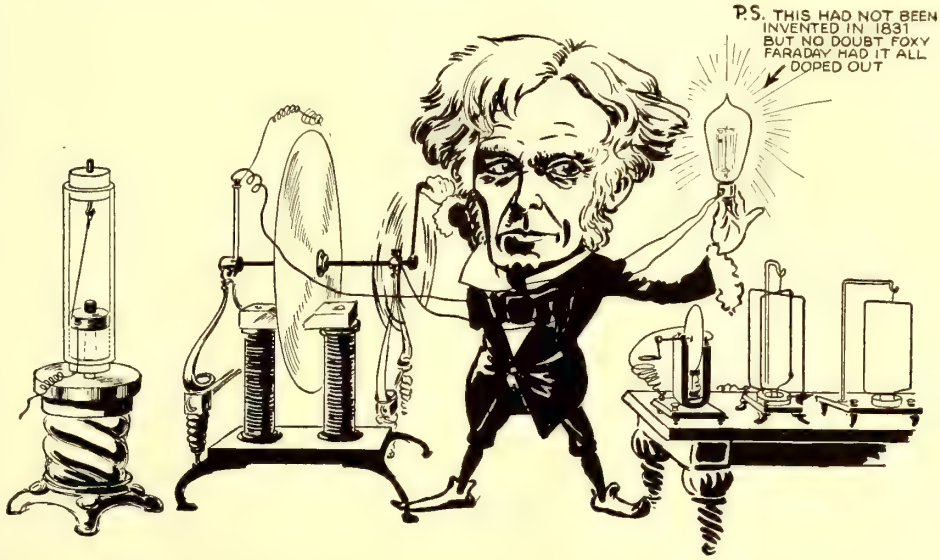
"You know," Jazz began, "that if a current of electricity is caused to flow thru a conductor and that if a magnetic conductor—I mean by that something that does what we term as retaining the magnetism, such as iron—be brought near the electric conductor a magnetic flux will be caused to flow around the electric conductor at right angles to the flow of the electric current; or if an electric conductor be placed so that there is a magnetic flux *fluxing* at right angles to the conductor and the flux be interrupted—as in the spark coil—or the lines of magnetic force be cut as it were by the electric conductor, then a current of electricity will be caused to flow in the conductor.

"I may not be exactly right about that flux being interrupted—but here is what I mean. When the juice stops in the primary there is a flow in the opposite direction in the secondary. As I understand it, the primary circuit sets up a magnetic flow, which in turn sets up an electric flow in the secondary. My hunch runs like this: The primary flow, thru the magnetic medium, sets up an electrical disturbance in the form of disequilibrium, that manifests itself as a flow as soon as the primary is cut off. It is like a teter board—one end the primary, the other the secondary; the current may be represented as a weight on the primary side of the fulcrum. The weight may do kinetic work by dropping. As soon as the weight is kicked off the primary, the secondary bangs down and does its bit. If you were standing under the board you might get the full weight of my argument. It may not be that way, but I believe that the magneto-electric relation that I stuck up before you is the corner-stone to the theoretical electrical conceptional structure—alligatorically speaking.

"Anyhow, one fine morning along about noon in the evening our friend, via History, while experimenting on the stuff that I have just been trying to slip you my 'I-think-I-got-it' about, brought to the surface of the deep sea of the unknown mysteries of Nature (human, feminine, and the kind we prefix 'Mother' to) the fact that if a wire be wiggled before a magnet a current will be found to flow in the wire. Like the cart developed from the drag, the dynamo developed. It was (naturally) found that by forming the wire into a shape sort of rectangular and spinning between the two poles of a magnet that the most amount of what they desired was to be had. Later the single wire armature was put up with more wires, as the makers found that they could get more of the precious what-you-may-call-it that they knew so little about—*littlier* than the little we know—and so later some wise guy pops up and slips an iron core into the wires framework and then stood back and buried his thumbs beneath his vest with a wise smile on his map.

"Mike Faraday in his early experiments with the dynamo used the Earth's magnetic field, by facing the generator East and West. It was not until later that the experimenters found that they could create a stronger magnetic field by mechanical means—magnets, permanent and electro-magnetic. Are we so sure but when the early researchers struck out on the trail that stept beyond the primal terrestrial field onto the mechanical, that they did not scent the wrong track? Do you think that the great efficient generators that we have today are the *best* means of harnessing the all-powerful energy that abounds the universe that we have accustomed ourselves to speak of as 'electricity'?

"But to get back closer to home—it was in eighteen hundred and thirty-one that Mike yanked the good one on the residue by giving future work for Noah (Webster) in the 'D' and 'G' departments of his immemorial little trunk pamphlet. He murdered along with discs and cylinders closed at one end—see, when the old boy would have a copper disc placed so that it would display its surface to the poles of an energized magnet and a little juice be shot in at the axle and taken off at the rim that the disc would do the worm stunt. He found that the disc rotated transversely to the direction of the magnetic flux, or lines of force—that's what all the text books peddle.



". . . It Was in 1831 That 'Mike' Faraday Yanked Out His Rotating Copper Disc Trick. The Old Boy Would Have a Copper Disc Pivoted So As to Display Its Surface to the Poles of An Energized Magnet. Current Could Be Taken Off from the Axle and a Brush Bearing Against Its Periphery. The Mazda Electric Lamp . . . But That's Another Story. . . ."

"Sir Charles Wheatstone along about the time the calendar manufacturers were getting used to chisling out 1841, slides into the limelight with a dynamo with a half o' dozen coils in the armature. That was a great stunt in 'them days.'

"In the year of 1845 he and a bird by the name of Cook sneaks into the patent office with the 'papers'. They proved (outside of court) to be the right profiteer on the electro-magnetic dynamo business — they filed away the first electro-magnetic juice pump, in other chatter.

"Jake Brett, along in 1848 got onto the right idea and spun the first self-excited machine. Simplicity and economy, he bellowed.

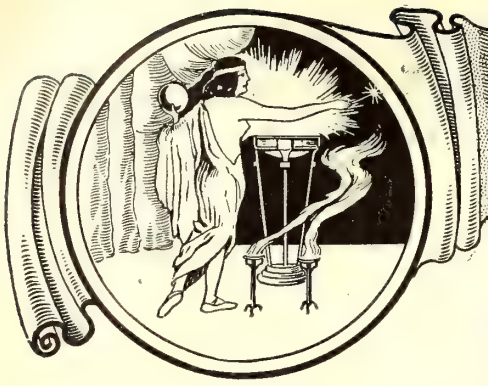
"Then Werner von Siemens (the guy herding the ancient public in the picture of the primitive trainload of masqueraders in the October issue) knocks at the door of recognition and shimmies in with the first drum wound motor. That step of his sure *took;* they are doing it yet down at the factories.

"Then Gramme pulls a boner somewhat like the Werner stunt—only he used some old unused iron wedding ring from the elephant quarters of the Zoo. We use something like it to-day in our experimenting. Sometimes.

"But before 1880 the generator stuff was like the aerial transportation is to-day. After Edison, the General Electric Company, Westinghouse, and some of the other big frogs took their coats off we had the pleasure of witnessing some pretty good forms of generators and motors. From the old bi-polar types we emigrated into the fields of the multi-polar, even experimenting with the meglapolar freaks.

"Then after Nick Tesla got us wisened up on the alternating current question we have produced some pretty good junk in the line of alternating current motors, generators, and ever'thing. The direct current has it over on the a. c. for power, but where the d. c. is not to be had as easily we have stuck in some pretty fair a. c. spinners. The three phase (that we dwelt on for a few paragraphs in the article on alternating currents) is the best

(*Continued on page* 1054)



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

WHAT CAUSES BURNOUT OF GENERATOR?

(1036) Theodore Mucha, Lajitas, via Alpine, Texas, writes the "Oracle" department:

Q. 1. Asking as to what could cause a short-circuit and burn-out of a radio transformer and also the generator supplying this transformer.

A. 1. If we understand your question correctly, you apparently wish to know, for the purpose of demonstration or otherwise, what would cause the *secondary* as well as the *primary* windings of an open core transformer, presumably that utilized with a radio transmitter, together with the windings of a self-exciting generator, to be "burned out." There are several cases that would cause this, among them being the following: One of the commonest and most usual sources of this causation would be a broken down secondary condenser. No matter whether this condenser happened to be connected across the secondary of the transformer or in series with the spark gap and oscillation transformer primary, a rupture of one of the condenser units or plates would cause a heavy overload on the secondary winding, which would invariably result in burning it out or destroying its insulation by heating up the winding above normal. Naturally, when the secondary is overloaded and carrying a heavier current than normal, the primary winding will also be overloaded, and likewise this increased load will back up as far as the generator supplying the current. The overload would have the same effect on the generator as on the transformer, i. e., it would cause the windings to heat up, due to the heavier current drawn from them, and cause the insulation to become charred or disintegrated, creating a general failure of the winding insulation and a break-down of the machine.

There are several other difficulties which may arise in the operation of such an apparatus which would cause a failure in the insulation of the transformer and invariably the generator, such as a short-circuited spark gap or a heavy "leak" current thru the base of the spark gap due to dampness or other trouble. We have seen transformers burn out more than once from a short-circuit or partial short-circuit caused by the current leaking thru a defective insulating terminal on the secondary. Another cause or method of causing a triple burn-out such as you describe would be a short-circuit or series of short-circuits in the secondary winding of the transformer itself. There are several ways in which these short-circuits might act. They might cut out a part of the secondary winding in such a way as to cause an abnormal current to flow, or short-circuit a certain section of the secondary turns, thus being the cause of heavy currents set up, which would act in the same manner as if a heavy load were connected across the secondary terminals. Another cause for such a phenomenon might be a complexity of "grounds" occurring in the primary and secondary circuits, which might under certain conditions cause a sufficiently heavy current to pass thru the transformer windings and burn them out, owing to the heavy current thus permitted to pass by the *grounded* circuit.

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Address photos to—Editor "Odd Photos", Electrical Experimenter, 233 Fulton Street, New York City.

ASTRONOMY QUERIES.

Question 1. If the approximate motions of the stars be anywhere between speeds of ten and fifty miles per second, why, in the course of a year can we find no apparent movement in a star traveling at right angles to us? Isabel M. Lewis answers:

Answer 1. We can detect such motion for many near stars. The motion of a star thru space as seen from the earth can be separated into two components, the "proper motion" or motion across the line of sight and the "radial velocity," motion towards or away from the observer in the line of sight. The latter component is measured in direction and amount by means of the spectroscope; the former is found by angular measurements of the displacement of the star with reference to fixed points. The universe is fashioned upon such an enormous scale that this angular displacement of a star due to its motion across the line of sight is very small. There are very few stars for which it amounts to as much as a second of arc a year while for many stars it does not amount to a second of arc even in a hundred years. Nevertheless such a motion of the stars does exist and by taking the time interval sufficiently long it can be detected.

Question 2. I understand that the stars of a constellation are named first by the letters of the Greek alphabet, then by numbers in order of magnitude. I would like complete information on the nomenclature for I see in star lists such names as χ^1, Orionis, 388 B. Leonis, S. Andromedæ, etc.

Answer 2. In general the brightest star in a constellation is known as Alpha, the second brightest Beta and so on but this convention has not been strictly followed in all cases or else certain stars have changed in relative brightness since they were named by early uranographers. For instance Beta Geminorum (Pollux) is brighter than Alpha Geminorum (Castor). The thousands of stars in star catalogues cannot, of course, be designated by Greek letters and they are usually known by their numbers in a certain catalogue, the distinguishing letter of the catalogue following the number. 388 B. Leonis is No. 388 in Bradley's catalogue.

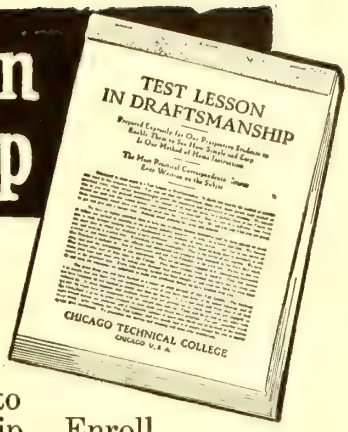
The letters R, S, SS, RZ, etc., have been employed in more recent times to designate variable stars in a constellation.

Such notations as χ^1, χ^{11} are used to designate the two components of a double star, named in the order in which they cross the meridian.

Question 3. Kindly explain the precession of the equinoxes.

Answer 3. The "precession of the equinoxes" is a gradual westward shifting of the point of intersection of the ecliptic with the celestial equator, (the vernal equinox or first point in Aries) which amounts to 50″.2 annually or thirty degrees in two thousand years. It results from the slow revolution of the earth's axis around the pole of the ecliptic which is in reality the "wobbling" of a rotating body acted on by external forces arising from the fact that the rotating earth is not a perfect sphere but has an "equatorial bulge" which is attracted by the sun and moon in such a way as to tend to draw the plane of the equator down into the plane of the ecliptic and the pole of the equator into coincidence with the pole of the ecliptic. As a result of the action of these forces the pole of the equator describes a circle with a radius of 23½° around the pole of the ecliptic in 25,800 years (360° divided by 50″.2).

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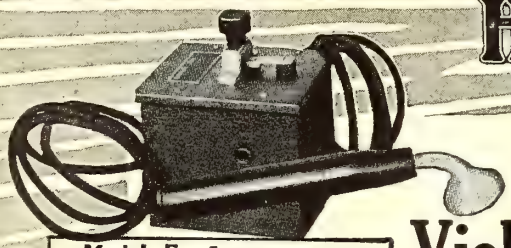
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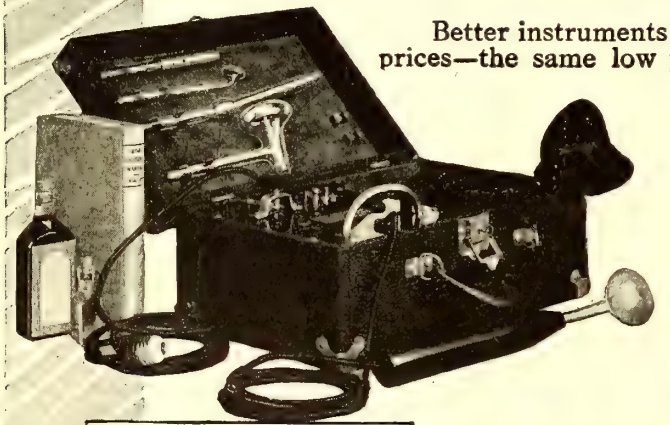


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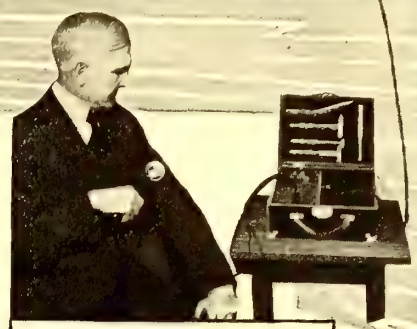


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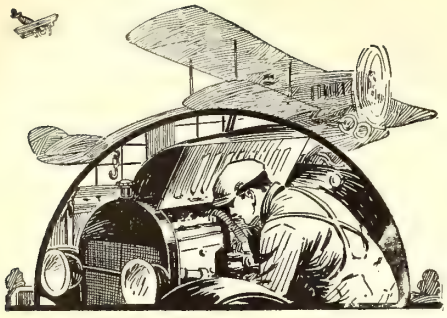


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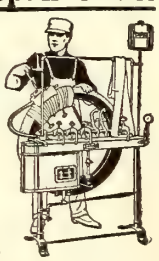
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How Becquerel Discovered Radioactivity

By JEAN BECQUEREL

(*Continued from page* 996)

ing a few days later, Becquerel then took out the prepared plate on which salts of Uranyl had remained, but, due to the natural precaution of a conscientious research physicist, he thought it best to change the photographic plate before resuming the experiment. Accordingly the plate, which had rested for several days in the drawer, was removed from its envelop and placed in the developing solution which happened to be at hand. While preparing the new plate, he watched the developing of the old one and observed with perfect amazement that it gave an impression far stronger than that of the first plate, which had remained for a few hours under the action of the Uranyl Salts, and exposed to the sun.

This immediately threw light on his whole subject; he understood at once that the action had taken place in the drawer *away from all exciting light and without the emission of any phosphorescent light* of the Uranyl Salts, because the luminosity of these Salts ceases within 1/100 of a second after being exposed to light. He immediately made a series of experiments with various Uranyl Salts which had remained away from light for some years; the results were always the same. However, one puzzling problem remained, but Henri Becquerel solved it as soon as he had taken it up. Was this new property due to the fact that the salts were phosphorescent (tho it was not necessary to first excite this phosphorescence) or simply due to the fact that they were Salts of Uranyl? All non-phosphorescent uranium salts were tried, as well as later on, uranium metal itself. The results were always the same, even when protecting the substances against all exterior radiation by putting them in a thick lead box. When exposed for the same length of time, the impressions obtained on the plates were more intense according to the greater richness in uranium salts of the composites. The new phenomenon was *atomical;* that is to say that it depended upon the atom of uranium, whatever its chemical combination might be.

From that time on there was no more doubt; Uranium and its composites emitted *spontaneously* a radiation which penetrated opaque bodies. It was an entirely new phenomenon and an unexpected property of matter. *Radioactivity was discovered* (March 1st, 1896).

Thus the study of electric phenomenon led Antoine Caesar Becquerel to study the action of discharges on phosphorescent substances; Edmond Becquerel, who had collaborated in this work, continued the study of phosphorescence and realized the exceptional properties of Uranyl Salts. Henri Becquerel wisht to go deeper into the problem and found *Radioactivity*, with which these labors were crowned.

Henri Becquerel, in his extreme modesty, liked to say: "The discovery of radioactivity *was bound to be made* in our laboratory and if my father had lived till 1896, *he* surely would have been its discoverer."

Immediately after this discovery, all of Henri Becquerel's new experiments became new conquests. It did not take him long to find out that the Uranium radiation discharges electrified bodies by making gases conductive to electricity. This fundamental property is still to-day the only one which permits us to measure the energy of these rays; it is also this property which permits us to prepare radioactive substances.

While Henri Becquerel was studying the nature of the radiations he had just discovered, M. and Madame Curie were making researches as to whether there existed other bodies presenting the same properties. Their splendid researches revealed, shortly after, that "Thorium" radiates just as Uranium, and brought about the discovery of products a great deal more active, such as Polonium and Radium. This last body has an activity about 2,000,000 times greater than that of Uranium. About the same time, M. Debierne discovered another very radioactive element which he called "Actinium."

Radium, because of its great activity, permitted a very much more complete study of this new phenomenon. With the small quantity of radium which Curie gave him, Henri Becquerel found out that its radiation excites the luminosity of phosphorescent substances and that Radium is able to produce radiations in a very diversified and penetrating manner. He also discovered that a magnetic field influences the radiations of radium and he obtained on a photographic plate clearly separate traces of the two different radiations which have been called Alpha and Beta rays. By an ingenious and simple method, he obtained a great number of photographic proofs showing that Beta rays are deviated by a magnet. He furthermore demonstrated the influence of an electric field on the Beta rays, and by the simultaneous measuring of electric and magnetic deviation he could, as had been done by Prof. J. J. Thomson with cathode rays, calculate the proportion between the charge and the mass of the corpuscles which form the radiation. *He proved beyond doubt that the corpuscles which form the Beta rays are identical with the corpuscles constituting the cathode rays,* but the speeds of the corpuscles reach much higher rates in the case of Beta rays; those which are less deviated by the magnet have a speed neighboring on that of light.

It is quite impossible for me in a short treatise to touch upon all the vast work concerning radioactivity. I will content myself to indicate the principal consequences of the discovery of Henri Becquerel. The corpuscles forming the Beta rays and those constituting the cathode rays are quite identical. Their charge is the atom of electricity, of which all other charges are the multiples. They are called *electrons.* The mass of an electron when its speed is quite inferior to that of light (300,000 kilometers per second) is 1800 times smaller than the mass of the lightest of atoms, namely, the atom of hydrogen. *The electron is the universal constituent of matter.*

Nevertheless, in a pencil of Beta rays, emanating from a radioactive body, the electrons have not all a like speed. This is why the pencil is deflected in a magnetic as well as in an electric field—for the greater the speed, the smaller the deflection. *A fact of great importance is that the more the speed approaches that of light, the larger becomes the mass.*

This result has been explained by the laws of Electromagnetism and by the Principle of Relativity established by Prof. Einstein. This principle, which has revolutionized the basis of mechanics, *shows that the mass of any body must grow indefinitely when its speed tends towards the speed of light* (which is the limit which no body in motion can surpass). *The theoretically established law was entirely verified by the results experimentally obtained with Beta rays.* (Bücherer.)

Everything leads us to believe that the mass of an electron is solely due to the charge that it carries. It is almost certain

(*Continued on page* 1044)

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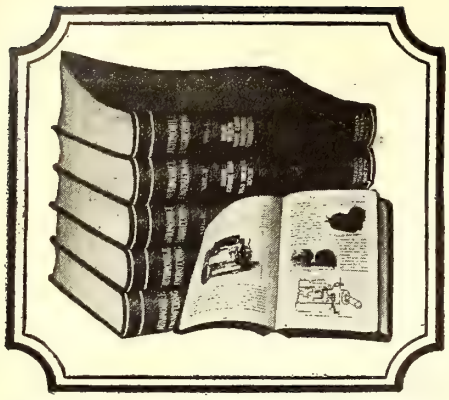
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How Becquerel Discovered Radioactivity

(*Continued from page* 1042)

that this conclusion must be extended to all matter of which the inertia is of entirely electric origin.

It becomes necessary therefore to give up the doctrine of the constancy of the mass of the old Newtonian mechanics: The constancy of a mass is only an approximation for the case of speeds greatly inferior to that of light; an approximation, by the way, perfectly legitimate in practise.

The Alpha rays are particles charged with positive electricity propelled by a speed of from 15,000 to 23,000 kilometers per second, depending upon the radio-active Substance which emits them. It has been proven that each particle is an atom of Helium gas positively charged by losing two electrons. (Helium is one of the rare gases contained in the atmosphere.)

Helium therefore appears to be a primordial element, the atom of which serves to build up more complex atoms. This is a wonderful fact!

There exists still a third kind of rays—Gamma rays. These are identical with X-rays, of great penetrating power. Despite their enormous speed, Alpha and Beta particles do not go far when they penetrate into a body. In solid bodies they are quickly stopt and in gases they also lose their speed because of the collisions they experience with the molecules. Then every time such a tiny projectile meets an obstacle, heat is the result. For that reason radium becomes hot under the action of its own rays; it is always at a temperature higher than the ambient temperature. One gram of radium disengages 132 calories per hour; that is to say, a quantity of heat sufficient to melt almost double of its weight in ice. This heat is due almost entirely to the Alpha particles whose energy constitutes 95% of the total energy of the radiation.

M. Rutherford discovered in 1900 that Thorium disengages continually a radio-active gas: Radium and Actinium possess the same properties. These gases are called "Emanations" and they transform themselves rapidly. Their *period,* which is to say, the time needed to become half-transformed, is from three to eight days for the Radium emanation; 53 seconds for that of Thorium, and only 3.9 seconds for that of Actinium. Messrs. Ramsay and Soddy observed that Helium is generated in direct ratio as the emanation of Radium disappears: this Helium is nothing other than the Alpha radiation emitted by the emanation. What is more, every object exposed to the emanation becomes radio-active itself, but this effect disappears soon. This is the inductive Radio-Activity discovered by Curie.

This transferred radio-activity itself is later replaced by less active but more stable products.

Professor Rutherford explains all these facts by his admirable theory of the Evolution of Matter. Each active body of large atomic weight, such as Uranium, Thorium and Actinium, gives birth to a family of elements of which each is produced by the preceding one; also, at each emission of Alpha rays, Helium is produced.

These elements are more or less ephemeral, altho the average life of an atom varies in wide limits, the average duration of life of the Uranium atom is 7 billion years—Actinium, 5½ seconds, and that of Actinium 1/500 of a second.

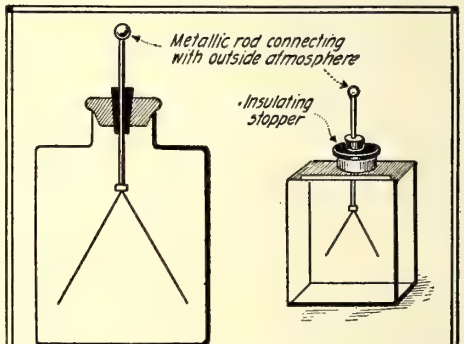
Uranium is the ancestor of Radium, of Polonium, and in this family it is very probable that, besides Helium, the final product, which appears stable to us, *is lead.*

It is essential to note that the radio-active transformations are not chemical decompositions for their character is absolutely different; they are spontaneous—they are independent of temperature effects and no physical agency can modify them—at least not within the limits of the average actions which we have at our disposal. Moreover, they bring into play a colossal energy.

Thus it is that radio-active bodies are not composite bodies—they are elements the atoms of which convert themselves. In this case it is a transmutation or, more exactly, a *disintegration of matter.*

Is radio-activity a general property of matter? It is quite natural to believe so. It is probable that all matter undergoes a transformation, the average life of ordinary atoms being at least several dozen trillions of years. The slow speed at which these transformations occur gives us the illusion of stability.

The phenomenon of radio-activity then teaches us that matter is not unchangeable, that elements become transformed and that they constitute a great reservoir of energy; one single gram of Radium which transforms itself completely into Helium and finally into Lead, furnishes as much energy of combusion as 500 kilograms of coal, and this is only an infinite part of its total energy, *for there still remains the energy*



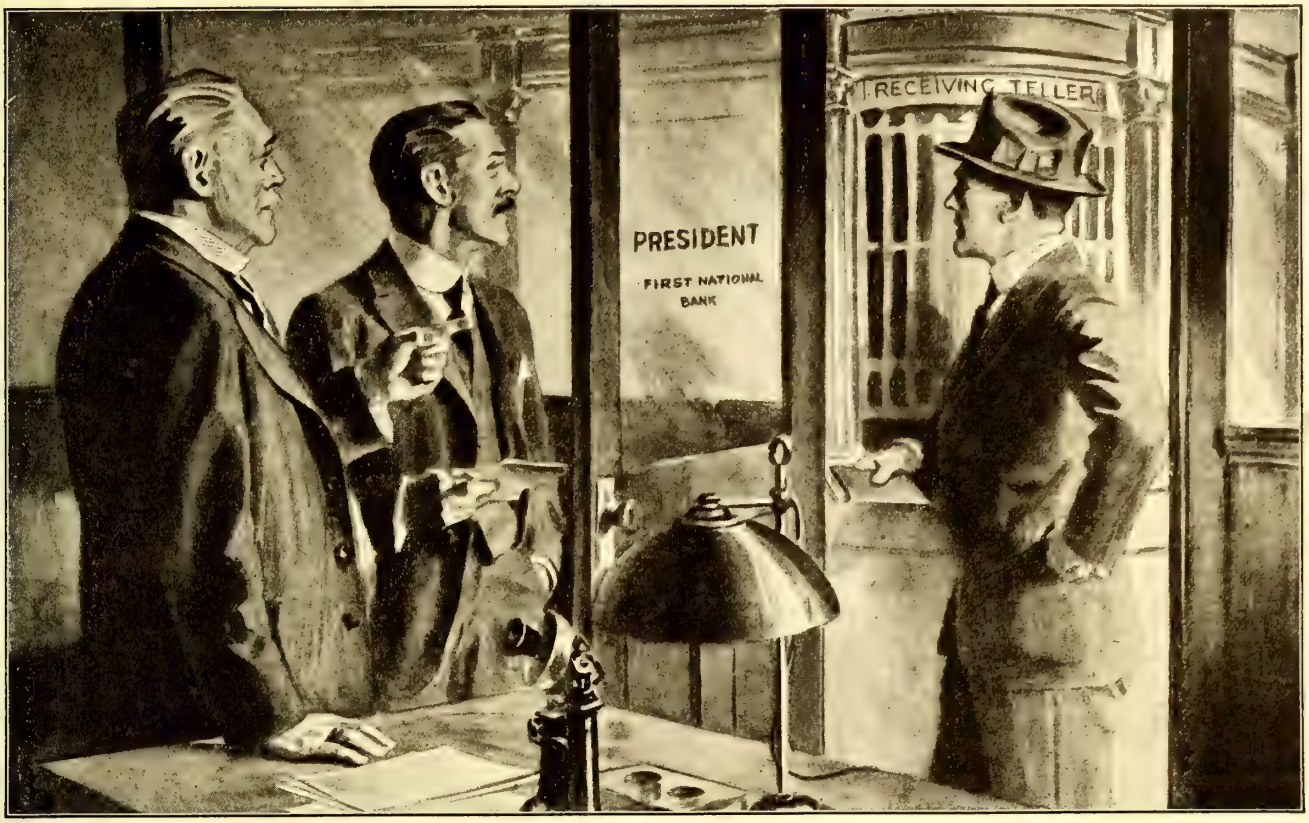
Electroscope Described by the Author and Having Diverging Leaves Made of Aluminum Instead of Gold Leaf. Radioactive Substances Act to Discharge a Charged Electroscope.

contained in Helium and Lead! Einstein has shown in his *Principle of Relativity* that any gram whatever of matter must hold 9.10^{20} ergs, which is to say, *a quantity of energy sufficient to lift ten million tons one kilometer* (.62 mile) *high.*

However, in the case of radio-active transformations the spontaneous disengagement of energy is very slow. It is to be hoped that some day we will know how to accelerate the decay of the atoms and thus utilize the forces they contain; then inversely use this energy to obtain *the entirety* (integration) of matter, which means the inverse phenomenon of radio-activity The man who discovers how to regulate at will the transformation of the elements will assuredly possess "divine power"!

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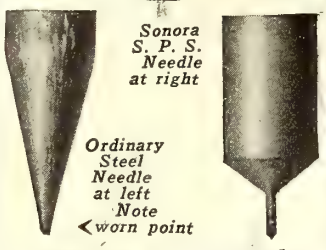
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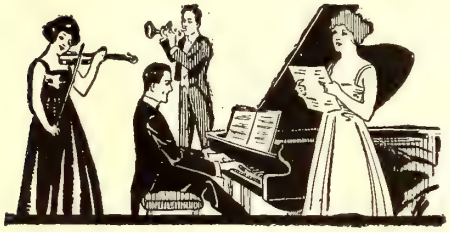
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Practical Chemical Experiments.
—Alcohol

By PROF. FLOYD L. DARROW.

(*Continued from page* 1017)

PROPERTIES AND EFFECTS OF METHYL ALCOHOL.

When pure, methyl alcohol is a clear colorless liquid with a not unpleasant vinous odor. The disagreeable odor usually noticed is due to the presence of impurities. The alcohol boils at about 67 degrees centigrade and burns with a hot, almost colorless flame, making it useful as a fuel. Its great power of solution renders it invaluable as a solvent for varnishes, dyes, fats, oils and resins. Because of its very poisonous properties it is used to denature ethyl alcohol and thus render the latter unfit for use in beverages, altho leaving it unimpaired for many industrial purposes. Such denatured alcohol can be imported duty free.

Taken into the stomach methyl alcohol is a violent poison and its presence in cheap, adulterated whiskies has been responsible for many deaths. Even the fumes from varnishes containing it has been known to produce fatal prostration. Wood alcohol has a peculiar selective action on the optic nerve and doses insufficient to produce death frequently result in permanent paralysis of this nerve and total blindness.

Wood alcohol is capable of producing intoxication similar to that of grain alcohol, but it is somewhat slow in action and its symptoms are of long duration. Fall of bodily temperature is very marked, followed by convulsive muscular movements of a ryhthmic character. There is a loss of sensation and also of the reflex movements of the muscles. The eyes are especially affected. Dilation of the pupil, contraction of the field of vision and a rapid failure of sight result.

The symptoms of wood alcohol poisoning are due to the chemical fact that *in the system it is oxidized to formic acid*, a highly poisonous substance. The similar oxidation of grain alcohol, or spirits of wine, yields acetic acid, the acid of vinegar. In either case the first product of the oxidation is an aldehyd, as is shown in the test for methyl alcohol, but this is followed in the system by oxidation to an acid.

All that can be done in cases of wood alcohol poisoning is to eliminate the alcohol by sweating and to drink large quantities of sodium bicarbonat solution. The bicarbonat will neutralize the formic acid in the system.

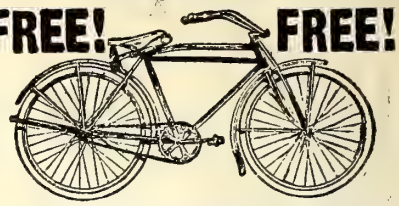
"EVADING" THE LIQUOR COP.

Place on the table three rows of tumblers. In the bottom of each tumbler in the first row put a few drops of an alcohol solution of the indicator phenolphthalein. Denatured alcohol may be used in making

(*Continued on page* 1048)

Boys Would you like to earn one of these Magnificent Bicycles absolutely without costing you one cent?

FREE! FREE!



HUNDREDS OF OTHER EXPENSIVE PRESENTS ALSO GIVEN

We have secured an enormous quantity of very beautiful colored pictures, consisting of art, floral, landscape, religious, patriotic, etc., and a very fortunate purchase permits us to sell them at the astonishingly low price of 25 cents each, at which price they are irresistible, and will certainly go fast.

Now all you have to do is to send us your name and address and we will send you 20 of these beautiful pictures, without any charge whatsoever. These pictures you are to sell at 25 cents each. When sold, send us the money, and we will send you goods OF YOUR OWN SELECTION from our 300 page catalog to the value of $4.00. Remember, you get these goods as a premium for selling the pictures and sending us the money. You don't have to pay a cent for them. Many of our agents have sold the whole 20 pictures in one day; some have sold them in the evening. One agent sold six on the way home from the post office, another sold some before he got out of the post office. Another agent sold the entire lot in one house. People are wild to get these pictures once they see them, and you will have no difficulty in disposing of them if you will only show them. Remember, you have our entire catalog to select your premiums from, and there are hundreds of presents such as Air Rifles, Guns, Moving Picture Machines, Musical Instruments, Cameras, Telescopes, Printing Presses, Typewriters, Books, Puzzles, Games, Tricks, Toys and Novelties, Rubber Stamps, Household Labor-Saving Devices, etc., many of them unprocurable elsewhere, and we are sure you would like to get many of them, especially if you can do so without having to pay any money for them.

By continuing the sale of our pictures you can earn the magnificent Bicycle illustrated. We will give you $4.00 worth of presents for every 20 pictures you sell. Send in your application at once, and we will send you the first lot of pictures immediately, accompanied by our big catalog of over a thousand different articles to select your premiums from. You don't have to send any money. We trust you absolutely.

Johnson Smith & Co., Dept. E7, 3224 N. Halsted St., Chicago



The Electric Safety razor makes shaving a pleasure. Blade vibrating 7,200 times a minute cuts the beard smoothly and without slightest pull or irritation—feels like a gentle massage. Can be used with or without electric current.

All users of the Lek-Tro Shav speak well of it

A barber says—"Have shaved for years and have never used any shaving device near its equal."

A home user says—"The most pleasing shave I've ever had in my life. Shaves my face closer than I used to shave, but there is no after irritation or ill effects as I usually get from another razor."

No. 1 Made for use from Light Socket.
No. 2 Made for use from Dry Battery.

Write for illustrated circular describing Lek-Tro-Shav Safety Razor fully.

VIBRATING ELECTRIC RAZOR CO.
Dept. 122, Omaha, Nebr.

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If you are not a regular reader, a dollar will bring you the next four numbers, each bigger and better than ever. When your subscription has expired you'll want the Photo Play World regularly.

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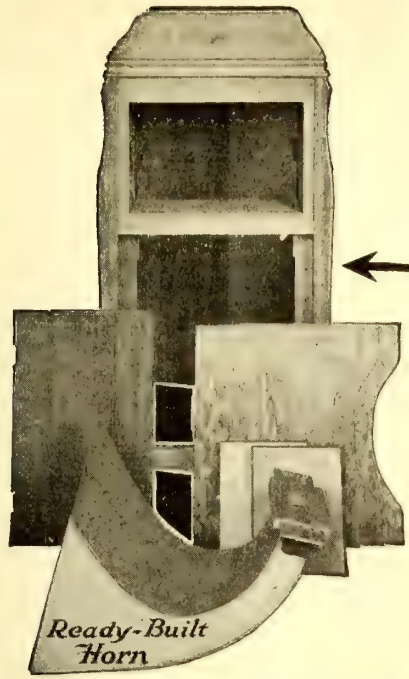
Sample copy on request.

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Bulletin Building Philadelphia, Pa.

"BOW LEGS and KNOCK-KNEES" UNSIGHTLY

Send for booklet showing photos of men with and without THE PERFECT LEG FORMS.

PERFECT SALES CO.
140 N. Mayfield Ave., Dept 50, Chicago, Ill.



The Cabinet pieces, as you receive them, all ready for assembly and finishing, according to plan 3. Also furnished, "knocked-down," plan 2, and for cabinet makers, plan 1, to be worked out from simplified plans and blue prints, which we supply.

This Shows How *Easy* We Make It For You To BUILD YOUR OWN PHONOGRAPH

LOOK at the cut at the left, and you will quickly see how easy we have made it for you to build your own Phonograph, in your own home, kitchen, basement, or, out in the garage, after you receive the cabinet pieces, all cut, fitted, all ready to go together according to our plan.

You Don't Need to Be a Cabinetmaker

to do the job. All the hard part has been done. No chance for mistakes. After it is all set up and the Tone Arm and Motor are in place, it will be another simple matter to finish it in the color you wish. You will enjoy the work immensely.

Read What This Ohio Man Says:

"I have found it no trick at all to build your Model 5. . . . Would not trade it for any selling around $200.00 in the stores . . . . I am going into the business of building Phonographs to sell my friends."
You can do what he did, and have a beautiful machine at a

Tremendous Saving in Cost

if you will do as we say—send for the cabinet pieces and do a little pleasant work, in spare time, at home.
The family will enjoy the phonograph as much as you, and all will be prouder of it because you made it—*Built It Yourself.*

The Cabinet Pieces consist of legs, shelves, doors, scroll, dome strips, panels, ready-built tone chamber, and all other pieces ready to assemble and glue together. No cutting, no fitting, no special tools required. The Cabinet in the White, so styled by our information literature, are the cabinet pieces all assembled and glued together. There remains only for you to install the motor and tone arm, attach the cabinet hardware and do the finishing. This is our Plan 3, and is very popular, as it calls for the least amount of mechanical work, and is more quickly done.

You do not have to confine yourself to any one model. There are

Six Models to Choose From

all handsome, offering you a wide range in price. The mechanical parts are the same in quality for all models and consist of motor, sound-box, tone-arm, turn-table, winding crank, speed regulator, brake, etc. No machine at any price has any finer mechanical equipment than these. They play all records.

Agents Are Making Big Money

How? *Making and selling Phonographs on our plan!* Naturally they can sell much cheaper than the retailer, and the demand is always greater than the supply. Soon a man has to devote all his time to HIS OWN BUSINESS.
He has entered *the manufacturers class,* and become engaged in one of the best businesses on earth—the musical instrument business, and by starting small, he can grow, and furnish his own capital. We help him with his manufacturing and merchandising plans, at every stage. There is not sufficient room here to give the particulars of the whole interesting plan, but we will do so if you will

SEND COUPON TODAY FOR FULL PARTICULARS

and read them carefully. They will open up a new business to you, as well as show you how you can build a phonograph for yourself, at a tremendous saving in cost—*fully one-fourth.* Send that coupon right away, while the subject is fresh in your mind.

MODERN PHONOGRAPH SUPPLY COMPANY

200 Springer Bldg. **313 S. Clinton St., Chicago, Ill.**

FILL OUT THIS COUPON AND MAIL TODAY

MODERN PHONOGRAPH SUPPLY CO.

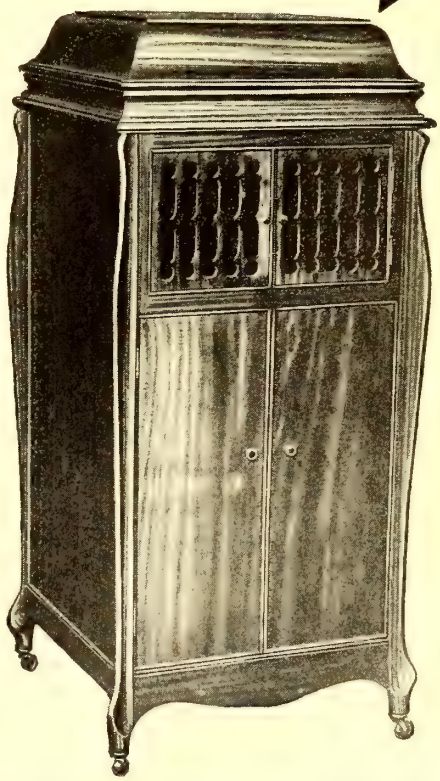
200 Springer Bldg., 313 S. Clinton St., Chicago, Ill.

Gentlemen:—Please send me full particulars of your "Build Your Own Phonograph" proposition, without obligation to me.

Name .....

Street Address.....

City or Town.....State.....



This is the finished product, model 5, that one of our patrons built himself, from our Cabinet Pieces, and mechanical parts, etc., at about one-fourth retail price asked for a machine of like quality.



One Hour a Day Will Raise Your Pay

MORE money! Isn't that the ambition of all of us? Isn't it YOUR ambition? The things you can do with money make life worth living—help you buy such luxuries as a home of your own, a car, better clothes, and have money in the bank. The mental satisfaction of making big money is a luxury itself. It gives a man confidence and pep to know that he has the ability to command big pay. To "make more money" is both a natural and healthy ambition—one you can accomplish *any time you are ready.*

Your ambition to hold a better job, to earn bigger pay, can be fulfilled when you realize that salaries are paid on a C. O. D. basis. Your pay check is a cold-blooded indication of what you can deliver. Therein lies the key to satisfying your ambition. DELIVER MORE. Your boss won't take the time to improve your delivery to him. That's up to you. When you can deliver more you'll find employers eager and willing to bid for your services. So many can deliver but a part of the requirements that there is naturally a big market for the man who is above this class—**the man who can think and act for himself.**

Set aside one hour a day to raise your pay—one hour that will not interfere with your work or pleasure—one hour that does not now earn you a cent. Designate in the Coupon below the work in which you would like to earn more money and we'll show you how to do it, without risk or obligation on your part.

American School of Correspondence
Dept. E-262 Chicago, U. S. A.

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Explain how I can qualify for the position checked.

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.....Electrical Engineer	.....Business Manager
.....Electric Light and Power Superintendent	.....Certified Pub. Acc'nt
	.....Accountant and Auditor
.....Hydroelectric Engineer	.....Bookkeeper
.....Telephone Engineer	.....Stenographer
.....Telegraph Engineer	.....Fire Insurance Expert
.....Wireless Operator	.....Sanitary Engineer
.....Architect	.....Master Plumber
.....Building Contractor	.....Heating and Ventilating Engineer
.....Civil Engineer	
.....Structural Engineer	.....Automobile Engineer
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MEAD CYCLE COMPANY Dept. M-107 Chicago

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Practical Chemical Experiments

(*Continued from page* 1046)

the solution. Cover the bottom of each tumbler in the second row with *strong* sulfuric acid. Likewise cover the bottom of each tumbler in the third row with a strong solution of caustic soda.

Fill a pitcher with clear water and add one or two tablespoonfuls of household ammonia. Stir thoroly.

Now announce to your audience that you are going to pour wine from a pitcher of water, at the same time filling the first row of tumblers. The ammonia and the phenolphthalein immediately react, giving a beautiful wine color and yet you are pouring into apparently empty tumblers.

Then suppose you spy the "Federal liquor officer" and wish to destroy the evidence of beverages of more than one-half per cent of alcohol. Pour the "wine" into the second row of tumblers and it will at once change into water. The acid destroys the ammonia and removes the color.

When the "officer" has gone and the danger is past, pour the decolorized "wine" into the third row of tumblers and the wine will reappear. The caustic soda reacts with the phenolphthalein to give the color again.

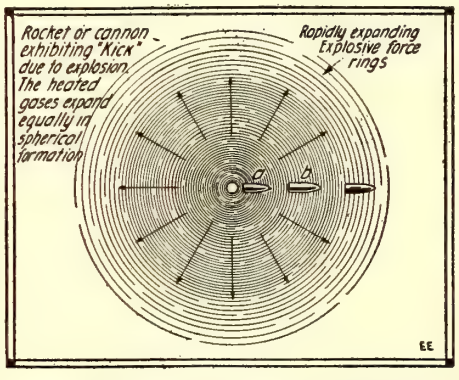
No more striking set of color changes than this can be seen on the stage.

The preparation of pitcher and tumblers are of course made in advance of the demonstration.

The Goddard Moon Rocket

(*Continued from page* 988)

the rocket takes only a few minutes to make its ascent and descent.



If an Explosion Occurs the Force Expands Rapidly in Rings as Shown, Causing a Movable Body to Exhibit a "Kick" or Movement Along the Line A-B.

The Possibility of Reaching the Moon.

From his findings Dr. Goddard claims that reaching such extreme altitudes as 2,310,000 feet (437 miles) is not at all improbable provided that the efficiency is high. Theoretically a body shot from this earth and traveling at a rate of 6.95 miles per second would never return. This was illustrated in the article by Mrs. Isabel Lewis in the September issue of this magazine.

Consider now that instead of an initial velocity which must die down due to air resistance, overcoming the gravitational pull of the earth, Dr. Goddard claims that if the energy is being supplied constantly there should be no difficulty in reaching even such bodies as the moon, and exploding there the effect could be noted thru a telescope.

How to Become A Master of English

is a valuable FREE booklet which *proves* that the Kleiser Mail Course in Practical English and Mental Efficiency will teach you to *Write Stories that Sell—Literature that will Compel Attention;* it will show you how to *Enlarge Your Stock of Words—Use the Right Word in the Right Place—Prepare Sermons, Addresses, Advertisements, Letters, etc.*

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LIFE'S BACKBONE

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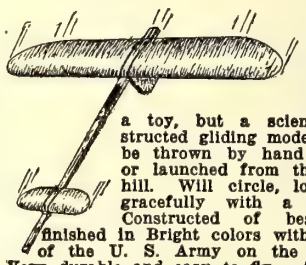
You need it right now if you haven't the pep-punch-ambition you should have. If you are irritable—nervous—unable to concentrate; if you suffer from dizzy spells — insomnia — headaches — rheumatic or other pains—constipation—indigestion—sore muscles—depression. It describes my world famous system of Condensed Exercise, and tells how you can win to robust, vigorous manhood through the use for ONLY TEN MINUTES EACH DAY of my wonderful invention

AUTOMATIC HEALTH EXERCISER

Scientifically built. You can actually watch yourself grow in strength from day to day. Helps you attain a superb physique—you can double your present strength. Learn to live right! Get all the happiness and joy there is in life! Life's Backbone points the way. It's FREE. Send for it now.

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Learn the principles of Aviation by flying our famous glide O plane. Not a toy, but a scientifically constructed gliding model, which may be thrown by hand on the field or launched from the top of the hill. Will circle, loop and glide gracefully with a light throw. Constructed of best materials, finished in Bright colors with the insignia of the U. S. Army on the Main Plane. Very durable and easy to fly. All wood, adjustable. Price 55c Postpaid in U. S. Send for catalogue H3.

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You Can Make Big Profits in BATTERY CHARGING

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No electrical knowledge required to install or operate. Recharges 6-volt batteries at once. Costs 10c to 15c each to recharge, customer pays 75c to $1.50. No burn outs or expensive renewals. Economical to run, requires no attention, save occasional oiling.

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Balance in easy monthly payments. Earnings easily pay for machine. Send today for full information. Sold under HB ABSOLUTE MONEY BACK GUARANTEE. Order NOW. Get busy! Get those Profits!



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5000 Graduates making good. Catalog Free.

Cleveland Automobile School, 1807 E. 24th St., Cleveland, O.

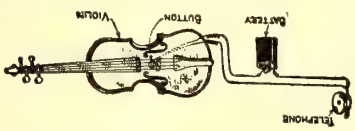
SKINDERVIKEN TRANSMITTER BUTTON

MOST SENSITIVE MICROPHONE

FOR $1.00

YOU can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *This outfit was used by secret service operatives during the War. It is being used on the stage.*

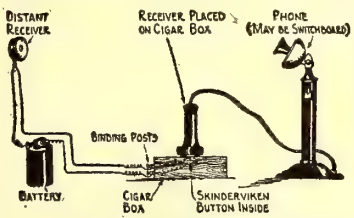


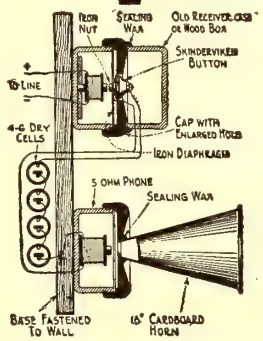
So much for its commercial adaptations! *You* can procure apparatus of the same type.

One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons cannot be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.

Full directions for connecting up the button for use as a detectophone are given in booklet which is sent with each button.

The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.

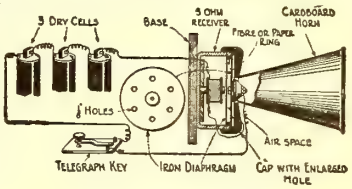


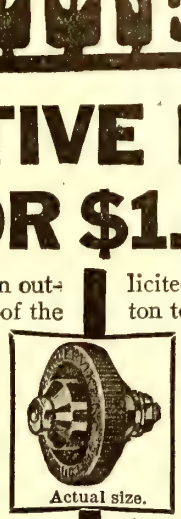






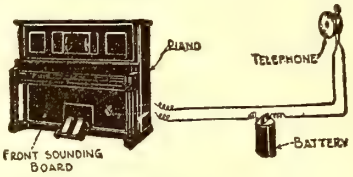





Actual size.

AMONG electrical experimenters the button has created a sensation. It is not uncommon to receive unsolicited letters like these: "I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

"I have been using one of these transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimenting." "I have been using one of these transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"



Mr. H. Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In the writer's opinion, obtained by actual elaborate tests, the Skinderviken Transmitter Button is probably the most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

We have the utmost faith in this transmitter button. We guarantee satisfactory service or we will refund the purchase price. Boys —Young and old—send in a dollar bill RIGHT NOW! You can't lose. If you're not satisfied, you receive your dollar back. Isn't that fair?

JOHNSON SMITH & CO., Dept. E-14, 3224 N. Halsted Street, Chicago

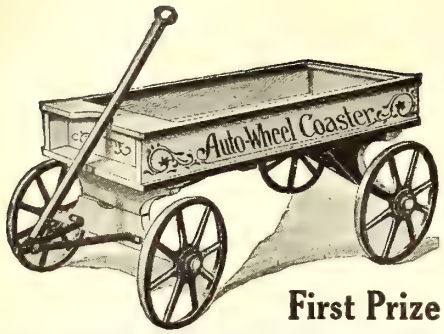
USE THIS COUPON

Johnson Smith & Co., Dept. E. 14, 3224 N. Halsted St., Chicago, Ill.

Gentlemen:—Please ship at once to address below.....Skinderviken Transmitter Buttons for which I enclose $.....

Name .....

Address .....City .....State.....



First Prize

Won By SCOUT KENNEDY PEIRCE, Tr. 63, Kansas City, Mo.

The judges decided that Scout Peirce's contest letter contained the sixteen best uses for the Auto-Wheel Coaster.

His Prize is the Auto-Wheel Coaster Itself.

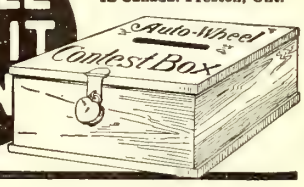
The Other Prizes Were Awarded as Follows:

2nd. Tent, Henry Jacobs, 37 Watkins St., Brooklyn, N. Y.
3rd. Poncho, Frederick M. Folger, - - - - Easley, S. C.
4th. Fleetwing Racer, Jas. O. Pierce, - West Plains, Mo.
5th. Camera, E. B. Roensch, Dooley Bldg., Houston, Tex.
6th. Mess Kit, W. Hayward, 603 Cross St., Ypsilanti, Mich.
7th. Flashlight, Jas. A. Bishon, Route 12, Knoxville, Tenn.
8th. Knife, Arthur Rick, 223 Mariposa St., Syracuse, N.Y.
9th. Scout Axe, Joseph Gerend, Box 76, S. Kaukauna, Wis.
10th. Watch, Albert Schulte, - - Box 364, Houghton, Mich.
11th. 3-Coin Bank, Stuart Demarest, - Roselle Park, N. J.
12th. Scout Compass, Charles E. Brady, - - Glen Ellyn, Ill.

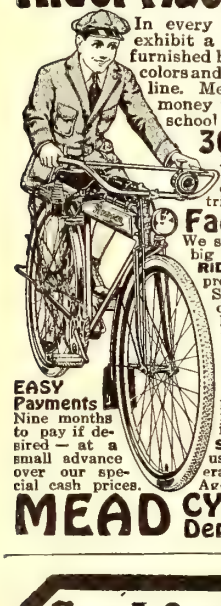
There will be several more Auto-Wheel contests this year. Watch for the announcements. Get the Auto-Wheel Booklet now. Send us the names of three local coaster dealers, mentioning which one handles Auto-Wheel. We'll send you a handsome *Felt Pennant FREE*. and our attractive booklet. Ask us about the Auto-Wheel Clubs—how to get special Caps for the members.

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In Canada: Preston, Ont.

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We sell bicycles made in our own big factories **DIRECT TO THE RIDER**—giving you a **superior** product at greatly reduced cost. Save time, money and trouble by dealing **direct** with our great Factory organization. Satisfaction in every detail guaranteed or money promptly refunded.

EASY Payments Nine months to pay if desired — at a small advance over our special cash prices.

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Suspended Gravitation

By H. GERNSBACK

(*Continued from page* 992)

descending to the earth like a parachute.

What is the practical object of this invention? Thousands of new uses will be found for it. All our homes and our offices will be equipt with the invention, and the immediate important result will be no doubt *greater longevity of human beings.* The wear and tear on the muscular and nervous systems due to the weight of our bodies is tremendous at present, all of which tends to shorten our lives. Remove the cause and we immediately become more or less rejuvenated.

In our illustration 5, I have shown several applications of the invention in which it will be seen that the persons or objects are all screened from the earth's gravitation. In sketch 1 we see a badly wounded patient in a hospital with his legs extended. He certainly will never be bed-ridden, and he will not become chafed because there is nothing to chafe against. Patients, particularly, will find the new invention of tremendous boon and they will all recover ever so much sooner. Our patient could sleep in any position and his sleep will be refreshing. He will not be smothered either by having his body pressing against an uncomfortable mattress. If he wishes to change his position, he uses the vertical hand rail as shown. He can move his body up or down and with practically no effort. Of course a well man would not need such a rail because by giving quick jerks, he could move from one position to another, but a sick person could not do this. Our patient's leg, too, remains in the exact position as ordered by the doctor.

Scene 2 shows a locomotive factory, where a weightless locomotive is being assembled without the use of electrical cranes or ponderous machinery. The huge six-foot wheels and the heavy piston case weigh nothing, and can be moved about and handled with the greatest ease. A locomotive will be assembled in one quarter of the present time by workmen who will not perspire in performing the job and who will not go home with "broken" backs due to the strenuous work. Work then will become a pleasure and a locomotive will be turned out in one quarter of the time at one tenth the labor expense it took heretofore.

Scene 3 shows a factory girl assembling various devices. It immediately becomes apparent that a very small space suffices for her work. *No longer is she restricted to one plane* as the present day working table. She could work in a dozen different working planes if she desires. The finisht boxes are at her left and the work she is doing is placed around her wherever it is most convenient. She does not have to reach and stretch as much as before, and being that things are right where she wants them, and furthermore because *her bodily movements no longer tire her,* she will become extraordinarily efficient, and will turn out ten or twelve times as much work as she did heretofore. No longer will she go home with a back-ache from physical exertion. She will go home refresht from her day's work, as is apparent.

Scene 4 shows our friend the typist in her office. Here too, work has become mere play. The confusion of the objects is only apparent. The things are just where they are needed and within easy reach. Everything is just where it should be and she can write in whatever position suits her best. She can either recline, or should she desire it, she could stretch flat on her back with her typewriter above her. Or if she is particularly eccentric, she can lie

(*Continued on page* 1052)

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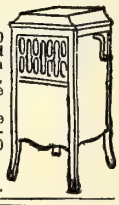
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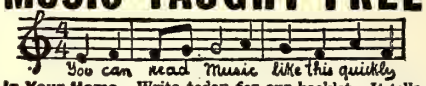


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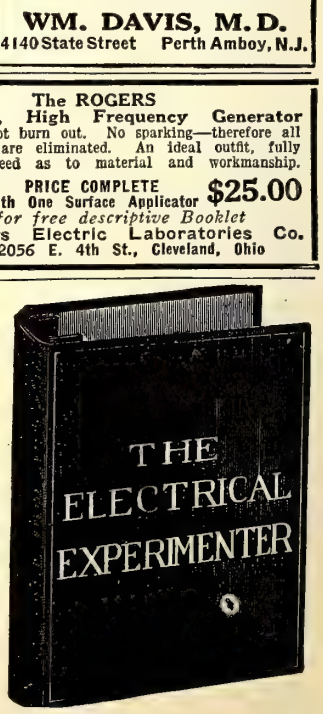
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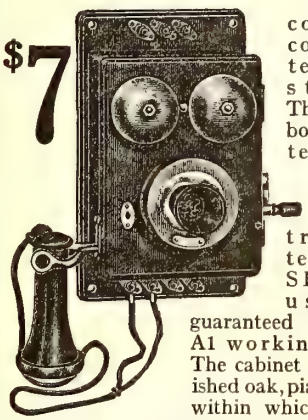
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Suspended Gravitation

By H. Gernsback

(*Continued from page* 1050)

with her face towards the floor and the typewriter beneath her! It all depends upon her head-ache, in whichever position she is most comfortable! The strap suspended in front of her is simply for her convenience as is the guard rail at her side. By these she can move into any position she wants to without jerking herself about or without touching the floor. Of course, she will turn out more letters than ever, and there will not be any three o'clock afternoon fatigue. One thing we must mention and that is that this typewriter must not be of the gravity type where the keys *fall* back by themselves. Such a typewriter would not work here. The typewriter must be one that has springs attached to the key levers to pull them back into the original position. Another thing and this is quite important, she must not bang the keys too hard because if she did the typewriter would "swim" away and hit the floor! This would make for a light touch! Perhaps she would find that after all the typewriter should be held by strings or cords, otherwise she would have to chase it all over the place!

Scene 5 shows how the heaviest of safes is moved readily by the smallest of "flivvers," simply by having an electrified net underneath the safe, which serves to cut off the earth's gravitational effects. In order that the safe is not blown away by the wind—you see it weighs nothing,—ropes or chains hold it to the truck. The automobile furnishes the electricity to electrify the net, and if our driver is wise he will carry an electrified net in front of the machine as well. Then if he runs into the stout party as shown, she will not be thrown violently against the hood of the flivver, but will remain suspended immediately in front of the auto without coming to grief; even if the wind blows her against the hood of the auto, little harm will be done to her, because you see altho nominally weighing 269 lbs., she now weighs nothing, hence has lost practically all inertia. A little bump therefore will hardly be felt.

Scene 6 shows what happens when the elevator cable in the sky-scraper breaks. This immediately closes a relay which electrifies the handy gravitation net below. Result—the elevator does not fall several floors, killing its occupants. Instead the elevator simply stays suspended as shown, until the repair crew "fishes" the elevator to the next floor where the passengers alight, none the worse for their experience.

After the repairs have been made, the power from the net is shut off because in an elevator *we desire the gravitation* in order to pull the elevator down. But going up is another matter. Instead of using a 10 horsepower motor to run the elevator as heretofore, we only need one of these little toy motors, because when the elevator goes up, the electrified net is switched on, and the car and its occupants then weigh nothing. Even 1/10 of a horsepower will be way sufficient to propel the elevator now.

Thousands of other uses will be found for the invention, and it will indeed revolutionize the entire globe. Life on this planet instead of being a daily drudge will become a pleasure. Perhaps then we will no longer need servants to do work about the house because it will be so easy to do it ourselves. Our tempers will be vastly improved, and as stated before our lives will be greatly prolonged.

The millennium certainly will have arrived for humanity when gravitation can be suspended at will by man.



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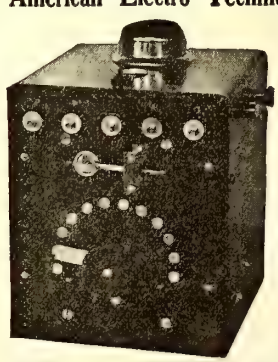
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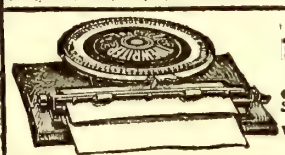
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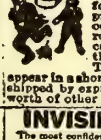
This trick is as effective as it is a surprising. The performer hands around the ball for examination, and immediately it is returned to him he seizes it by the tips of his thumbs and fingers and a second ball mysteriously appears. These are held in full view of the audience by the tips of the fingers of the left hand, and even while being placed in position, another ball unaccountably makes its appearance. Finally the magician apparently suffers from some kind of spasm and yet another ball is the result. The feat can then be reversed, the balls disappearing one after another until none remains. It is a very interesting trick that is quite easily performed by following the directions that accompany the apparatus. PRICE, 25 CENTS.

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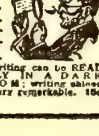
This is another good practical joke. Intense discomfiture of your victims to everyone but themselves is thoroughly enjoyable. All that is necessary to start the ball rolling is to deposit a little of the powder on a person's hand and the powder can be relied upon to do the rest. The result is a vigorous scratch, then some more scratch, and still some more. 8 Boxes for 25c. Sent only by express. (Must order at least One Dollar's worth of other merchandise.)

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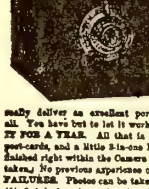
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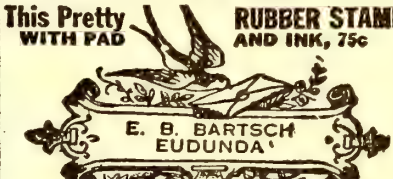
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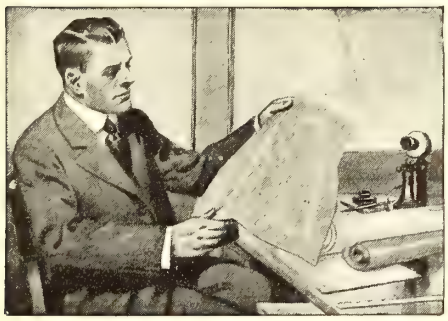
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Science In Slang

By EMERSON EASTERLING.

(*Continued from page* 1037)

type for work. In a. c. we have both the brush and commutator, and induction types. The induction works on the principle of fields changing due to the fluctuations—speaking of that, it reminds me, the current in the direct current generators are not constant but fluctuate from zero to the peak; of course in the improved types the fields are arranged so as to keep a peak handy to fill up the gap at zero, I suppose they do; I can't see why they shouldn't. It seems to me they could arrange it so.

"As I was saying, the field fluctuating from zero to the peak, or maximum, and the pull being in reverse directions each wave—were it not for the windings rendering the pull in the same. But it goes like this: The field yanks the armature around in one direction. As that field dies out and the next field builds up the pull is gradually moved to the next pole. By winding the armature and shorting it in itself, according to the results of Mike's experiments in induced currents, the armature core would tend to be possest with a different polarity, which would attract it to the field poles."

The Giant Canadian Reflector

By PROF. FLOYD L. DARROW.

(*Continued from page* 1011)

It may be asked, "Of what value is all this?"—"Why spend $200,000 on the perfection of an instrument which adds nothing to material comfort?" But it may be answered that Astronomy is the oldest and noblest of the sciences. It has added more to our knowledge of the Universe than any other. It pilots our fleets over the uncharted wastes of the sea and guides the caravan across the trackless sands of the desert. By its aid we establish boundary lines and without it surveying would be impossible. "Correct time" is absolutely dependent upon astronomical observations. But more important than all else is the broadening of men's minds to comprehend a universe of vast extent. Coincident with the growth of astronomical science has been the conquest of superstition and the sway of intellectual progress. Every other science magnifies the achievements of this little planet, but Astronomy asks us to remember that this boundless universe doubtless teems with life, even as a drop of water from a stagnant pool. Only when we behold the infinite depths of space thru these marvelous instruments of science can we have even an approximate appreciation of the relatively insignificant part which our little earth plays in the universe of time and events.

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Until within the last fifteen years the biggest telescopes of the world have been of the *refracting* type. Now it seems probable that the practicable limit of big lenses has been nearly if not quite reached and the astronomical progress of the fu-

(*Continued on page* 1056)

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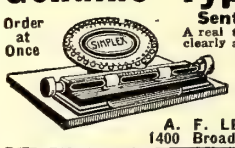
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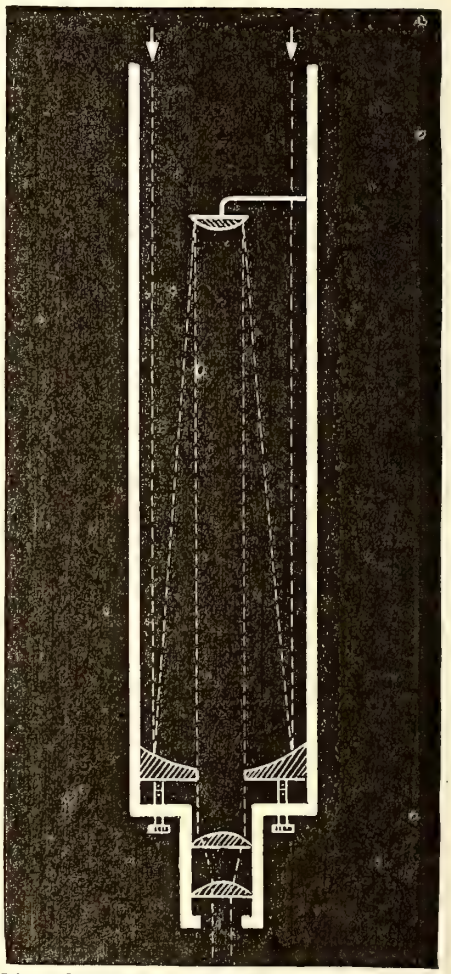


Luxurious lobbies, spacious verandas and sun parlors overlooking the ocean. Charming afternoon musicales and evening concerts. A palatial residence for those seeking rest and recreation. Sea water baths. Fireproof garage. Illustrated booklet sent on request.

The Giant Canadian Reflector

(*Continued from page* 1054)

ture must be made with the *reflecting* instrument. Certainly the reflector possesses several points of decided superiority. It is claimed that its cost is much less than that of a refractor of the same size. Smaller and less expensive housing for it is possible. While it is true that for visual observation better definition is secured with the *refractor,* yet for photographic work, which is now of chief importance, the *reflector* is unquestionably superior. It brings all rays of light of all colors to the same focus without dispersion. Another point to consider is the mounting of the optical unit. Both lenses and mirrors must be so mounted as to avoid flexure. A lens must be supported at the edges and the 40-inch



The Cassegrain Telescope Scheme. The Image Reflected from the Main Mirror Is Thrown Up Again Onto a Second Smaller Mirror, Thence Downward Thru a Hole in the Large Mirror, to the Eyepiece Below.

Yerkes lens is thought to be about the limit of size for successful mounting in this way. The mounting of a large mirror is not so difficult. It may be very thick and so supported at the back as to avoid distortion. But the thicker the lens the more light there is lost by absorption. The Yerkes and Lick lenses now transmit only 50 per cent of the light that falls upon them and doubling their size would permit only 25 per cent to pass. A mirror reflects 60 *per cent* of the light *and the thickness of the glass has no effect.* Reflectors are better for spectrographic work, too. Therefore, it would seem that the great telescopes of the future will be reflectors, like those of Canada and Mount Wilson.

(*The next paper will appear in an early issue.*)

Trolleys We Have Met

(*Continued from page* 1007)

pose of retaining, for one thing, the franchise right-of-way, or "track rights," of the trolley company, as this franchise stipulated that at least one car must be operated over the system every 24 hours.

THE CONDUIT OR SLOT TROLLEY.

At Figs. 5 and 6 are shown a single and double pole *slot trolley* such as used in several large cities, including New York and Washington, D. C. These do away with any trolley poles or exposed third rails, but they have always, or at least until recent years, presented more or less trouble, especially in stormy weather, owing to the large amount of water, due to rain and snow, which gets into the conduit in which the live third rails are mounted, which often causes short circuits, etc.

At Fig. 5 a single-pole slot system is shown. Here the current passes, let us say, from the insulated third rail slot, up thru a special, very thin insulated contact shoe passing down into the slot and riding along within the slot as the trolley proceeds. This current is then led thru the usual controller and motor elements. The current is here returned thru the grounded shaft and wheels of the car to the rails on which it runs, and thence back to the power house.

The double-pole conduit is shown at Fig. 6; here no current is returned thru the running rails, but both positive and negative conductors are mounted within the conduit. Of course, in this case, a special double-contact insulated shoe has to be used to pick up the current from the two rails. The path of the current thru the usual controller and motor elements is shown by dotted lines.

THE GASOLINE-ELECTRIC CAR.

This is one of the latest advances in electric interurban car design and is capable of very high speed and long runs. These cars embody a complete, self-contained electric generating plant and don't use any third rails, slots or trolley poles. A gasoline engine on board the car drives a dynamo of suitable size; this dynamo supplying electric current thru a speed controller to the motors on the trucks of the car.

Current is also available from the same source for heating and lighting purposes. This car can make a run of 75 or 100 miles very easily and the only fuel required is gasoline. Several of these cars are being operated in the central west and in the western part of the United States.

WASHINGTON, D. C., TROLLEYS FITTED FOR WIRE AND SLOT SERVICE.

Where the slot system is used it is the general thing that these cars do not travel beyond the districts equipt with that particular system, but in Washington, D. C., many of the cars run out thru suburban districts, and it is interesting to see the change made from the elevated trolley wire and pole system, to the slot arrangement. The operation requires but a few moments. What happens is this: The conductor pulls down the trolley pole at the rear of the car, and slips it under the hook on the roof. At the same time, if you are observant, you will have noticed the motorman equally busy at the front end of the car spinning a large wheel mounted on a substantial iron pedestal, beside the usual motorman's controller. When he turns this wheel a set of gears and connecting rods are put in motion underneath the car, which lowers the shoe down into the slot, and the car is then ready to proceed thru the city streets, deriving its current thru the underground slot distribution system.

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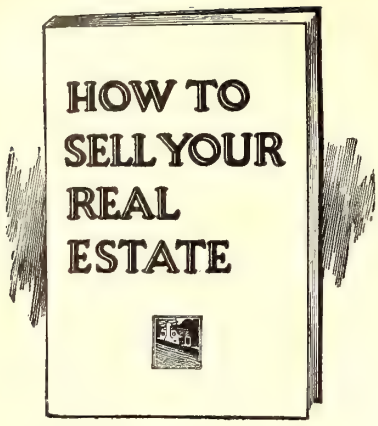
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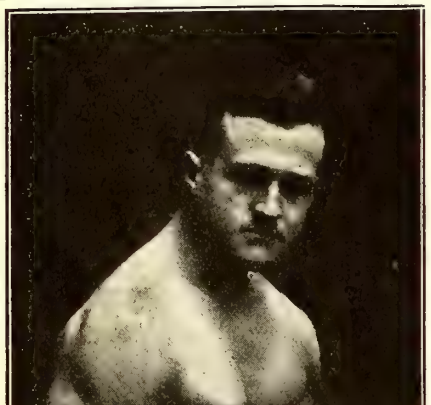
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Dept. 217 203 Broadway, New York

Electrifying The Holy Land

(*Continued from page* 983)

evaporation, namely, up to about forty-eight hundred square miles, an increase corresponding to one-fifth of the recent area. With an efficient head of not more than 656 feet, the plant would produce more than forty thousand horsepower.

This power would be utilized in the following ways:

For the production of lime nitrat from the air and for local mining operations.

For the distribution of electric light and power throughout the country.

For a pumping plant at the southern end of the Lake of Genezareth, which should be regulated by dams and by lowering the surface level, also possibly by making the River Jarmuk a tributary. At a suitable altitude above the normal water level, two canals would be built running from the lake parallel with the River Jordan, and from these canals the irrigation water would be distributed to the local irrigation centers among the freshly cultivated fields, sloping for drainage toward the Jordan. By economizing the water during the dry season, and by a thoro regulation even above the Lake of Genezareth, there would thus be obtained an ample supply of water for the irrigation of several hundred thousand acres, and perhaps some water might even be spared for a third canal parallel to the Jordan and the coast line, and irrigating the Plain of Sharon, with drainage toward the sea. Thousands of existing cisterns, and also some quite imposing waterworks dating as far back as the reign of David, could be partially included in these works.

For large salt works to produce common salt from sea water. From the point where the turbine pipes join the tunnel, a horizontal canal could be constructed from which a thin film of brine would be allowed to escape down the steep, sun-baked rocks, toward the Dead Sea. The water would evaporate, and the salt could be collected in the ordinary way.

For the exploitation of the vast deposits of asphalt in the Plains of Sodom and Gomorrah.

The geological maps of the country indicate what would appear to be very favorable conditions for the boring of a tunnel, altho progress might be delayed by hot springs.

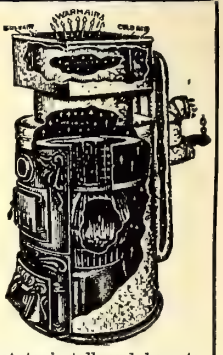
If we reckon no more than two openings the cost of the Dead Sea tunnel, mostly without masonry, and with a minimum area of 135 square feet (or having a diameter of about 13 feet), might be estimated at nearly $40,000,000. To this should be added the cost of the power plant, factory works, canals, other irrigation work and the salt works. The interest on and the amortizement of a capital of about $60,000,000 must be distributed over all these concerns. If the technical works (lime nitrat, salt, distribution of electric power, etc.) are charged with one-half of this amount and the other half to be charged to forestry, agriculture and horticulture, a rough estimate based on the incomplete data so far available will show that this plan does not compare at all unfavorably with the irrigation works constructed in Asia and America in the past decade.

Mr. Hjorth's plans have met with great sympathy among leading scientific authorities and practical technicists in Norway, and the latter have come to the conclusion that such an enterprise as this is not only to be considered as technically feasible, but that it will in all probability be a financial success.



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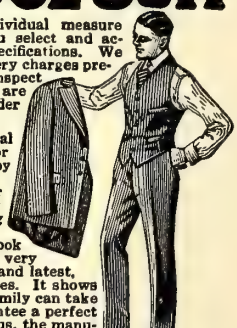
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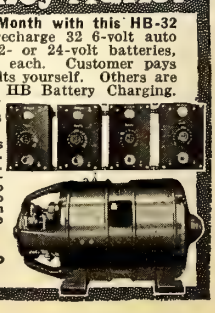
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Perpetual Motion Contest Awards

(*Continued from page* 1013)

THE GENTLE SEX IS AWARDED A PRIZE OF ONE SUBSCRIPTION.

Scheme 1. Does the guide rod run thru the center of the air chamber or is there a separate compartment for the guide rod separating it from the air chamber? If the first case is true, then the air chamber is *not* air tight and the rubber will not be distended to begin with. If the second case is true and the air chambers are air tight, then these rubber chambers could not collapse. In either case there would be equal buoyancy on both sides and there would be no motion whatever.

Scheme 2. If there were no "appreciable leakage" the balls would fit so tightly in the tube that the friction could not be overcome by buoyancy. Even if this were not so, the ball just entering the tube has the weight of the whole column of liquid upon it. This downward force would be too great to be overcome by the buoyancy on the other balls and the comparatively small amount of gravity on the outer balls.

Scheme 3. When the north pole of the bar magnet is at "a", it will move to the *left,* as it is driven away by the north pole and at the same time attracted by the south pole. When it reaches this first south pole to the left, it will remain stock still, as there will be repulsion from the two nearest north poles in the same direction in which the south pole attracts it.

HANNAH DVORCEF,
26 St. Paul St., Montpelier, Vt.

NOT BAD FOR 13 YEARS—PRIZE ONE SUBSCRIPTION.

The three ideas for perpetual motion illustrated in November issue will not "work" for the following reasons:

Idea No. 1. When the expansive rubber chambers, having come down on the right side, run over the pulley, they are supposed to fill with air in the centre of a tank of H_2O, that is, *"where no air is."*

Idea No. 2. When the hollow copper balls enter the tank of water, at the bottom, all the weight of water in the tank is pressing down on top of them. This would counterbalance any effect of buoyancy on the balls forcing them to drop, thereby driving the arrangement in the direction *opposite* to that intended. The water passing thru the tube, in the hollows between the balls, would soon empty the tank.

Idea No. 3. The north pole of the free magnet resting at A would be attracted more by the south pole of the top left-hand magnet, than by that of the top right-hand magnet, owing to the former being nearer; also the north pole of the top left-hand magnet repels the free one back to A, then the free magnet going toward D would stop opposite the south pole of the left-hand magnet, any momentum it might have acquired being counteracted by the repulsion of the north pole of the one at the bottom.

R. HOPE, (Age 13.)
376 20th St. W., North Vancouver, B. C., Canada.

A "SWINING MEGNET"—SPECIAL PRIZE 1C. POSTAGE STAMP.

My answer to figure one is the air chambers when empty as shone on the right hand when it reaches the bottom and starts up it will fill with water insted of air because there is no air in the tank. The air is all forsed out as the chamber desends.



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You want these things and probably many others, so why don't you double and treble your pay? **You can do it.** With double and treble the amount you are now earning you can go to the bank each pay day and put away a sum of money for a "rainy day," or that can be used for profitable investments or building your own home. Bigger pay would enable you to own an automobile and to get many pleasures out of life that you cannot now afford. To be able to go to the bank each pay day and steadily build up a bank account **without missing it** is alone worth any effort it may take to increase your earning power. Then think of the things you want that are not pictured here. Whether you ever enjoy those things depends entirely on yourself.

Every day you see men around you stepping up into better jobs and drawing bigger pay. It isn't a question of "how do they do it?" You know they have trained themselves to handle the jobs ahead of them. The question is "WHY DON'T YOU DO IT?" You want the things that better pay will bring you so why not decide NOW to prepare yourself for a better job and better pay?

Don't Dodge a Better Job

Promotion and better pay is up to you and not the boss. The big pay checks go to those who can think, act and do things for themselves. Training will make you a master of your work **and place you in the job you want.** There are no two ways about it; while you ignore the benefits of training you are **dodging a better job.** Without interfering with your work you can prepare for bigger pay right in your own home—after supper in some of the hours you now waste. The thousands who have marked and mailed the Coupon to the right have doubled and trebled their pay. That is just what you can do—so do as they did. Send the Coupon.

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Sneezing, hawking, spitting and coughing. Why do you have catarrh anyway? You were not born with catarrh — you contracted it. This offensive, unwholesome, disagreeable complaint fastened itself upon you and grew. Nature in trying to prevent more serious consequences due to the congestion in your body, finds an outlet for the accumulated waste, by way of catarrh. You cannot get rid of it the way you are going—sprays, lotions, snuffing powders, drugs and medicines won't stop it. You know catarrh leads to other troubles — serious ones — throat, lungs, stomach, intestines — all become affected. You can never enjoy good health if you have catarrh; you won't be efficient in anything as long as you have catarrh, and it detracts from your personality to be hawking and snuffling around others.



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My answer to No. 2 is the water the tank will tend to run out the bottom and the heft of the water will hold the hollow stellball in chack.

My answer for No. 3 is all megnets have the same strength the *swining megnet* will go to the megnet and stop and the other megnets will not have strength to pull it away.

LOY COAK,
802 Griswold St., Jackson, Mich.

100 WORDS—HONORABLE MENTION.

My brief answers to your problems are as follows:

No. 1. The pockets being air tight and would therefore remain so there being no way for air to get into the bottom of the tank of water this machine would remain stationary.

No. 2. There would be a great upward pull and also a great pressure at the tube in the stand pipe. It is this pressure which would make this machine stationary.

No. 3. Starting with the upper left corner the pendulum magnet would get no further than said corner as the south pole would attract and the north pole would repel and the pendulum magnet would remain right in the same corner.

Anxiously awaiting the outcome of this contest, I am,

Respectfully,
H. B. TROMBLY,
97½ Worcester Ave., Pasadena, Cal.

HONORABLE MENTION.

Scheme 1. This scheme could not work even if friction is neglected because when the buckets are on the left-hand side and commence to "ascend" the weights will extend the buckets and fill them with water since there is no means to fill them with air. The weight of the water displaced on each side or the buoyancy will therefore be equal; also since the chain is symmetrical the force of gravity on each part will be equal. The total forces will be the same on each side and in opposite directions so the machine will be in neutral equilibrium and not move.

Scheme 2. This plan will not work because we have the forces of gravity on each side equal and opposite; because there is friction of the bearings to be overcome; because power is needed to bend and unbend the rope; because of the large viscous friction of the belt and balls in motion thru the water; because the surface tension would operate to oppose motion; and finally, and this is the most important, if it was possible to construct a water-tight joint around the entrance of the hollow balls in the water the friction would alone be so great as to make motion impossible.

Scheme 3. This plan is unworkable because, admitting that powerful enough, concentrated permanent magnets could be built to cause any appreciable motion, when the pole of the hanging magnet came opposite the south pole of the second magnet it would be held there and there would be no further motion because the strongest force which is acting on it would be this attraction. Also suppose that the free magnet was started at a point between the poles of a single magnet the force would be that of attraction by the south pole and repulsion by the north pole and the motion would have a tendency toward the south pole. Once there, there would be no force causing motion from the pole. There would also be frictional losses in the machine and the difficulty in the construction of magnets which I have mentioned.

ALAN C. ROCKWOOD,
Iowa City, Iowa.

HONORABLE MENTION.

Scheme 1. In order to prevent the weight from rupturing the chamber, when

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inverted, a force is necessary. This is supplied by two agents; first, the tension in the rubber, and second, the pressure of the water above and below the chamber has the effect of a clamp which tends to close it. If the tension plus this "clamp" is insufficient to keep the chamber closed it will open until the increased tension (Hookes Law) plus the increase in the "clamp," due to the increase in displacement, is sufficient to prevent further opening. This increase in the "clamp" is equal to the weight of the additional liquid displaced and is therefore the additional buoyancy sought (Principle of Archimedes). However, it will be seen that this increase of buoyancy is used wholly to aid in the prevention of a rupture of the chamber that *it in no way lessens the downward pull on the belt.* Hence the machine will not run.

Scheme 2. The upward force depended upon to run this machine is the buoyancy of the balls, and is therefore equal to the combined weight of the liquid displaced by them. However, the entrance of the balls into the tank is resisted by the pressure of the water and is therefore equal to the weight of the column of water above the entrance. It is easily seen that this downward force will be greater than the upward force, so instead of the machine running as wished, it would, neglecting friction, run backwards until the tank was emptied, in this case running at the expense of the potential energy of the stored water. Hence the failure of this one.

Scheme 3. Suppose we start the suspended north pole to swing from d to a. In so swinging it would be attracted by the south pole at a and repelled by the north pole at d. But altho its inertia might carry it as far as the vertex a it would go no farther, for the south pole would attract it and the north pole repel it so as to cause it to return towards d and thus oscillate between the two vertexes like a pendulum. Thus comes the failure of the third machine.

Q. E. D.

NOTE: These machines are similar to all other "perpetual motion" machines in that all details are perfected *except that they won't work.* And rightly so for they are in direct contradiction of the principle that energy can neither be *created* or destroyed by human agents.

DANA P. MITCHELL,
Angola, Indiana.

Honorable Mention.

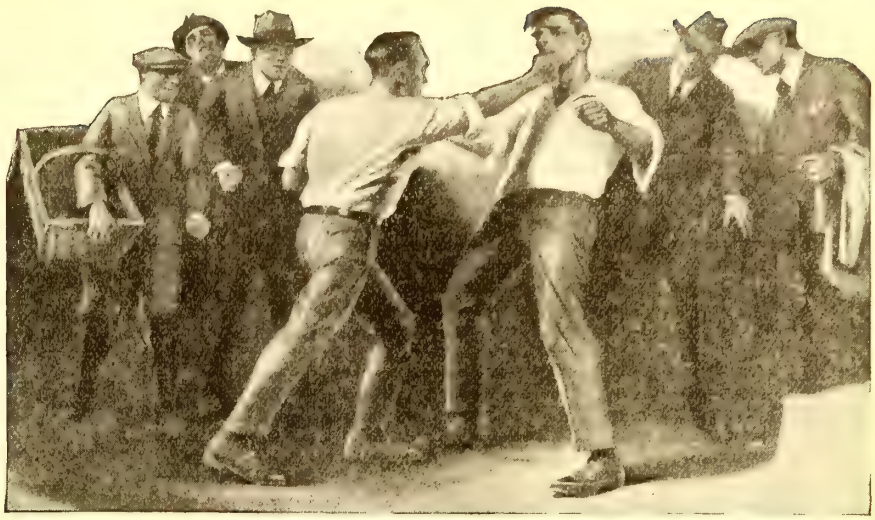
Theoretically the three so-called perpetual motion machines described in your November issue may be all right. But——

No. 1 will not work because the dropping of the weights, which is supposed to distend the rubber air sacks would tend to create a vacuum and cause the sacks to fill with water. There is no way for air to get into the sacks.

No. 2 will not work for the reason that the opening in the bottom of the water tank corresponds to a cylinder, and the buoyancy of the balls would not be sufficient to overcome the weight of the water. If the machine ran at all, it would run backwards. It would do that only so long as the tank was kept filled with water.

No. 3 will not work because, as the swinging magnet's north pole reaches one of the corners it would have to pass a north pole of stationary magnet in order to continue its journey. The pull would be exactly equal to the push, with the result that the suspended magnet would have to be assisted over the "dead center."

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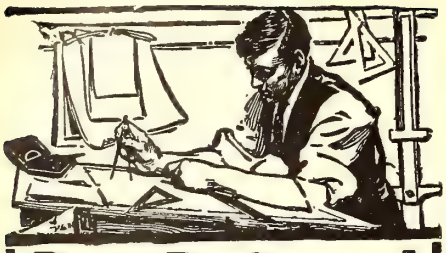
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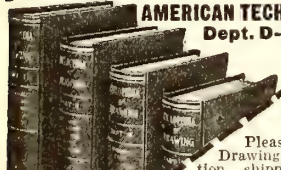
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By E. H. JOHNSON

(*Continued from page* 997)

stopt under a lamp, pulled out his lately acquired paper, read and re-read something in it, and finally with all the appearance of one who enjoys the contemplation of a master joke that he has engineered, he thrust it once more deep within his pocket, seized his coat by the lapels, pulled himself up, and chuckled,—actually chuckled, tho a careful examination of another paper identical with the one he carried, failed to reveal the slightest cause for such behavior.

Then slowly he wandered on thru the higher residence portions of the city, occasionally whistling in a rambling way,—aimlessly it seemed, even like his own wandering. But the frequent repetition of a few notes suggested the unconscious echoing of some song of other days. They were, however, unheeded by the few who were still awake, save one, an old night watchman, in whom the peculiar strains had suddenly awakened strange memories. He seemed to be once more leaning from the little window in his father's house in a land once dear to him, but which he had come to regard as no longer first in his affections, now that he was an American. With each repetition of those haunting strains he could almost hear the tramp, tramp of the gay *Studenten*, as they sang late into the night. There was no mistaking it, and for the first time in a score of years the words came back to him:

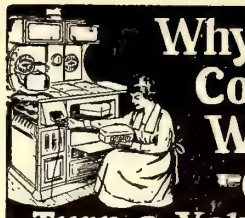
"Alt Heidelberg, du feine,
Du Stadt an Ehren reich,
Am Neckar und am Rheine
Keine andre kommet dir gleich."

No mistake! Old Heidelberg, even the lilt at the end of each line had been common to the students in old Heidelberg. Who ever it was that thus whistled away the midnight hours, he was either a native of Germany or one of those Americans who had long studied there. And in spite of his recent feeling of shame because of his own nationality, the old man hastened on around the corner hoping to meet this possible friend, only to see a distant figure vanish into a side street, to be lost entirely as the whistling ceased.

Thus it was that Grieg had wandered about the city—Doctor Grieg, the man with an enviable past and before whom lay limitless opportunity for aiding or upsetting much of the social organization of the years ahead.

As a boy he had grown up in that much disputed and undoubtedly desirable country bearing the poetic name of *Alsace-Lorraine*. Early he had been sent to both the *Realschule* and the Gymnasium, and later by some forgotten bit of fortune had been able to go to Heidelberg, Bonn and Berlin. Here he had studied under some of the greatest of living scientists, Helmoltz among the rest, and he had not only shown unusual ability in mastering the deep mysteries of chemistry and physics, but had on several occasions given evidence of the possession of no common power of insight into natural phenomena. Deep electrical problems had been his chief delight, and it was even suggested that had he cared for notoriety he might have anticipated the great Heinrich Hertz in announcing some of the facts which the latter discovered concerning electromagnetic waves. In 1893 and the years following, he had been back and forth between Paris and some of the German universities where was going on the feverish work immediately preceding the world-stirring announcements of Becquerel and Roentgen. He had followed closely some of the earliest work of the Curies, in their epoch-making isolation of radio-active substances and, at the time (1896-7) when Perrin was trying to gen-

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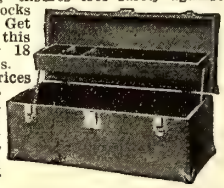
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erate electric currents by means of the Roentgen rays, Dr. Grieg was not only frequently in London attending meetings of the English scientific societies, but had given a series of lectures before the Philosophical Society of Cambridge on the "Electrical Nature of Matter." These papers, preserved in the transactions of the society, show now perhaps more clearly than they did then the wonderful perspicacity of the man. In a manner worthy of Faraday or Maxwell, he had predicted certain phenomena—or their absence—to be upheld by the work of other investigators a decade later. Especially had he been interested in all electrical experiments conducted in a vacuum, as he was watching for every possible verification of his early theory that any form of matter in a sufficiently divided elementary form—atoms or their subdivisions—might be transported by electrical forces, like the ray particles investigated by Becquerel and Crookes. Tho this suggestion seemed radically visionary, the experience of the scientific world between 1895 and 1900 had taught it to reserve judgment. Only after a certain familiarity with the newer rays and radiations had been acquired did men of science once more venture to make dogmatic statements relative to possible natural phenomena. Then they had condemned Grieg as a notoriety seeker, and owing to the fact that at that time he was not holding any high academic position, he had little recourse in his adversity. But his resolve to prove his point doubled from that time on. It became the dominating passion of his life to show that his critics were wrong. To strengthen his own conviction further work was unnecessary. He would yet demonstrate to the world a transformation more wonderful than any for which the philosopher's stone had ever been sought.

Then it was, about 1902, that he turned to America. Hurt but far from crushed, he resolved to leave the blind leaders of the old world, and come to the land of golden opportunity. As his controversies in Europe had been largely over matters of opinion, his distinction in this country was scarcely if at all diminished, and he was immediately offered the chair of electrochemistry in several of the eastern universities. But after a few special lectures before some of the scientific societies in the eastern states he continued his journey westward, finally to settle down in the sunkist city of San Francisco. Here the western spirit of youthful enthusiasm inspired him as nothing else had since his student days in Bonn. He found everyone ready to accept a newcomer at his apparent worth, with no questions about the past, and requiring no promise for the future.

He now rented a few rooms, gathered his books about him and began a period of study and experimentation more intense, if possible, than any of his earlier years. Aside from the postman with his armful of scientific journals and letters from foreign savants, he had no visitors; no one knew anything of his order of life. Days and nights lost all distinction for him. Rest came only when sorely needed and with no relation whatever to the time of day or the custom of those about him. He lived as in a prison, glad that its doors locked out the entire world of possible disturbers.

During the years that followed Dr. Grieg gradually felt his way along the path of which he had dreamed while yet a student. Every fact, every relation between the phenomena of molecular physics, brought him nearer his desired goal. While a mere boy he had read with wild interest of the ancient experiments in which water inclosed in gold and silver spheres had been made to actually pass thru the pores of the metal when subjected to sufficient pressure.



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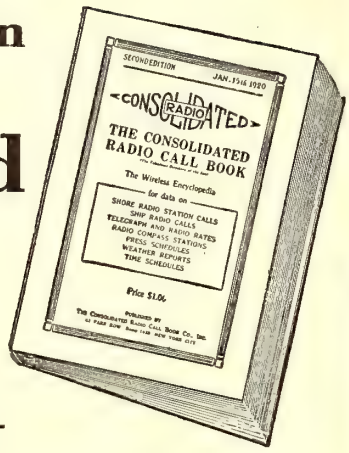
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Why might not the same thing be accomplished by some other force than a mechanical one,—by an electric or a magnetic force, for instance? He had also followed the well-known experiments on the diffusion of metals, in which molecules of gold and lead had mixed when blocks of the pure substances had been kept in close contact for a long time. Here the materials, in small portions to be sure, had migrated under some influence broadly classified under molecular forces. Were these too not electrical? Could they not be controlled artificially?

Then later there were the remarkable experiments of Bridgman, in this country, and Adams and others in England, which had shown that the ordinary characterizing properties of all substances disappear or change radically when suitable forces are applied to them. He had seen the rock specimens produced by Adams, proving that solid, cold granite could be made to change its form and flow by the mere application of sufficient pressure. He had studied Bridgman's data showing that liquids may behave as solids, and vice versa, if confined and subjected to forces of great enough magnitude. And many of their other physical properties were changed to such an extent as to afford a new field of knowledge.

All of this came to Grieg as welcome support for his theories. Each discovery by another enabled him to shorten his own methods for arriving at his goal. He recalled the famous experiments on electricity and the ether, by Sir Oliver Lodge and others, and the later theories about electrons filled him with ecstasies of joy. Other investigators as well as himself were finding out that atoms of matter when in vibration at a sufficiently high rate, had some effect on the ether of space; they actually sent out waves, and in some cases they themselves disappeared as if borne away on the rays of energy they had emitted—radiations actually affecting certain electrical instruments. Soon it was found that as these electrical properties of matter were made to increase, many of the other ordinary "substance" characteristics diminished or disappeared entirely. The identity of some of the "rays" from radio-active substances and atoms of helium had long been suspected, and it only remained to produce such a separation and transfer of matter artificially to overcome the great difficulty which was temporarily threatening all of Dr. Grieg's hopes. He must make atoms,—atoms of helium, for instance, do some of the things that the alpha-particles of radium had been shown to do. Perhaps it might be possible to do even more.

Of the experimental details involved in this attempt little can be told. Naturally the apparatus used was complex and delicate. Dr. Grieg's rooms had gradually taken on the confused appearance of living room, library and laboratory. In the larger room of the three which now constituted this "little kingdom," was a long table covered high with a mysterious conglomeration of instruments, glass tubes, bulbs of quartz and other substances, an electrically driven vacuum pump, and a MacLeod gage for showing the exact degree of vacuum obtained. There were also wires, switches, rheostats and electrical meters in great numbers, a hopeless mix-up to the uninitiated, but to the master—to Grieg—all was undoubtedly in precise order, in pleasingly fine adjustment—a thing alive, a creature of promise!

Of this mass of equipment several portions were conspicuous beyond the rest. Mounted near the center of the table was a semi-transparent globe, apparently of glass and tinted faintly to a lemon-yellow color. From above it was joined by a tube to the gage and pump, and below it tapered to a neck provided with a glass stop-cock.

On opposite sides entered two wires which seemed to terminate in small concave metal reflectors not unlike the cathodes in early forms of X-ray tubes. These two were identical and seemed as if curved to focus at a common point midway between them. A close observer would have noticed at this focal point a small, bright metal bead, mounted on the end of a fine wire coming from another electrode in the rear wall of the bulb. Externally, these were all connected by wires to the electrical instruments with which the table and the space beneath it was largely filled.

Not far away was a second bulb of about the same size as the former, but containing a large concave mirror of very peculiar appearance. At first sight it would have been taken for metal, like the smaller ones, but closer inspection showed it to be at the same time somewhat of a glassy nature, almost transparent when viewed directly from in front. At its focus were the ends of several tiny wires bearing small frames at once suggestive of the grid arrangement in some of the *vacuum detectors* used in wireless telegraphy. This bulb was not connected to the air pump, but apparently sealed permanently, and supported in such a manner that it could be rotated to face in any direction. Dr. Grieg called the latter bulb the *Medior,* and the other one the *Materializer.* In them lay the secret of his entire work, the result of his years of study, and they were at one and the same time weapons and tools for possible good of previously undreamed of potency.

Long ago he had seen enough of the realization of his dreams to work on in feverish haste. Altho a little thought would have shown that his secret was safe, even had his rooms been open to every one, he lived in a constant tremor of fear, lest his new-found power should slip into the hands of others. Calmly thoughtful by nature, he at times lost all self-control at the very thought of an outsider within his sanctum. And this fear grew day by day until reasons began to formulate themselves in his mind for leaving the house he had come to regard almost as his own, and find other quarters, where there might be no curious land-lady, where walls were not so thin, where fire risk would be less, facilities better, and so on, until, as he surveyed the array he saw clearly that there was no course left him but to move, and the sooner the better.

So it came about that before long a dray load of huge boxes and crates was moved into one of the rear rooms on the second floor of a down-town office building. Grieg had reasoned rightly, that seclusion was more certain in the heart of the city than where people's thoughts were less occupied. Here he had a spacious room, only one to be sure, and one having but two windows high up so as to afford only a view of a few square feet of brick wall a few feet away. But these and other factors were great sources of gratification to the new occupant, and the least of the several reasons for this was that they made the rent far lower than that for any similar space to be found. And the walls, they were of solid brick and masonry, two feet thick if an inch,—and the floor was of concrete. What more could he wish for? Greater security and isolation could scarcely have been provided by a lonely island in Polynesia.

Now it was that the work began in earnest. Dr. Grieg had some months earlier succeeded in transmitting helium from one bulb to another several feet distant by means of his electrical rays. And the method had been surprisingly simple after all of the superfluous details in the apparatus had been eliminated. At first the flask containing the helium had been placed in the path of a powerful beam of ultra-violet rays and the *Medior* bulb immedi-

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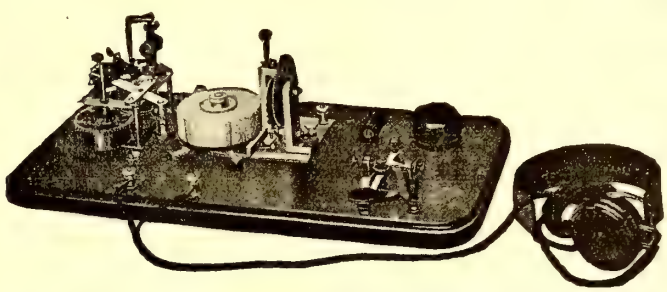
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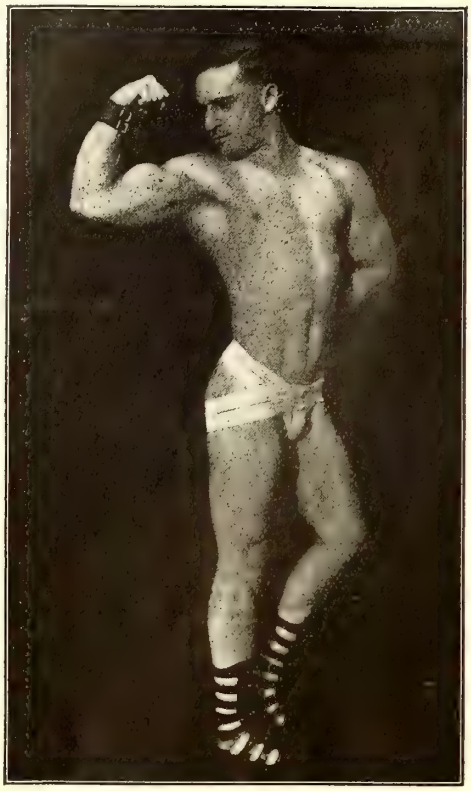
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ately in front of it in the same rays. Then, when the proper pressures were obtained in the two containers, he had succeeded in showing by means of the spectroscope that the space within the *Medior* contained a small percentage of helium, whereas before the exposure it had contained absolutely none.

From that time on the developments were of the nature of slight adjustments and improvements rather than fundamental inventions. He now had the embryo of the creation which he fully believed could be made to grow to almost any proportions if properly studied and assisted. Before his mind's eye lay a changing universe, its laws upset, and all human notions of its stability and fixity set at nought. If helium, for example, could be thus called by him from one closed vessel and made to appear within another, when there was no apparent physical connection or functioning medium between them, why might not his command be extended to all other elements as well?

One evening while sitting far into the night and gazing at his beloved bulbs, as he had often done before, but now as one hypnotized and immovable for the first time in many hours, he gradually lost all sense of time and space in contemplating a widening vision that built itself up and up before him. His cheeks became flushed and an unwonted fire glowed in the depths of his half-closed eyes and, drunk with the dream as well as exhausted, he fell asleep and dreamed on.

Hour after hour his little clock ticked away the seconds and the little motor that drove the air-pump purred on so contentedly that one would scarcely have dreamed that its song was one of ceaseless labor and faithfulness. Perhaps it knew the importance of its task, and who shall say that the little old clock did not philosophize deeply before ticking off another second, knowing that no power could bring it back.

Suddenly Grieg awoke. He seemed at first startled, as if surprised in some secret business, and then recognizing his whereabouts, he almost laughed aloud. Undoubtedly he would have done so had not his habit of secrecy and quietness become quite fixt. But he did laugh a little, and for a long time as he walked about the room with his hands behind his back he seemed to be reviewing some pleasant scene. He would stop occasionally and caress some queer-looking piece of apparatus, or perhaps he would speak to some other mysterious contrivance, all the time with the bearing of one who was both a general marshalling his troops for a glorious assault and a dear friend. His brief ejaculations were of the nature of assurances, of promises, of congratulations.

That night, or rather morning, Grieg thought no more of sleep. For a time he pored over the books which were scattered about the room,—the most of them open to some reference of immediate interest. Then he renewed his experimental work. For days he scarcely seemed to pause for a moment. When or where he ate is not known. Had he not actually slept amid his apparatus on that other night he might have been credited with perpetual sleeplessness, among his other powers. But thru it all, something seemed to buoy him up, to renew his vigor and instill youth into his veins.

It has long been known that when under the influence of the force of electric currents of sufficiently high frequencies and high potentials, practically all substances act as conductors. This fact had been made use of by Grieg in making the *Medior*. Now he constructed strange transformers for increasing these qualities as far as possible. Huge coils, like those of Tesla and Oudin, were built into the

(*Continued on page* 1069)



In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

SPECIAL NOTICE!

Of late we have received so many letters from our correspondents regarding patent advice, that it has been quite impossible to publish all of them.

Altho printed in the smallest type possible, we cannot accommodate more than ten or twelve answers a month. At the present time we are about four months behind. Of course, if our correspondents have time, no harm is done! We would, however, advise that if a quicker answer is wanted, correspondents should avail themselves of our special service, as per the notice printed at the head of this column.

All letters are answered in turn as they come into this office, and for this reason it will be understood why it takes so long for an answer to be publisht. Will correspondents please bear this in mind?—EDITOR.

Typewriter Device.

(370) Walter C. Leahy, Bogalusa, La., has written the following interesting letter: "I would be very glad to have you publish at your earliest convenience, the prospects of obtaining a patent should the following idea justify one, on a device described below, which, as far as I can ascertain, is entirely original.

This attachment can be used with any design of typewriter or billing machine, to make use of other special characters than just those originally in the machine, without the necessity of removing one of the original keys and inserting the new type-bar with the special character.

This consists of a "shell" made of any spring metal just large enough to snugly fit over the type and containing on its face or printing edge the special character which it is desired to use. Its shape would depend on the shape of the type in the machine, and has to be made "springy" enough to hold firm to the type-bar without jumping off and still loose enough to be easily attached or removed.

Its advantages are as follows:

Extra and special characters are on hand at all times for use.

Considerable, in fact one-half of the time required in making double lines, on a typewriter can be saved, as follows:

The corporation for whom I am employed uses typewriters to make up a great many daily, as also monthly, financial, cost and statistical reports, and these statements, etc., make use of a great number of single and double ruled lines drawn on a typewriter. In making double lines, it is necessary to draw one single line clean across the page, turn the paper slightly forward, and draw another single line under the first.

I constructed a number of attachments as per the above for use on Underwood typewriters out of spring bronze, with lead printing surfaces, on which were cut out the character. When one of these was slipt over the type for instance, one not used but very seldom, say fractions, etc., and the key pressed, the result was a double line with the same time it would have taken to draw a single line, or one-half the time previously consumed in drawing double lines by the old method. This was readily proven a great time-saver.

I should like very much to learn your views on the above thru the columns of your excellent paper, which we all realize is foremost in the scientific and electrical world, and I trust you will give this early publication.

A. The idea certainly is new, and we think a patent can be obtained upon it. Without knowing how the shell is attached over the typewriter letters, it is impossible for us to tell whether the idea is practical. Off hand, without having seen a model, we are inclined to believe that such shells would work themselves loose and would not give writing strictly in alignment, but perhaps our correspondent has overcome this. If the shells can be made so that they do not come loose and the writing stays in alignment, we think a valuable patent can be obtained upon such a device.

Generator.

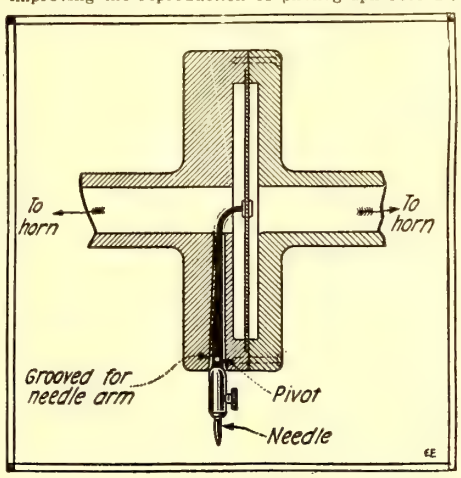
(371) Martyn Cooney, San Francisco, Calif., states: I would like your opinion on an idea of mine. A generator produces electricity by the armature rotating inside the field magnets and I have also heard of the field rotating while the armature was stationary. My idea is to have the armature rotate in one direction and the field magnets rotate in an opposite direction, thus producing more current and also enable the machine to run at slower speeds. In the case of a large alternator it would have a number of field magnets all rotating in opposite directions.

A. This is not a new idea, having been tried by many investigators. The trouble with such a device is that it is much too complicated for commercial work, and nothing is gained in power.

Phonograph Reproducer.

(372) Paul B. Kingsley writes us:

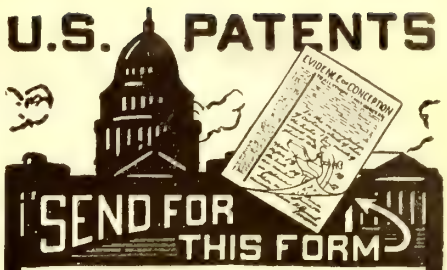
Would like your advice co cerning a method for improving the reproduction of phonograph records.



On all phonographs I have had the privilege of examining, the sound from only one side of the reproducer diafram is amplified. In all musical instruments which have a vibrating element, such as a string or reed, the sound from the moving element is used completely.

The reproducer I have in mind, as you will see by examining the diagram, utilizes the sound from both sides of the diagram which, to my mind, will give a greater clarity of tone, more nearly recreating the original source of sound. And it certainly would give a greater volume of sound with smaller means of amplification. While this deduction is wholly theoretical, since I have no model, I can recall no acoustical law which would seem to contradict my prediction. I am not sure of the real value of his idea nor of the originality.

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A. We have carefully looked over your contrivance, and would say we do not think much will be gained by having the sound come out from two sides of the diafram. Our reasoning is based on the following:

If only one side is used, the small chamber that is created between the closed side of the diafram and the wall of the reproducer acts as an amplifier on the diafram, and thus strong impulses are set up in the diafram itself. As soon as you perforate this wall, the action must be reduced and the diafram will not vibrate as powerfully as before.

In the 80's, some telephone receivers were constructed on exactly the same plan as for instance Mr. Ader's of Paris, who constructed several types with two horns. Any standard book on telephone types will reveal this. The advantages, however, were not sufficient to go to the added expenses of these telephones which are not in use now.

Chair Device.

(373) Mr. Robert N. Rose, of Whittier Street, Queens, L. I., writes:

I would like to ask thru your "Patent Advice" if you think a patent could be obtained on the following idea:

Perhaps you have often noticed that the rungs of chair are often scratched and the paint rubbed off by placing our feet on them. So I have devised a protection for them. I use a steel rod, which may be cut to any size, and at each end is fitted a spring clip, the rod being one-quarter inch thick and the clips are soldered to the rod.

This is very easily made and can be retailed at about three cents apiece.

A. We should say that while this device seems to have merits, we do not think there is sufficient demand for it, and we doubt that a patent can be obtained.

Stereoscopic Movies.

(374) Mr. Horace S. Cottrell, of Napier, N. Z., writes us the following interesting letter:

An article on Stereoscopic Movies in a recent number of your journal has had my attention. 'Way back in 1911 I evolved an idea for producing stereoscopic effects on the screen. I believe it will work, but then I have no facilities for trying it out.

Since the time the idea came to me, now over eight years ago, I have kept an eye open both in the movie magazines and on the screen for the "stereo" movie to become a reality. The basic idea of my scheme seems to me so obvious that I cannot but think that it is sure to have been tried out before. The somewhat impractical scheme outlined in your paper, except from an experimental point of view perhaps, is the first discussion on the stereo movie that I have seen for some years. Anyway, here's my idea: *That the two pictures of stereoscopic vision shall be photographed alternately on the Kine film.*

The optical and mechanical means of producing this result should present few difficulties. I have my ideas of the way it might be done, but that is of secondary importance at the present stage.

In expounding the scheme, I would point out that the stereoscopic effect can be and is secured on the screen for the un-aided eye under certain circumstances. You will see it on train rides and scenes taken from a moving boat where the camera is moving, the picture and the next one just a little farther on, letting you see with the other eye, so to speak.

I have also seen stereo effects in some Pathé fashion and flower studies. In these, the camera was stationary and the figure and flower revolving slowly.

A. There seems to be no objection to the fundamental idea of our correspondent, but we are very much in doubt as to whether the film would work as described, in actual practise. The action of which our correspondent speaks is nothing but a freak action and does not always occur. It depends a great deal upon the speed of the film as well as on the subject. We do not think, therefore, that all the subjects would lend themselves for stereoscopic production as mentioned.

EXPECTED ELECTRIC SHOCK IS RARELY FATAL.

Dr. S. Jellinek, analyzing the effects of severe electric shocks received by contact with electrified wire fences during the war, writes in *Elektrotechnik und Maschinenbau* that an important factor was the state of preparedness of the victim. Experience has shown that a shock which was likely to prove fatal if received unexpectedly was harmless when anticipated. Experiments on animals have confirmed this impression and have been instrumental in showing that physiological effects of shocks administered with direct and indirect current are distinctly different.

It is also remarked that a close resemblance to death after shock should not be accepted too readily as proof. Persons apparently dead have not infrequently recovered when artificial respiration was applied. It is best to give the victim the benefit of the doubt.

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The Golden Vapor

By E. H. JOHNSON

(*Continued from page* 1066)

apparatus already filling a large portion of the room. Devices for producing ultra-violet light in powerful beams were added, and mercury vapor lamps replaced the ordinary electric lamps in the ceiling. This was because he had always found his experiments to succeed best in the presence of these radiations of short wave-length.

Such was his success that he was soon able to transfer some of the heavier gases from one bulb to another, just as he had first done with the helium. Then came metallic vapors, the lighter ones first, and finally that of mercury,—all of course, initially inclosed in a sealed bulb free from the presence of other substances and made to reappear in the *Medior*. But the latter, for the reasons which had led him to so name it, was never intended to be the final receiver; it was to be but the *medium*, the agency to affect the transformation of what it received from an ether wave energy form to that of a particular electric current. This, in turn, was to be further transformed into its characteristic matter form by the *Materializer*. However, the difficulties involved when this step was attempted under any but ideal conditions, had made the *Materializer* hitherto of little more than theoretical usefulness. And then in a brief moment he had found that the interposition of suitable condensers between the two bulbs solved the problem completely. When in operation the faintly luminous rays in the *Materializer* brought the tiny metallic bead to a bright incandescence, and a vapor soon appeared around it, condensing and forming on the sides of the bulb as an impalpable powder or sometimes as a liquid, which could be drawn off by means of the stop-cock below.

The principal steps in the process were as follows: A bulb containing, say mercury vapor, was set in the path of a beam of ultra-violet light which in turn also past to the Medior, tho the latter was possibly some feet away. (Absorption of these radiations by the air and other media had been obviated by giving the waves themselves a suitable form.) The grid in the *Medior* was then heated by an auxiliary electric current from a small storage battery, and the entire bulb was oriented so that its concave mirror faced the beam of ultra-violet rays. Then the high-frequency, high-potential apparatus was started and as soon as the condensers were adjusted to the proper capacities, the tiny sphere at the focus of the mirrors of the *Materializer* would begin to glow,—a bluish vapor would surround it and soon minute globules of metallic mercury would begin to roll down the sides of the bulb and could be drawn into a beaker below.

However, some limitations still remained that he saw must be removed before his great dream could be entirely realized. Among them was the fact that the substance to be transferred by this method must begin its transformation in a hermetically sealed flask, entirely freed from the presence of even the slightest trace of any other substance. Then again, he had been able to make the transfer only when the active beam of ultra-violet rays was approximately at right angles to the direction of the earth's gravitational force. On this latter subject he had thought almost constantly, and had even written a lengthy paper—*"On the Relation of Electronic Path to the Direction of the Gravitational Vector"*—with the notion of reading it at the approaching meeting of the *American Physical Society* in San Francisco. But

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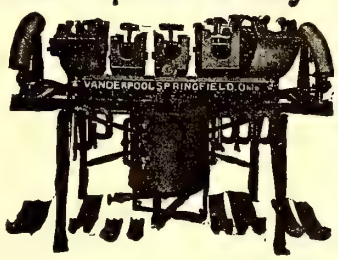
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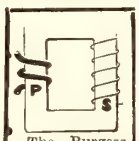
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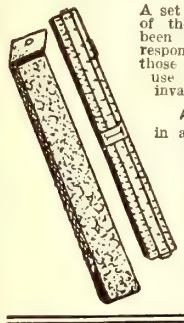
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the first thought of his earlier treatment at the hands of those other scientific societies in Europe caused him to tear it up and burn the strips slowly over a Bunsen burner, smiling as he watched the glow of the ink on the falling flakes of ash, as if the joke were on others and not on himself.

The work of Mosely, the Braggs and others opened up a new avenue for attacking the problem which now excluded all other thoughts. It had been found that the X-rays excite secondary X-rays by the molecular agitations of the substances thru which they pass, and that these new rays possess characteristics relating them to the emitting substances. Their directions were also different from those of the primary rays which had excited them, so that they seemed at first to be only the same radiations after reflection.

Beginning with these facts Grieg was soon able to reverse the action of his *Materializer* and *Medior* so that a vapor or finely divided solid which had been inserted into the former might be de-materialized and transmitted to a distant place, and there re-materialized by the same sort of apparatus used as a receiver.

Then came another great discovery. If the flask which was to act as the receiver, already contained a substance in a similar form (that is, solid or vapor) to the substance in the transmitting bulb, but of greater molecular weight, the mere impinging of the charged violet rays on this substance set up molecular agitations resulting not only in the automatic materialization of the substance sought, but also in the emission of secondary rays in exactly the opposite direction, and these in turn bore back in pure energy form, portions of the denser material. Thus a single transmitter became both a *de-materializer* and a *materializer, a sender and a receiver!*

The experiment was tried out repeatedly. For example, equal masses of tin and lead had thus been exchanged, and the only characteristic difference in the appearance of the sending bulb was that when acting at the same time as a receiver, its vapors were in violent tumult. This motion ceased only when one or both of the substances had been completely transferred. Still further refinements had then enabled Grieg to make the exchange in any direction and thus the gravitational factor which had long been a stumbling block was eliminated.

Following this last success and for the first time in months, he seemed to move leisurely. Deliberately he would wander about his room with the air of one who knows that his plans have not miscarried, and who sees their final triumph easily within his reach. The battle was won; he had but to accept the victory! The fact that he was meditating on what society would call a grave crime, scarcely entered his mind. When it did he only smiled cynically, as always, in the consciousness of his own security. Tho he should not be clast as a moral pervert, or one naturally bad, he was perhaps now little better, for he had lost all of his former feeling of moral and social responsibility. Human laws and customs mattered to him not at all. The experiment should be tried, come what might. It would in itself be his life's triumph, his triumph over his old critics, the supreme proof of the fallacy of human notions of security. And of the more material reward which would accompany it, well, that was secondary; but after all it would be pleasant to rest, and in what way more enjoyably than to wander leisurely up and down the length and breadth of his native Alsace-Lorraine and visit again the scenes of his student days—when the means were available?

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Thus it was that the days went by. The first day of November had arrived and nearly past. Grieg, who had just eaten a good meal at a nearby restaurant, was now strolling aimlessly along the streets and thinking for the most part of mere trivialities, but never for one moment losing sight of the fact that to-night he was to carry out an experiment more wonderful than any dreamed of by the alchemists. To-night should witness an enterprise that would at once distance all other human endeavors and baffle the keenest of sleuths.

As a distant clock chimed the hour of nine, he turned back to his room. At once his step took on the alertness of one who has made a decision. There was work to be done and done now. Once more he was the keen scientific investigator. Every sensibility was alert, and the training of a lifetime showed itself in every movement.

On entering his room he switched on a small, blue light, glanced around and at once seated himself before the apparatus on the huge table in the center. The pump had been running uninterruptedly for days and the gage showed that every joint was tight. A tiny pilot light here and there told that all wires were intact and ready for their task. In place of the single *Materializer* bulb that had been seen previously, there was now a row of such bulbs, six of them, each larger than the original one, and they were all connected to the pump and so arranged that each could be switched into circuit instantaneously. Above them was a large glass funnel or hopper filled with a bluish-gray metallic appearing powder. From this ran a large tube which in turn branched out so as to enter the top of each of the *Materializer* bulbs, and admit the powder to any one of them on opening the proper stopcock. Beneath each of these bulbs was the usual large beaker. No receiver was visible. It had ceased to be necessary soon after Grieg had succeeded in using the secondary radiations as a returning agency. Evidently the experiment was to take some form not hitherto seen.

With a last glance over the apparatus, he slowly closed the master switch which made the whole assembly of mechanism become a thing of potentialities. Then one by one, smaller switches were also closed, until from the slight hum and glow of the various contrivances one would judge that all was in working order, set for the attack, whatever it might be.

Slowly Grieg turned the great *Medior* bulb first one way and then another and finally he clamped it pointing directly downwards. After opening one of the inlet cocks so as to let a little of the gray powder filter down into the first *Materializer,* he watched it intently for a long time. The focus glowed and then the usual vapors appeared, velvety and blue and hovering quiescent like a spirit soon to vanish. Then he examined the luminous region with a spectroscope, but soon he set it aside, shook his head in a worried manner, and directed his attention once more to the powerful *Medior.* Apparently some adjustment was incomplete. Beginning as before, he swung the great globe one way and another as one might guide a searchlight in exploring a distant hillside. Always he kept it *pointing in a general downward direction,* while the *Medior* rays played upon some iron bars, and always he watched the glowing haze in the *Materializer.* From time to time it seemed to show slight tremors, but nothing of the violent nature he was seeking. Then he swung it thru a wider angle, sweeping out larger and larger circles with its axis, and all the while watching intently the tell-tale glow at his side.

Suddenly he stopt. For a moment he seemed as one stupefied. The iron bars on



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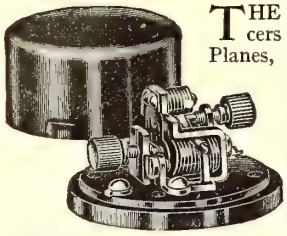
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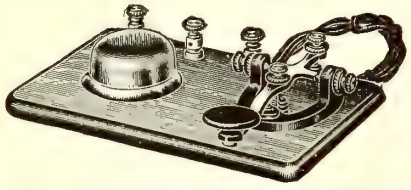
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which the downward rays were playing slowly seemed to "dematerialize," nay, vanish into the thin air! Then he leaped to the spectroscope, directed it toward the boiling vapors in the globe before him, and sat for a time as if hypnotized—held by some strange sight.

As soon as he moved slightly, it was apparent that his excitement was very high. His breathing came short and fast. And then with what seemed almost a shudder, he sank back in his chair, buried his face in his hands, and remained silent for a long time. When again he looked up, his eyes and hands were wet. New lines in his face told how great had been his recent emotion.

Like one who has climbed long and laboriously to reach some far height, and who sighs almost in disappointment when he realizes that no higher levels exist, Grieg sat and gazed blankly before him rapt by vistas reaching far beyond his laboratory walls. Pleasant lands spread out before him, thru which came many roads filled with all manner of travelers. They were bringing tribute to him. It was a golden view, rich in the warmth of a bluish golden light that filled the dome of the sky above and seemed to hover like a gilded cloud about his fair mountain. And from all around arose the hum of a teeming civilization—the droning tone of a busy world—the monotone of existence itself. But no, it was only the purr of his faithful little motor, and the buzzing and hissing of a myriad tiny sparks that had shaped his dream. And the glow was still confined to the fragile bulbs before him.

Shaking off his stupor, he turned once more to examine them. Slowly their vapors were condensing in a fine powder about the sides and bottom of the sphere. He opened the bottom stop-cock and caught a little of it on a watch glass, rubbed a bit of it between his fingers, and held it near a light. IT WAS DISTINCTLY YELLOW! And the clouds within his bulbs were still seething violently. . . .

It was on the fourth of December when next Grieg was seen—on that night when the crowds had been hurrying homeward and when the newsboys had been calling out their wares with such uncommon vigor. In the private office of the bank occupying the first floor of the building in which Grieg had worked so long, the directors and officers sat solemnly listening to a distinguished looking man, evidently their president. Excitement, worry and suspicion were written on the face of every one present, and it was all on account of a brief telegram that had been received that day from China. Tho it concerned a loss that would be considerable, still worse was the fact that its information had leaked out and might alarm the depositors. On the table about which these men were gathered lay a copy of the evening paper, scarcely an hour from the press, but by now widely scattered in all parts of the city. Under glaring headlines on the first page was the following:

GOLD SENT, IRON ARRIVES

Contents of $100,000 Box Mysteriously Change on Way to China.

SAN FRANCISCO, Dec. 4.—A box containing $100,000 in gold coin shipped by the Anglo and London-Paris National Bank of San Francisco on the liner Korea Maru was found to contain only iron when opened by the consignee in Hong Kong, according to advices received by the bank and steamship company today.

The box had been strongly guarded since it was first filled in the vaults of the San Francisco bank under the close inspection of several of the bank officials themselves. As the seals then applied were unbroken when it reached its destination, officials are at a loss to imagine how or where the exchange took place, and they frankly admit that so far they have found no clue that might lead to a solution of the mystery.

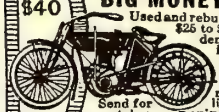


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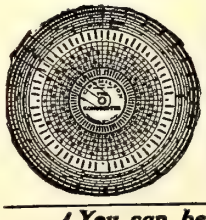


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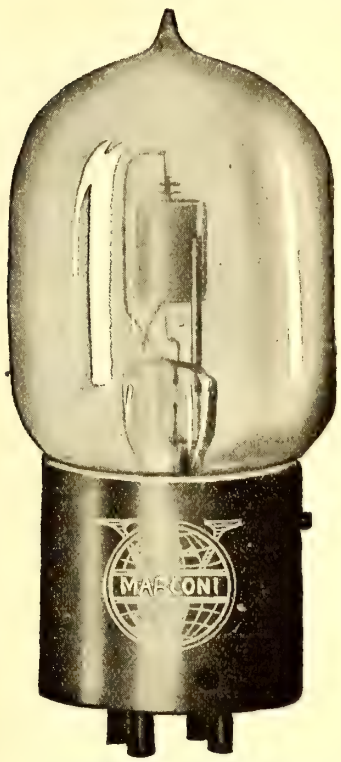


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A WARNING

to Manufacturers
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Purchasers
Users of

Vacuum Tubes

The Marconi V. T. Patent is Basic

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

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LIMITLESS FORCE IN ATOMS.

Some remarkable predictions are contained in a volume recently publisht by Frederick Soddy, who is Lee Professor of Physical Chemistry at Oxford, and famous for his research into the nature of elements and particularly into radium and its cognates, says the New York *Times*. He says:

"Discoveries in radioactivity have shown that in the smallest atoms of matter all around us there exist stores of energy a million times greater than any so far harnessed. Limitless physical power awaits humanity as soon as knowledge that shall lead to its control and application has been obtained. How many unrecorded ages elapsed before the energy of fuel was controlled, and in how short a space of subsequent time has it altered the whole mode of life of the world. Given a clear course, and that most rare of national qualities, common sense, physical science can abolish the struggle for existence so far as concerns food and fuel."

He holds, too, that the moon "cannot be really dead. It is, in the present state of physics, impossible to conceive of a physically dead world; that is to say, a world without any available source of energy."

Prof. Soddy has much to say of queer elements and strange atoms of alchemists' dreams of turning base metal into gold. There was nothing extravagant in them, he says. The elements can be transmuted into one another, or could be, if the atoms in them could be varied slightly. "To get gold from mercury," he says, "expel from the atom of mercury one betaparticle which will make thallium, then one alphaparticle which will turn thallium into gold, or to get gold from lead expel from one atom of lead one alphaparticle, which will turn into mercury and proceed as before."

AUTHORS, ATTENTION!!!

The editors wish to call the attention of authors of electrical, radio, and scientific articles, stories, descriptive writeups, et cetera, to the fact that owing to the increase in text space now available in the ELECTRICAL EXPERIMENTER, more articles can be used than ever before, AND AT GOOD RATES.

Sub-Sea Exploration

By JOSEPH H. KRAUS.

(*Continued from page* 984)

cles; propellers repaired; rudders and injection pipes cleaned and repaired without the necessity of shifting the cargo in order to tip the vessel up aft, so that the slight repair on the propeller or rudder could be made. Most every seaport has seen at some time or other an ocean going craft compelled to load down forward. Now at all times such work is under the direct supervision of the ship's officers and underwriting officials and no mistake as to its accuracy and the extent of damage or repair is possible. Note how easy it is to manage tools and handle them with practically the same ease and efficiency as they are handled anywhere on the surface or land. An air space is provided so that all tools, pneumatic and electrical, will function properly.

In Fig. 3 we see a method of reclaiming and recovering treasures from the bottom of the ocean. Vast treasures have lain there for ages, just beyond reach of all expert wrecking and diving methods heretofore used. All that is necessary is to go down there and reach for the treasure with hook or derrick. The operation is followed continuously by the aid of windows and in solid comfort. Here also, is a wonderful

(*Continued on page* 1076)

Radio Diagrams and Formulae in Loose Leaf Form

The publishers of the CONSOLIDATED RADIO CALL BOOK have completed the preparation of diagrams and instructions on:—

Measurement of Capacity of a Condenser. (Substitution Method.) Calibration of a Variable Condenser. Two Diagrams and Curve.....No. 1
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Measurement of Distributed Capacity of an Inductance. Diagram and Curve.....No. 3
Measurement of Fundamental Wavelength of an Antenna. Three Methods. Three Diagrams.....No. 4
Measurement of Wavelength of Distant Transmitting Station. Two Methods. Calibration of a Receiving Set. Two Diagrams....No. 5
Measurement of Effective Antenna Capacity. Two Methods. Two Diagrams.....No. 6
Measurement of Inductance of Antenna and a Third Method of Measuring Effective Capacity of Antenna. One Diagram.....No. 7
Measurement of Antenna Resistance. Substitution Method.....No. 8
Schematic Wiring Diagram of Regenerative Audion Receiving Set Suitable for Receiving High Power Undamped Wave Stations. Connections shown are those used in most Navy and Commercial Receivers.....No. 50
Table giving the value of LC (Product of Inductance and Capacity) for wavelengths from 300 to 20,000 meters. Inductance in Microhenrys.....No. 100
Table same as above but with Inductance in centimeters.....No. 101
Schematic Wiring Diagram of Signal Corps Type SCR-68 Radio Telephone Transmitting and Receiving Set.....No. 51
Schematic Wiring Diagram of Type CW-936 (Navy Submarine Chaser) Radio Telephone and Telegraph Transmitter and Receiver. No. 52
Schematic Diagram of Type S.E. 1100 (Navy Flying Boat) Radio Telephone and Telegraph Transmitter.....No. 53

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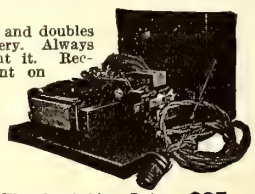
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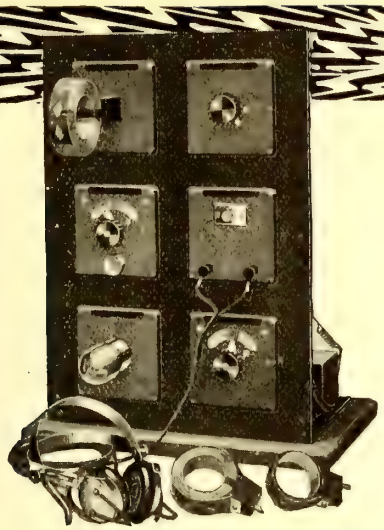
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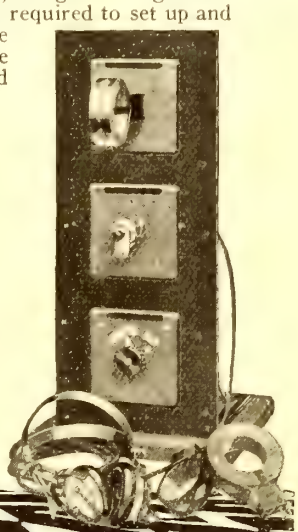
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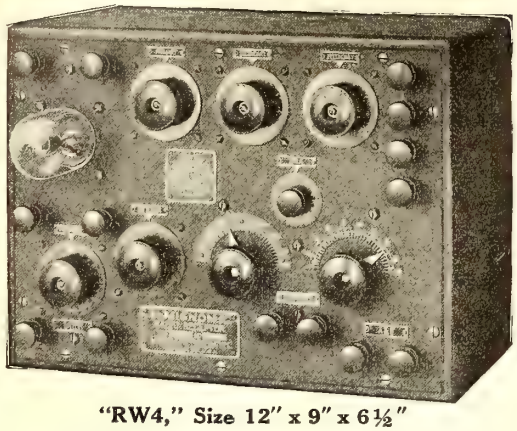
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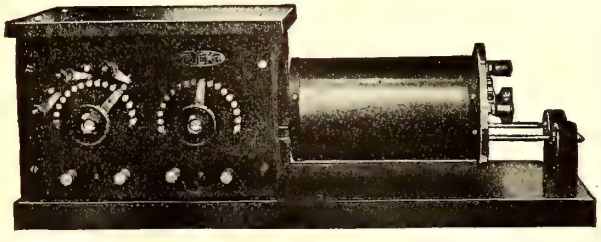
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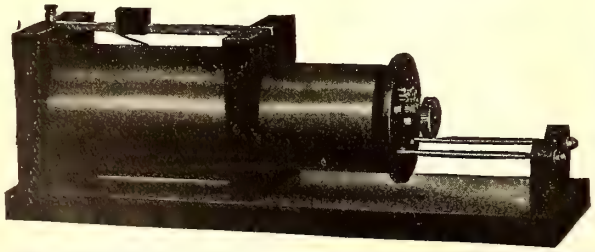
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Sub-Sea Exploration

(*Continued from page* 1074)

opportunity for the biologist, the scientist, the naturalist, the treasure hunter and explorer, and all others who wish to increase their knowledge of the vast underseas, a region three times as great as the land.

The order comes down from a high official to go to the base of a great bridge to make some repairs. Do we send for a diver? Indeed not. We take a little trip, not in a diving suit, but under ordinary atmospheric pressure, and when we come up, we are satisfied that we have seen and know exactly what the trouble is, know what to order, and—we can superintend any construction work right on the spot, (Fig. 4).

Scene 5, depicts the application of the apparatus for drilling and blasting rock under water. Why should we spend hundreds of thousands of dollars for blasting rocks and bolders and send divers down with expensive drilling instruments, when we can place any man experienced with the tools down the tube and let him work under atmospheric pressure. We can personally superintend the work and experts as well as other hardy workers can operate a tool or wield a hammer regardless of whether they are accustomed to heavy air pressure, or not. The flexibility of the entire tube construction prevents the operating chamber at the bottom from rocking even tho the surface waters are agitated by wave motion or passing vessels.

All cable repairs can be done without the necessity of grappling for the cable, pulling it up and attempting to repair it, even tho gales, thunder storms, and cold spells are holding sway; by simply underrunning them and repairing them right on the bottom. In fact, telephone and telegraph cables lying under water, can be inspected as frequently as found necessary. This method is clearly illustrated and the ease of operation demonstrated in Fig. 6.

Taking of under-sea photographs and motion pictures and its practical results shown in Fig. 7 has already been described and needs no further mention.

In Fig. 8, we see, sponge fishing and oyster fishing via the new method. Formerly, grappling irons were used to tear these sponges from their bases. These realms are now open to the practical man, taking him down to the hitherto unexplored areas and enabling him to obtain the more perfect, and valuable specimens, larger than can be obtained otherwise. Pearls, amber, corals, sea fish, and in fact all commodities upon which extreme prices are being laid, will offer their vast fields to the practical individual.

Gold mining, Fig. 9, is one of the industries over which men have fought and even killed each other in an attempt to procure the precious metal. Mountain streams carry down large quantities of the already washed material—why not get the gold there? The method here depicted enables the operator to sit on the bottom of a nice warm chamber, and proceed to wash some of the nuggets out of the gravel and sand. He works in practical comfort, and when he gets tired, can be replaced by his partner.

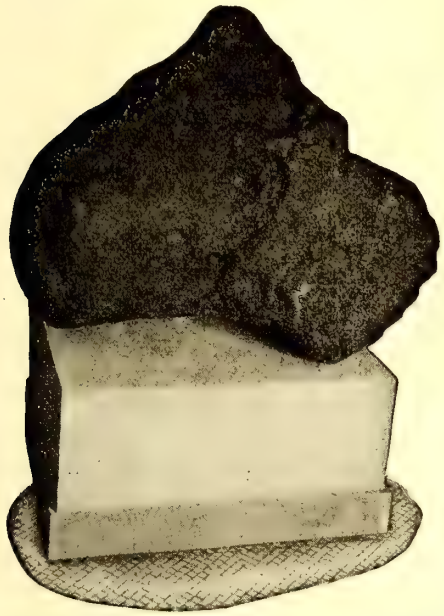
Captain Williamson's device promises many radical departures and attainments in all kinds of under-sea work. There is a dual project being proposed, under direct supervision of Captain Williamson, and it will be well for those whose interest lies in this particular kind of work, to keep their eyes on the columns of this magazine for an event which will undoubtedly startle those interested in subaqueous exploration, construction and salvage work.

Popular Astronomy
Meteorites

(*Continued from page* 1009)

microscopic examinations of meteorites have yielded any results that could be interpreted in favor of such a view.

Falls of meteorites are accompanied in nearly every instance by terrific explosions and sharp reports that can be heard for many miles around often causing the ground to shake as in an earthquake. The meteorite itself has been described as resembling a ball of fire or the headlight of a locomotive and is followed frequently by a trail of light or a cloud of smoke. At the time it enters our atmosphere a meteorite is moving with planetary velocity ranging from two to forty-five miles per second. Its interior is intensely cold, approaching in temperature the absolute zero of interplanetary space, and it is, therefore, far more brittle than it would be at ordinary temperatures. As it ploughs its way into the earth's atmosphere its surface temperature is soon raised by friction to at least 3000° or 4000° C. which is sufficient to fuse all surface materials into the characteristic black crust with which stony meteorites are coated.



"The Woman" Meteorite—in the American Museum of Natural History Collection, at New York City. Found at Cape York, Greenland.

Meteorites are usually first seen at an altitude of fifty or sixty miles. Altho they are moving with a velocity comparable to that of the planets, when they enter the earth's atmosphere, this velocity is so rapidly reduced by friction with the atmosphere that they usually drop to the surface of the earth with a velocity about equal to that of ordinary falling objects.

The flight of a meteorite often extends over a path several hundred miles in length and the meteorite may be seen by many observers in several different states and yet finally fall in some unknown spot and never be found.

The evidence gathered regarding the actual fall of meteorites is often contradictory. Some stones are too hot to handle for hours after they fall, others are merely warm, while still others have been picked up cool or even intensely cold. Meteorites have been seen to fall upon dried grass and upon straw without producing even charring effects. The evidence regarding the depths

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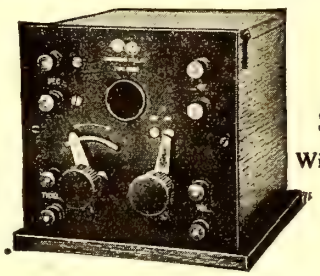
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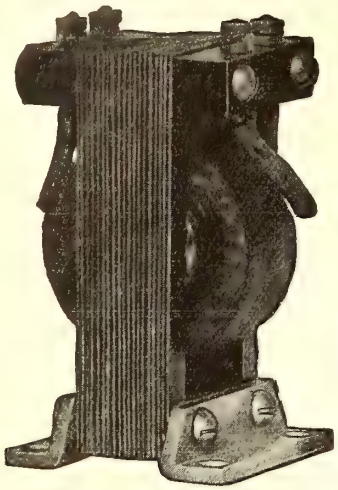
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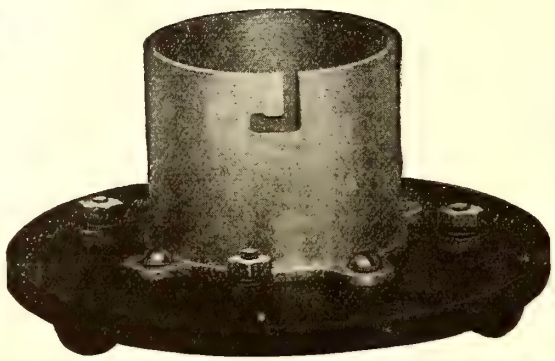
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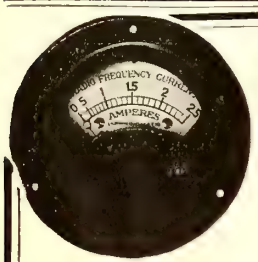
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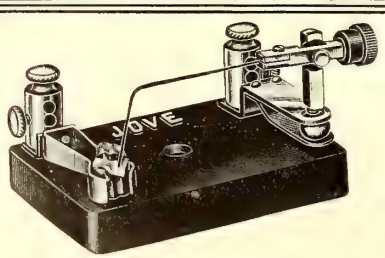
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to which meteorites penetrate the ground is quite as conflicting. The largest of all the stony meteorites which fell at Krnyahinya, Hungary, weighed 647 pounds and buried itself to a depth of eleven feet. Yet Peary's Cape York iron weighing 37½ tons was only partially covered and showed no signs of abrasions of surface resulting from the fall.

The Willamette iron meteorite weighing 16½ tons lay in a forest when found and was not deeply buried. The Bacubirito iron weighing 20 tons lay in soft soil barely beneath the level of the surface. On the other hand a fragment of a stony-iron metorite, weighing 437 pounds, that fell at Estherville, Iowa, buried itself eight feet in stiff clay.

There are no well-authenticated instances of any persons or animals being killed by falls of meteorites or of conflagrations being started by such means.

The Electrical Machinist

By H. WINFIELD SECOR.

(*Continued from page* 1023)

size is drilled thru the bar. This is then filed out with a small square file, until it just accommodates a piece of about ¼ inch self-hardening steel. This tool point is held rigidly in position by means of a steel set screw. This is usually a tempered steel or case-hardened screw. The cutting edge should be ground to a diamond point with plenty of clearance, as shown in Figs. 2-B and 2-C.

If the field casting is completed and does not have separate pole-pieces bolted into place within the polar ring, then this casting can be bolted or clamped on to the lathe carriage or else to the lathe bed itself in any suitable manner. The casting does not move cross-wise, but successive increase of "cut" of the boring tool are made by loosening the set screw and advancing the tool point slightly. The carriage can then be traversed while the tool is cutting and a cut first taken across and then back on the pole-faces. Don't forget to use plenty of oil on the tail-stock center and see that the *dog* used to drive the shaft firmly is properly tightened.

Where a casting of any appreciable size is to be machined in this fashion, a double tool boring bar shown at Fig. 2-C is preferred. This causes a balanced pressure in cutting and not only lowers the strain on the cutting tools and bar, but gives a much more even cut and finish to the work.

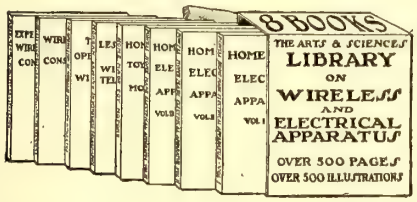
REVOLVING THE CASTINGS WHILE MACHINING.

In many cases, even with fairly large castings, the polar boring as well as the machining of the front and rear faces of the yoke and complete casting are accomplisht by clamping or bolting the casting to the face plate of the lathe. This is a very good method, indeed, and is practised in a great many electrical manufacturing and machine shops.

In this case the machining operations are all carried out by means of boring-out tools supported in the usual tool post on the lathe carriage. At Fig. 3 the operation of boring out the pole-faces of a two-pole motor casting is shown. As will be evident, the desired diameter of the polar bore is obtained by gradually increasing the cut with the boring-out tool, until a sufficient amount of iron shall have been removed. Before removing the casting, and while it is in this position on the face plate, it is the best practise to then machine off the yoke ring against which the bearing housings are to abutt. When this has been done you have a true face as a guide, and which is parallel with the finished polar bore axis, so that when you loosen the casting and reverse it on the

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face plate, it will then be in an exactly parallel position for tooling off the second yoke face. When this has been done, you will have the back and front yoke rings as well as the polar bore finished, and all of them parallel to one another.

MACHINING SEPARATE POLE-PIECES ON THE FACE PLATE.

Many dynamos and motors today are built with unit or independent pole-shoes and magnet cores, as shown at Fig. 4, and unless this has been accurately built up from steel punchings, as they are in some electrical machines, they will have to be accurately machined or turned on both front and rear to the proper diameter. It is usual to machine either a two, four or six pole magnet layout at the same time. They should be thoroly clampt to the face-plate by means of clamping bars placed over the pole-shoes and bolts are then past thru these to the back of the face plate, where they are held firmly in place by nuts and washers. When setting the several pole-pieces into position they should be accurately lined up first for their position on the angular displacement of the poles, i. e., 90° apart for a four pole field, 60° apart for a six pole field, etc.

The New Theory of Electrical Mass

By ROGERS D. RUSK, M.A.

(*Continued from page* 1014)

passed. For convenience the simple field only has been indicated and not the complete electric and magnetic field.

This deduction that energy itself in the form of electricity may have mass is quite in agreement with still other experiments in which it has been proved that energy in still other forms may exert a pressure and exhibit the property of mass. For instance, it has been proved *that light waves can exert a pressure,* and it has been shown that other forms of radiation possess inertia which is the distinctive property of mass. Perhaps we shall some time have to change the old definition we used to use that matter is anything that possesses inertia. *Perhaps, after all, mass is a property of energy and matter itself is only an expression of energy.* The question has not been finally settled, but we can speak with some assurance about the negative electron. Concerning the positive particle we have yet to hear. One thing more, however, is in favor of the electrical theory of mass, and that is that the positive nucleus of the atom, in which the most of the weight is concentrated, appears from mathematical considerations to be much smaller even than the electron. If this is true it could hardly consist of anything very material.

Experiments In Physics

By JOHN J. FURIA, A.M.

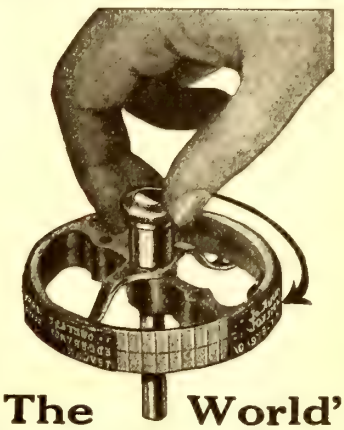
(*Continued from page* 1015)

as to correspond to the natural frequency of vibration of the bell. Shortly the heavy bell is set ringing. Mere random pulls would practically not disturb the bell at all. When an army crosses a bridge, the commanding officer gives the order to break step. The army in step would give to the bridge a series of impulses of definite timed frequency and the bridge would slowly be set in vibration. The vibration might very easily cause the bridge to collapse. When the wireless amateur wishes to hear his friend, he tunes his set, *i. e.,* varies his inductances and capacities so as to make his outfit have a natural frequency equal to that of the incoming signal.

(Next installment will appear in an early issue.)

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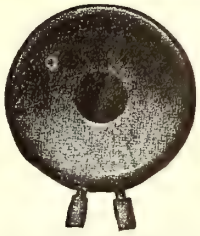
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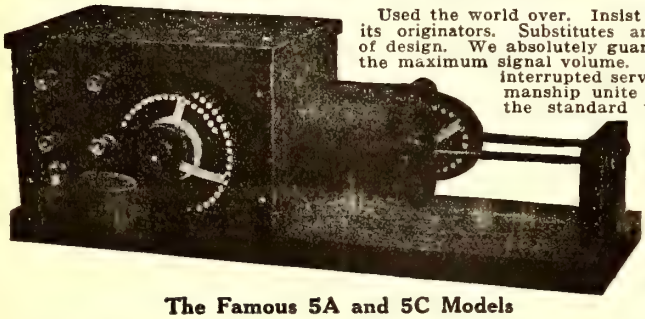
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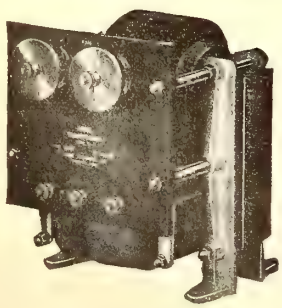
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The Versatile Audion

By H. WINFIELD SECOR

(*Continued from page* 1000)

audion amplifier and signals from far distant ship and shore radio stations which cannot even be heard with a crystal detector and telephones, become clearly audible and readable with the audion amplifier, when it is connected up to the receiving set.

It is interesting to recall that several years ago, when the first radio transmission was attempted between San Francisco and Honolulu, that the signals from Honolulu would die out as sunrise approached, and the dots and dashes which had been coming in very faint during the night, would fade away to zero and become absolutely inaudible even with the most sensitive detectors and high resistance telephones. Audion amplifiers were then tried in the receiving stations in San Francisco, and reception was maintained and kept up for several hours after sunrise, due to their marvelous detecting and amplifying properties. In other words, they actually "made something out of nothing," as the radio operators said. See Fig. 3.

AUDION ORGAN GIVES PUREST MUSIC.

Fig. 4 shows what we may call the "audion organ," and this was described in the December, 1915, *Electrical Experimenter,* together with a large illustration of the device as well as a diagram of the connections for producing pure musical notes or any number of notes with one or more bulbs. This device brings out one of the prominent characteristics of the audion, i. e., that once it has been set to oscillating under certain capacity and inductance circuit conditions, it will invariably maintain this condition for an indefinite period and, furthermore, the frequency of the oscillation or the rate at which the circuit vibrates will depend upon the capacity and inductance in the circuit connected to the audion.

Thus, by having a set of keys connected to various taps on the inductance coil, so that differing amounts of inductance can be interposed in the circuits, various tunes can be played even with a single bulb, and when more than one tune is to be played, or chords, a number of bulbs will have to be used as shown in the illustration. A very pure sweet note is produced by the audion in this fashion, a revelation even to the ear of the trained musician.

AUDION TELEPHONE AMPLIFIERS AND REPEATERS.

It is well known today that *Transcontinental Telephony* was made possible by the audion repeater and amplifier. It is conceivable that, had not the audion been invented and developed to the stage that it was a few years ago, when the first transcontinental telephone line was put into successful operation, that some other form of successful telephonic repeater and amplifier would have been invented, altho 20 years of experiment by telephone engineers had failed to produce such an amplifier; but one thing is certain,—it would surely have been a very difficult, and we might almost say unnecessary task, to endeavor to devise a more efficient and reliable telephone amplifier or repeater than the vacuum valve. Audions are placed at several points along the transcontinental telephone line, such as at Chicago, Denver, etc.

This telephone circuit is about 3,500 miles in length and one can pick up the receiver in New York and hear the voice on the Pacific Coast just as perfectly as if he had simply called up his suburban home 15 or 20 miles out of town. See Fig. 5.

MULTIPLEX TELEGRAPH AND TELEPHONE.

About a year ago the American Telephone and Telegraph Company demonstrated over a circuit between New York and Pittsburg, as well as on several other circuits, that it was successfully and accurately transmitting and receiving several telephone messages over a *single wire* at the same time, by utilizing audion generators of high-frequency currents, each frequency having a different value so as not to interfere with the others.

Major-General George O. Squier was the first to suggest the application of such currents to the multiplex telegraph and telephone system and took out patents on this system about ten years ago. The test conducted by the A. T. & T. Co. demonstrated conclusively that his "stunt" would certainly work.

At the present time the first cost of the necessary apparatus for producing the essential high-frequency currents prohibits it from being adopted, except over certain circuits, and particularly under military conditions, where this scheme is of undeniable and invaluable advantage, which may often have to be made use of. For example, imagine the advantage a military unit would possess when but one wire exists between two widely separated points and instead of sending but one telephone message or current over this wire, five or six could be sent over it simultaneously, while *telegraph* signals could also be exchanged over it while the *talking* is being carried on, without any interference.

Such is the work of the *multiplex telephone* backed by the Audion, where the audion generator is used for producing each frequency. A different frequency is used for each telephone message. See Fig. 6.

LOUD SPEAKING TELEPHONE.

In the old days, especially at the circus and theater we were accustomed to hear the voice amplified at times by means of a large megaphone, thru which a person endeavored to shout. But the voice was invariably muffled and did not sound as clear as the original by the time it reached you. Now, thanks to the audion amplifier, the human voice can be amplified until it is so loud that it will almost scare you to death, and always it is articulate and distinct.

Some months ago, while the Victory Liberty Loan was under way, there was installed a remarkably loud and powerful voice amplifier along Victory Way, on Park Avenue. Fig. 7 illustrates this installation, where the voice of the speaker was amplified until it was *equivalent to approximately* 100 *H. P. of energy.* In other words, you could speak with a "100 horsepower voice" if you happened to be one of the select few who addrest the thousands gathered along Victory Way during their daily exercises. In some cases the speaker was located in Washington; his voice was then transmitted telephonically over special leased wires to the audion laboratory on Victory Way and there amplified, whence the powerful intensified voice travelled along the wires above Victory Way to a series of loud-speaking telephones provided with large horns, and in this way thousands of people could hear the voice at the same time.

TELEPHONE MODULATOR FOR HIGH-FREQUENCY ALTERNATOR.

This application is illustrated in Fig. 8. The audion is often used as a telephone modulator, especially in connection with high-frequency alternators, or dynamos, rated at say 200 K.W. or 270 H.P. as in the installation at New Brunswick, N. J., where the Alexanderson alternator is making some very remarkable radio history. Here vacuum bulbs of the audion type, known as *Pliotrons,* used in connection with an ordinary microphone such as that



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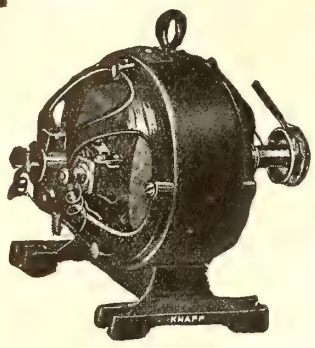
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Perhaps in no other single field are the advantages of the vacuum bulb transmitter and receiver more apparent than in aviation. The usual radio transmitting set had several disadvantages for aircraft radio where the open spark gap is used, which present a serious fire hazard, and also the ordinary crystal detector receiving set was almost worthless on board the airplane, for there was such a tremendous amount of noise present from the airplane engine that unless the signals received were exceedingly strong, they could not be heard by the pilot or radio officer.

Fig. 9 illustrates the applications of aircraft radio and shows how communication can be successfully and efficiently carried on from a shore station to balloons and airplanes, and also between two or more airplanes of a flying squadron or again as well as between airplanes and balloons. Radiotelephonic communication can be carried on both ways, without any fire hazard and with a minimum amount of power, thanks to the audion.

TRANSATLANTIC RADIO TELEPHONE.

Brief reference was made previously to the fact that several years ago the first trans-oceanic radiotelephonic messages were successfully transmitted and received, thanks to the audion, several hundred of which were connected on parallel, so as to form a veritable power plant at Arlington, Va. See Fig. 10.

There are several interesting developments now going on in this direction, which will undoubtedly bear fruit shortly. One of these lies in the development of large specially cooled high-power bulbs for generating radio or high-frequency energy, when high-voltage D.C. energy is applied to the plate and other members of the bulb. One of the principal advantages of audion transmitting sets, even in high-power units, lies in the fact that an ordinary microphone only is required to modulate or perfectly control the total output which may amount to 50 to 200 kilowatts.

THE AUDION DETECTOPHONE.

One could write an entire paper on the subject of the audion detectophone alone, if he was to even describe the applications of this most valuable instrument during the recent World War.

Telephone and telegraph messages were in some instances intercepted one mile back of the lines by a sensitive microphone, and these signals then amplified by a six, eight, or ten-stage audion amplifier, until they were clearly audible and readable by our intelligence officers.

Radio signals were in some cases picked up from far distant enemy stations, which altho in some cases of small size were of extreme strategic importance. See Fig. 11. Just to show how sensitive some of these measurements had become under the pressure of war, it may be mentioned that with a 10-stage audion amplifier in one of the college laboratories in New York City, radio signals were received with such powerful intensity, from the Nauen station in Germany, that they could be received on a loop-antenna six feet square, located in the basement and directional readings taken on this station, nearly 4,000 miles away, to within a fraction of a degree.

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The English radio experts developed a 19-stage audion amplifier, with which it became possible to hear buzzer signals being transmitted between German warships over 100 miles away; and the beauty of this marvelous amplification work is that there is practically no distortion or attenuation of the current or signals, whether they be telegraphic or telephonic.

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AN AUDION CLOCK OR CHRONOMETER.

As an illustration of a newly devised "audion clock," consider the system of Fig. 12-A which shows how a three-electrode tube may be used to maintain undamped oscillations of a pendulum.* Two sets of magnet coils are respectively inserted in the grid and plate circuits of the tube as indicated and placed in front of a small iron armature which is integral with the pendulum. As the pendulum is swung out of position, it oscillates back and forth, moving one end of the armature alternately toward and away from the grid coil. This induces an alternating potential between the grid and filament of the tube, which in turn varies the current in the plate circuit and plate coil. There results a correspondingly varying attraction of the coil on the opposite end of the armature which, for suitable magnitude of the currents and proper polarity of the connections has such a phase relation with respect to the oscillation cycle of the pendulum as to sustain its motion continuously. The energy expenditure from the plate battery is thus seen to compensate for the friction losses, which in the absence of the vacuum tube device would damp out the oscillations of the pendulum or bring it to rest.

A SYNCHRONOUS AUDION MOTOR.

A somewhat different case is that of Fig. 12-B which, however, is merely a different application of the same fundamental principle. The grid and plate coils are wound over iron cores having a gap in which is placed an iron disc which is free to rotate around the central axis. This disc is provided with a number of teeth. When set in motion, the teeth and slots of the disc alternately pass the iron core yoke of the grid coils, inducing an alternating grid E. M. F. which in turn synchronously varies the current in the plate coils. The attraction of the latter on the rotor teeth thus varies synchronously with the motion of the angular position of the two sets of coils around the disc and the proper polarity of the connections; these variations will occur at such times that the rotor is kept in continuous motion.

*See "Radio Engineering Principles," by Lauer and Brown, 1920. Pages 293-295.

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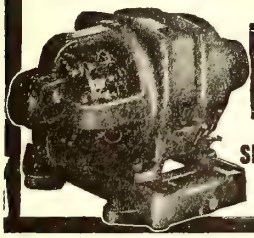
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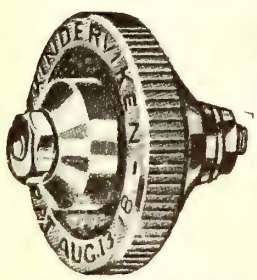
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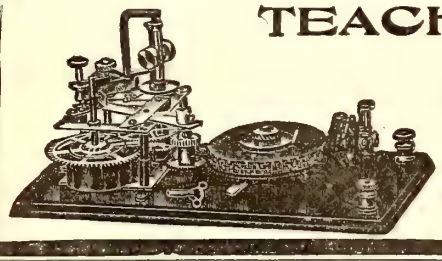
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By PIERRE H. BOUCHERON, Ensign, U.S.N.R.F.

(*Continued from page* 1028)

perhaps interesting to note that regenerative amplification differs from "cascade" amplification (see Fig. 10) in that the original grid potential is not past on to the grid circuit of a second or third tube, but is actually transferred to the grid circuit of the initial tube, where it again passes thru to the plate circuit, but this time greatly amplified owing to the inherent amplifying properties of the VT, thereby causing a much greater response in the telephones. All parts of Circuit No. 6 are essentially the same as any detector circuit with the addition of the coupling L1 and L2, sometimes termed the "feed back" or "tickler." This coupler may easily be constructed by winding a number of turns of No. 22 or 24 insulated copper wire on card-board tubes three or four inches in diameter, and by so arranging them that the degree of their coupling may be varied at will. With this circuit it is possible to receive either *damped* or *undamped* signals; the first by loosening the coupling to such a point that no oscillations will be set up in the secondary coil (L1); the second, by increasing the coupling to the point where sustained oscillations are set up in the secondary circuit. In the latter case, a musical note of any desired pitch will be heard in the telephones depending upon the degree of *de-tuning.*

NO. 7—COMBINATION "VT" AND CRYSTAL AMPLIFIER.

If the experimenter possesses but one VT and yet wishes to experiment in *damped wave amplification,* circuit No. 7 may be employed with considerable success. The VT circuit is the same as circuit No. 4, with the exception that in the place of the telephones is inserted the primary of the coupling transformer C. T., the secondary of which is connected to the crystal and telephones in the manner shown. The condenser shown in the detector circuit may be shunted directly across the telephones and in its present place a variable condenser substituted enabling this oscillating circuit to be tuned to the frequency of the incoming waves. The ground variable condenser G. V. C. is optional and is not absolutely essential in this case. The transformer referred to is one specially designed for radio frequencies. If this is not obtainable, use may be made of a grafite rod of a half megohm or so. A signal amplification of 100 times or more may be obtained with this hook-up.

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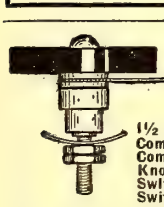
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Broadly speaking, damped signals (spark) range from 200 to 5,000 meters, while undamped signals (arc or alternator) may range from 5,000 to 20,000 meters, tho, of course, there are some few exceptions to this. Sufficient antenna and tickler inductance must therefore be chosen to meet the desired wavelengths.

NO. 9—NAVY TYPE TWO-STAGE AMPLIFIER.

This circuit is quite within the province of the up-to-date amateur and can be constructed in compact form similar to the amplifiers used by the Army and Navy which are enclosed in convenient and portable cabinets. It will be noted that the two *audio frequency* transformers T1 and T2 are arranged so that their inductance will be at right angles to each other *in order to eliminate any possible mutual relation* which would cause undesirable operating conditions. The make-up of each of these *air core* amplifying transformers usually consists of 8 sections, the inside diameter of which is about 2 inches and the outside diameter about 2¾ inches. There should be six secondary sections, each one wound with 6,000 feet of No. 40 enameled copper wire and all connected in series, and there should be two primary sections, each one wound with 3,000 feet of No. 40 enameled wire, also connected in series. The primary and secondary sections should be arranged on an insulated air core about 2½ inches long, side by side, in the following sequence: Two sections of SECONDARY, one section of PRIMARY, two sections of SECONDARY, one section of PRIMARY and again two sections of SECONDARY. It is more convenient, however, to purchase these outright. *Radio frequency* transformers may be employed instead. Both types sometimes have a laminated *soft iron core*. Experimenters should bear in mind that there are two general methods of amplification, both of which are used extensively; i. e., radio frequency amplification (above 10,000 cycles) and audio frequency amplification (below 10,000 cycles). In circuit No. 9, the usual receiver and detector system, not shown in cut, is connected from the point where the telephones would ordinarily be placed, to the two connections marked "Input". The common "A" and the common "B" batteries furnish the necessary current for the filaments and for the plates of the two tubes, respectively, and altho the plate voltage in this case is shown to be 20 to 40 volts, experimenting will decide the voltage best adapted to the individual tube. The telephones are fitted with a plug which in turn may be plugged in any one of the telephone jacks marked "Detector," "Step 1," and "Step 2" as desired.

NO. 10—AMATEUR CASCADE AMPLIFIER CIRCUIT (DAMPED WAVES).

It necessitates three tubes, but as will be noted from circuit diagram, it employs only one common "A" and one common "B" battery, which is in itself a great economy. The "A" battery should be either 4 or 6 volts, according to what the particular tubes require and should be of the storage battery type, altho dry cells may be used instead for short intervals. The "B" battery should be from 40 to 80 volts, the proper voltage also depending on the type bulb used. Most tubes are sold with instructions giving the necessary data. Variable condensers V.C. are of standard .005 mfd capacity. The three leak resistances R1, R2, R3, as well as the coupling resistance R4, are grafite rods of two megohms each, and can be purchased at any grafite or radio supply house. The "choke" shown in the circuit can be made by winding 10,000 turns or so of No. 36 enameled copper wire on a metal core made up of small iron wires ⅝ of an inch in diameter and about 3 inches in length. The grid condenser G.C., of course, is the standard fixt type, .0001 mfd capacity, while the coupling condensers C1 and C2 are prefer-

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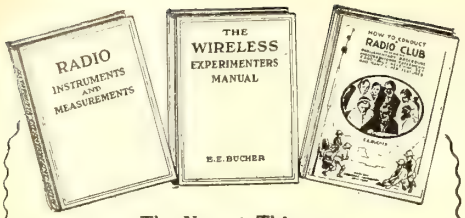
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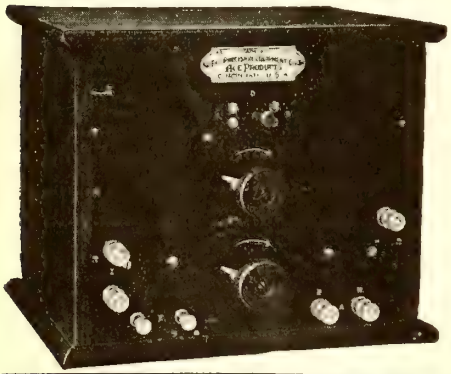
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ably .005 mfd each, either fixt or variable. tho the first is the least expensive. The head telephones P should have a combined series resistance of 3,000 ohms. All connections to and from the various instruments should be as short as possible, well insulated and devoid of surrounding undesirable induction. Run all wires at right angles to avoid "howling" effects.

Experiment with this circuit. Try lead pencil line grid leaks of different sizes. Increase or decrease the potential of the "A" and "B" batteries.

NO. 11—VT TELEGRAPH TRANSMITTING CIRCUIT.

There are many complicated circuits capable of undamped wave generation, but one of the most simple ones is shown here. Briefly speaking, all that is required to produce undamped waves suitable for transmission, is that it is necessary to couple the plate and grid circuits of the VT to a common oscillatory circuit (in this case, the antenna circuit), and in such a manner that the resulting grid-to-plate coupling will be of negative potential. In this circuit, L2 and L3 are variable in their coupling of the common oscillatory circuit L1. The antenna circuit, however, must have a natural wave length at least equal to that of the oscillations produced by the VT.

This circuit will not be effective if the antenna has too large a radiating capacity and therefore experiments of this nature must be carried out on small antennæ of 200 meters or less, and for very short distances of less than a mile. Better results can be secured by using a regular transmitting tube capable of operating at high plate potential such as 400 or 500 volts. Several receiving VT's may also be connected in parallel, but the plate voltage must be confined to a potential not greatly exceeding 100 volts, otherwise undesirable "blue glow" of the bulbs will result.

No. 12—A VT RADIOPHONE TRANSMITTING CIRCUIT.

This circuit, known as the direct current modulation control, does not involve complicated apparatus and has been used successfully by up-to-date amateurs over considerable distances, when using three or more tubes in parallel instead of one as shown here. The principle of this method is to impress upon the grid G, a constantly changing potential by speaking in the telephone transmitter T, which in turn changes the internal plate resistance of the tube. Thus the plate current is transformed into high frequency oscillations, which in turn are modulated by the characteristics of the voice.

The following explains the various parts of the circuit: T is an ordinary telephone transmitter; C is a 4-volt battery; T.T. is a small telephone transformer; K is an iron wire core "choke" of large inductance, but small ohmic resistance; B is the high potential plate battery; A is the low potential filament battery; R is a grid leak resistance of 1 or 2 megohms; G.C. is a grid condenser; L the variable antenna inductance and V.C. the aerial-ground variable condenser which couples the plate to the system.

In the various receiving circuit diagrams shown in various publications there seems to have been no set rule concerning the "A" and "B" battery polarity connections, and this fact often perplexes some experimenters. In this connection, prolonged tests by experts has establisht the fact that there is no great difference in the manner in which the negative side of the high potential "B" battery is connected to either the negative or positive side of the filament current "A" battery. For the purpose of simplicity most government diagrams prefer a connection from the negative side of the "B" battery to the negative side of the "A" battery, while many De Forest circuits show a negative to positive connection. Try both ways.

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Reversible Airplane Propellers

(*Continued from page* 1002)

the horsepower, design of the wing and speed of the plane. Therefore, it must include the gliding factor of any plane however designed. For instance, if a plane has a high gliding factor, a reversible propeller may show good results. On the contrary, if the gliding factor of a plane is low, a reversible propeller would be positively dangerous because a plane with a low gliding factor, if it was stopt down to a speed which would still further lower its gliding factor, the result would be unquestionably a serious crash, endangering, if not causing, the end of the pilot's life. From a practical point of view, the propeller could best be used immediately upon the plane touching its landing place, but hardly before.

When a plane leaves the ground a low-pitch propeller could quickly make it rise from its position. If, then, the propeller could be used for the purpose of increasing its pitch, it would gradually gather speed and quickly reach a reasonably high "ceiling." After a ceiling has been reached which showed the maximum altitude of the plane with the propeller at a certain pitch, if this propeller could be increased in pitch the plane would make further progress in altitude and results would indicate such procedure as being both practical and successful.

It is difficult, of course, to give an intelligent opinion on the subject of reversible propellers such as used at McCook Field, Dayton, Ohio, unless the full facts were well known. These facts, of course, are more or less not in evidence from the description of this device given in the daily press.

The principle involved, of course, is interesting and may be practically operable. If so, we have made quite a decided advance in aeronautics, and I sincerely hope that this principle has been practically worked out and will continue to improve in value.

Tokio has about 45,000 telephones and 60,000 persons are said to be seeking the service.

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Hitting Invisible Targets

(*Continued from page* 1003)

at least two methods of nullifying the effect of any counter attack shell-fire from the enemy battle-fleet, so far as this advanced ship is concerned, and these are to wit: First the scout ship may be a very fast vessel, perhaps on the order of Doctor Alexander Graham Bell's new sea-going speed ship which can make 70 miles an hour and better, and which, when properly camouflaged, would present a very difficult target to hit. Secondly,—and if the attacking fleet is one of Uncle Sam's or one of a British fleet, let us say, we can take a chance of being mist by the inferior gunfire of the enemy. And then we have smoke barrages to hide the ship, etc., etc.

The seaplane of course provided a very excellent scout for any such battle maneuver as this and while it has practically nothing to fear from anti-aircraft guns at such a distance as would probably intervene, it still has one worry,—counter-attack by an enemy airplane which might engage it in aerial combat. Thus, we see that so far we have discovered two ways in which to



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fire at an enemy target with accuracy, at least after firing a few ranging shots at the start of the engagement, i.e., by using a fast scout ship or else a seaplane. A third scheme, which is used by land batteries, such as coast defense guns and fortifications, for firing at an invisible target, such as a war vessel beyond the horizon, is to have the water between the battery and the fort laid off in squares and to plot these squares accurately on special maps. With this arrangement, the guns of the battery can be trained to drop shells in any square desired, even those out of sight, the gunner never seeing the target in any case, but firing literally and figuratively, solely by mathematics, into the blue sky.

The position of the enemy vessel in a certain numbered square is all the information that is required, and there are several ways in which this information may be obtained today. They might get this information from fast scout vessels, such as torpedo boat destroyers or submarine chasers, lying just out of sight of the approaching enemy war vessels, but over the horizon, and whose information would be radioed to the fort.

Another way would be to spot the locations of the enemy vessels either from an air or seaplane or observing balloon, flying over the fort, while still another manner of ascertaining this valuable information would be to employ one of the newly devised under-water sound listening methods, which were very highly perfected during the war for locating the direction in which the ship lies, by the sound given off thru the water by its propellers, and as a further afterthought would it not be possible, at least in an emergency, to use the airwave sound ranging device described in Colonel Trowbridge's article, which appeared in the December issue, in the event of course, that the enemy had opened fire on some outlying vessels or other fortifications, so that the gun bursts could be accurately timed and located. It should not be forgotten also that the sound-ranging methods used by the A. E. F. in France, with such great success, could be used in this case for locating the position of the "bursts" of the friendly shellfire so that if the exact position of the enemy target was known to the battery commander, he could locate by *sound-ranging*, the exact distance to the right or left, as to where the shell were bursting in the vicinity of the target.

Radio Telephony and the Airplane

By WILLIAM C. MUNDT

(*Continued from page* 1030)

this type was used only on receiving planes. The directional effect would have been the same even with 200-foot trailers and the capacity has been taken care of in the double-W of the antenna, which was seven-stranded No. 20 antenna wire, while the trailers are of single stranded bare copper.

Whenever a plane landed it was the duty of the "Line Radio Mechanic," who carried a reel of No. 20 wire, to at once wind up the trailers on the lower wing, thereby checking the length of the antenna. Fourteen turns was the necessary amount for the trailing type and three and a half turns for the "double-W" type. If there was less he at once added enough to make up the loss.

When the planes were ready to take off, the trailers were unwound and laid out on the ground. A condenser of 2 microfarads was placed in series with antenna leads in the transmitting ship to prevent a short circuit thru the set, should the trailing wires touch any part of the plane while

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in flight or if the wires were on the ground while testing plane motor and switch on Radio Set was on "Transmit." The capacity of the above condenser was made large so it would not appreciably affect the wavelength of the antenna.

The fan-driven generator used on transmitting ships of course increased the head-resistance. However, actual tests of climbing made with an American Curtiss plane, with and without generators, showed the climbing speed to be reduced only about 8 per cent by the addition of the generator.

The types of Radio-Telephone equipment used by "formation squadrons" was naturally of short wavelength, as a larger wavelength was not necessary for the purposes then needed.

The Navy to-day has available a large type Radiophone which has communicated over distances better than 150 miles.

Much has been said in regard to eliminating the fan-driven generator and having the power given directly from the motor. This is possible, but would it be any more advantageous? A finer degree of power regulation would be necessary and also some method of furnishing power when the motor was shut off. It is, however, a good problem for the Radio Engineer to work on and one that would bring him everlasting fame should he devise a good practical solution to the problem.

In conclusion will state I have endeavored to show the different steps used before arriving at what was last considered the best airplane antenna for Radio-Telephone Inter-Plane Communication. The adoption of other types will most assuredly take place as the requirements are brought out.

Getting Together on the Antenna

By E. T. JONES

(*Continued from page* 1033)

was strung from a stub which was left by the said vile storm, only 20 feet high; the wire was run down to a fence post 6 feet high. I came to the conclusion that this antenna (before testing it out) would be just the thing for long distance Amateurs' work, which was the rage at that time, so I started in one night with a small panel type receiving set constructed by myself (the same receiver used with the large antenna), and was surprised to note that I could not hear any Amateurs, due to the fact,—as I came to the conclusion afterwards,—that the long lengths of wire insulated from each other along their entire length (being connected only at each end), produced a considerable amount of capacity, which made its natural period too large for the reception of Amateurs, other than local ones with considerable power (forced oscillations).

That night, however, "the cat was let out of the bag" when on approximately the same tune as was used in connection with the larger antenna, I picked up Swan Island with a signal strength of 60 (audibility). The slight increase in signal strength may have been caused by the change in weather from November, 1916, to December, 1916, but it is pleasing to say that even the same strength of signal with the exceedingly lower and shorter antenna was a surprise.

It is easy to recognize the importance of using such an antenna in view of the fact that lower antennas do not pick up as much static and that the expense of erecting high receiving antennas is eliminated that this type of antenna should be adopted universally by ALL. Of course a longer length of the same stranded wire could be expected to furnish better results.

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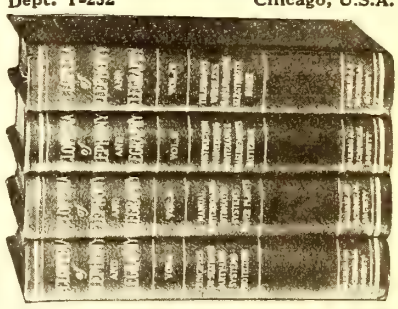
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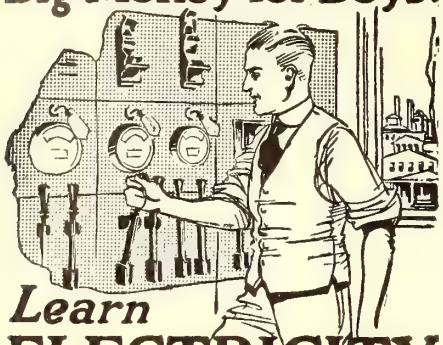
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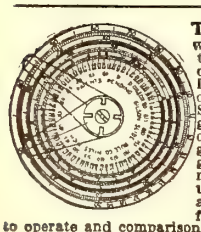
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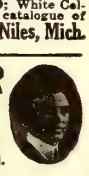
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The Fessenden Oscillator

By E. T. JONES

(*Continued from page* 1020)

clamping it to the steel with the field rings, leaving an air gap between, and completing the magnetic circuit of the field.

The oscillating system has a copper tube supported in the air gap between the core and the field without touching either. The supports for the copper tubes are two steel discs, rigidly clamped to a shaft passing through a clearance hole in the center of the core. One end of this shaft is firmly secured to a large steel diafram, whose outer edge is bolted to the front steel ring of the field.

An internal air pressure of 25 pounds is maintained in the oscillator. The oscillator should be placed at least 15 feet below the water line. Best results are obtained when the generator frequency is equal to the natural period of the vibration of the diafram. The velocity of sound thru water is 4,750 feet per second, thru air 1,120 feet per second, both at ordinary temperature, or 70° Fah. Velocity thru water varies with temperature (slightly). The diafram of the oscillator vibrates approximately .01 inch when transmitting.

Ocean Beach Set (Description): One motor-generator, 500 cycles A.C. 200 volts for the oscillator armature windings. Both, while sending a constant current of 7½ amperes was maintained in the field of the oscillator (D.C.). When transmitting a 500 cycle note, a current of 11 amperes was sent thru the armature winding of the oscillator. Storage batteries yielded the D.C. supply for the field. The oscillator itself is supported on a steel tripod about one mile from the station and is connected with a submarine cable. For receiving, a pair of 75 ohm receivers is used. The amplifier is being used with exceptionally good results.

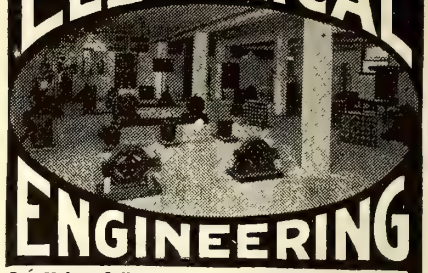
THE OSCILLATOR WILL EITHER TRANSMIT OR RECEIVE SOUND WAVES IN THE WATER. *Transmitting:* The field coil is energized by direct current, thereby creating a magnetic field in the air gap at right angles to the surface of the copper tube. When an alternating current passes thru the core winding, currents of electricity are generated by induction in the copper tube. These alternating currents in the tube, together with the magnetic field, produce great forces and cause the tube to move back and forth at the frequency of the alternating current. The motion of the tube is transmitted by the discs to the diafram and to the water in contact with it. The frequency used is approximately 540 cycles per second.

Receiving: The field coils are energized as in sending, and the core winding is connected to the receivers. When incoming sound waves actuate the diafram, motion is imparted to the copper tube. The movement of the copper tube at right angles to the magnetic field produces currents in it, which in turn induce currents in the core winding. The currents in the telephone receivers connected to the core winding produce sounds of the same periodicity as those vibrating the diafram of the oscillator at the distant transmitting station.

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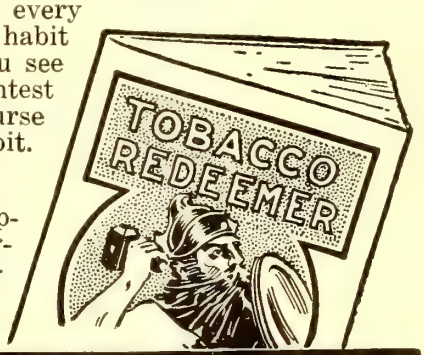
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(*Continued on page* 1094)

(*Continued from page* 1093)

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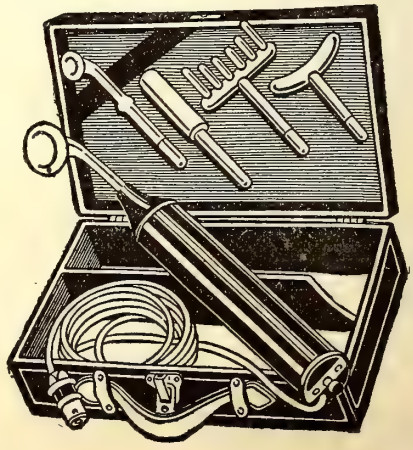
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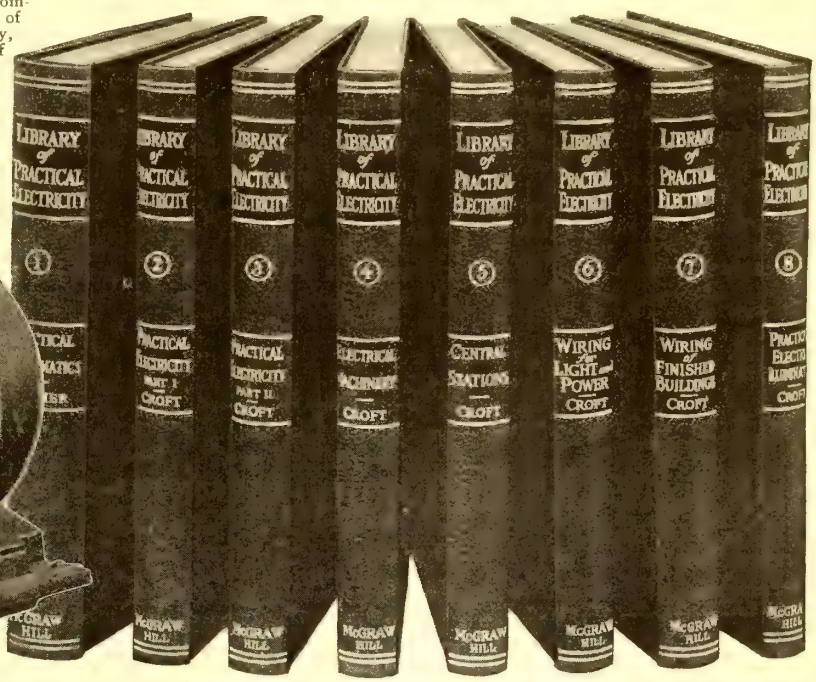
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EDITORIAL

The Moon Rocket

IN our February issue we discust the Goddard Moon Rocket minutely, presenting the entire problem as laid down by the inventor. Right here it should again be pointed out, as already mentioned in the original account, that Dr. Goddard *did not* primarily invent his rocket to travel from the earth to the moon. This was only a secondary consideration.

Once a rocket has gone up for 400 or 500 miles into the atmosphere, it would be impossible to prove by any means that it had actually reached this great heighth. A minute's reflection will show that no barograph or other recording instrument would be of any value because at this heighth there is no air.

While we know that the temperature in free space is —459° Fahrenheit, we could of course employ some sort of a recording instrument which would show that the rocket had actually past into free space. This could be verified if the temperature recorded was —459°. However, the trouble is that the rocket could go on for a thousand miles higher and still the temperature would remain just exactly the same, viz. —459°.

Dr. Goddard conceived the idea to make the rocket big enough so that it would actually propel itself on to the dark side of the moon and there explode a magnesium flash charge; the proof of its landing upon the moon would be conclusive if our astronomers actually saw the flash upon the dark side of the moon.

Theoretically the scheme of firing a rocket to the moon is feasible; practically, we are much afraid it is not. We do not deny the possibility of building an enormous gun *à la* Jules Verne and fire a projectile which could reach the moon. It would only be a consideration of making the gun large enough and using enough high explosive. If the gun were trained at the correct point in the heavens, there is little doubt that such a missile would, after some hours flight, alight on the moon. But in the case of a rocket this becomes a vastly different problem.

In the first place, it should be borne in mind that at the time when a rocket or even a shell is fired, it is of course not fired at the moon at all. The reason is that it takes many hours or even days for the projectile to land upon our satellite. For that reason when we fire the gun or the rocket, it becomes evident that it is fired direct into space with no moon anywhere in sight. In other words, the gun is trained on a certain point in space, accurately calculated by astronomers, the calculation being such that we will know the length of time it will take the projectile to traverse the space between the earth and the moon. The latter during this period will have moved to the point where it will intercept the flight of the projectile. As to the Goddard Rocket, it has been calculated that it would take about 100 hours to traverse this space of 220,000 miles.

Granted that we had fired the Rocket on a very calm day when there was no breath of air stirring, so as not to deviate the path of the rocket even an inch (and this condition alone is almost impossible), we now come to the next consideration. A rocket which propels itself in a vacuum will not move in an absolute straight line. The reason is that the explosions acting upon the body of the rocket will not project the rocket *exactly along its axis.*

It should be remembered that it has to traverse 220,000 miles to hit an object 2,164 miles in diameter. Consequently, it can be readily seen that a deflection of a small fraction of an inch to either side at the start would prevent the rocket from making a successful landing upon the moon.

Even if meteorites never actually hit the rocket, many, however, would certainly come near enough to the rocket to draw it slightly out of its path, due to gravitational attraction.

If a rocket is ever used, it would be necessary to have it carry with it some human beings, who could correct these influences along the way.

H. GERNSBACK.

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By J. A. Mauborgne, Lieut.-Col., Signal Corps, U. S. A.
TWENTY-FIVE DOLLARS FOR A POEM.....1157

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What Is a Master Key?

A key which will unlock any one of a series of locks.

What Is the Master Key System?

A System of Philosophy which will assist in the solution of any problem.

What Is Philosophy?

Knowledge, in a scientific system, of the ultimate principles, elements, causes and laws that underlie and explain all knowledge and existence.

What Is a System?

An orderly arrangement and combination of knowledge according to some rational principle or organic idea, giving it unity and completeness.

What Is Science?

Knowledge gained and verified by exact observation and correct thinking. The Master Key System is therefore "Knowledge of the ultimate principles, elements, causes and laws that underlie and explain all knowledge and existence, arranged according to some rational principle or organic idea, giving it unity and completeness, and verified by exact observation and correct thinking."

Of what value is a system of this kind?

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Why is this so?

Because it explains the principles, causes and laws by which conditions are created.

Do you mean that the individual may consciously change apparently fixed conditions and environment in his life?

Most assuredly; there is not the slightest doubt concerning this. It is being accomplished every day by thousands who are coming into an understanding of the creative principle of the Universe.

Is this Creative Principle subject to the control of the individual?

No. All natural laws are definite, fixed, eternal. They never change. The individual may, however, come into an understanding of these laws and make use of them to his advantage exactly as he makes use of the laws governing electricity, gravitation or any other Natural law. He does not change them, but he operates in harmony with them, and thereby secures the result which he desires and anticipates.

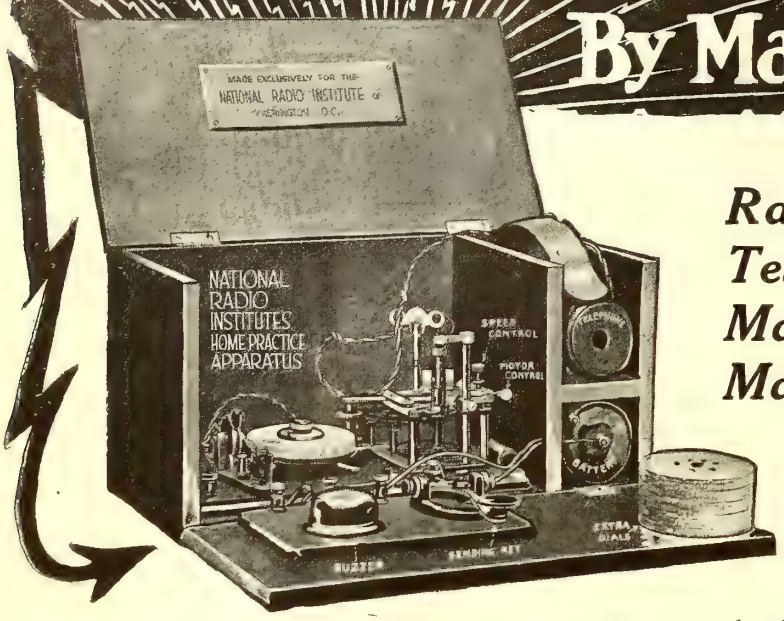
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How I Improved My Memory in a Half Hour

And Performed A Remarkable Memory Feat That Same Evening

The True Experience of RALPH GORDON, Cartoonist and Writer

THIS is my story. Out of the ordinary? Amazing? Emphatically so—but absolutely true.

I put off sending for the Roth Memory Course until I could not resist the temptation any longer. My deep conviction after reading the publishers' announcements told me that here was something I could not afford to miss. And how *literally* true that was you will understand when I tell you this almost unbelievable, but to me perfectly simple and natural, personal experience.

On October 16, 1919, I brought home with me the Roth Memory Course. I still pinch myself to see if all the wonderful results obtained that first evening are really true.

I had always been discouraged at my poor memory. In some respects it was remarkably good and stood me in good stead in my business of cartooning; but in many other respects it was shockingly feeble—and caused me constant embarrassment, self-reproach, and vexation.

Well, this is what happened—when I made the glorious discovery that set me right.

On that memorable evening I had an engagement at a Masonic banquet of the Doric Lodge in Toronto, where I was scheduled to do one of my cartoon sketching acts.

My appearance at the banquet was scheduled for 10 o'clock. I also had to meet a man at 8 o'clock, from which appointment I return home at 8:30.

With a half-hour to spare, I opened my Roth Memory Course just received that day. And, presto! I was deep in it—from the first crisp introduction to the absorbing pages that followed.

I read only 24 pages. Please mark, I *read* them only—didn't give them any study—for there was no time for that.

But in this quick reading, I fixed in my mind Mr. Roth's first 50 code words, and 20 words of my own selection without the slightest mental effort. It was impossible to "stick" me. I could repeat them any way I was asked.

Then I went to the banquet. While I was awaiting my turn on the program, I conceived the wild idea of putting on a memory demonstration after my cartooning act. It scared me, but I went through with it.

I asked one of the guests to call off 20 words, which I immediately repeated forward and backward without a mistake.

A second list of 20 words I handled just as easily, making in all 110 words I had memorized.

Mind you, all this with only a half-hour's reading of Mr. Roth's course—and no chance for study!

After the banquet I gave the list again, without a single error except the careless transposition of two words—not a mistake of memory.

It was 12:30 o'clock before my amazed and fascinated friends would let me go.

I went to the home of one of the officers of the Lodge the following evening and continued the test still further. The next surprise came when, upon arriving at my friend's home, I wrote down, without a moment's hesitation, all the words that had been given me at the banquet, and called them off in precisely the order given.

He was astounded, but I was more than that, for I realized that suddenly and almost miraculously I had discovered the secret of an infallible memory. Its possibilities loomed up to me then in enormous proportions.

I would not have believed this experience if it had not happened to me—myself. I would have doubted the truthfulness of even my most trusted friend, had he claimed to do what I did so easily and simply on that momentous evening of the banquet.

Lest you doubt me, I will quote here two letters from those who can vouch for my sudden acquisition of an improved memory.

Harry R. Reid, Worshipful Master, Doric Lodge Number 316, Toronto, Canada, affirms in part:

> "This certifies that Ralph Gordon appeared on the program last evening at our lodge banquet. After the banquet he gave a memory test before the officers present in which we gave him 20 words that he did not know.
> Then, after looking at the list for a few minutes, he turned his back to the easel and repeated the list forward and backward, making only one mistake, which was a slip of the tongue and not of memory. This is the more remarkable because he had given the subject only a half hour's reading before coming to the banquet—A wonderful feat!"

J. A. Montgomery, Vy. W. Past Master of the same Lodge also affirms:

> "I was present when Mr. Gordon gave a memory test. Next evening he called upon me, asking to continue the test. He asked me to take a pencil and paper, and write down a list of words. 'Now,' said Mr. Gordon, 'I shall repeat for you, backward and forward, the words you have called off.' This he did without a mistake. I was simply astonished. I consider this test an extraordinary exhibition!"

Just one more amazing result of my reading of Mr. Roth's course, and I leave the idea to you for what it is worth (which I claim is a great deal), with the earnest advice that you do not waste a single instant in getting this wonderful secret from the "Master of Memory Masters."

The following poem, just as given here, I wrote down from memory immediately after reading Lesson 4 of Mr. Roth's course as far as this poem. I read it only twice. Think of it! You will not believe this until you have secured Mr. Roth's course—then you will.



These are the things I hold divine;
A trusting child's hand laid in mine,
Rich red earth and wind tossed trees,
The taste of grapes and the hum of bees,
A rhythmic gallop, and bright June days,
A rose-hedged lane and lovers' lays,
The welcome smile on neighbors' faces,
Cool, wild heights, and open places,
Breeze-tossed fields of silver rye,
The wild, sweet note of the plover's cry,
Summer showers, the scent of lox,
The soft pale tint of the garden phlox,
Blooming lilacs, a lazy noon,
The flight of geese and an autumn moon,
Rolling meadows and storm-washed heights,
A fountain's murmur on summer nights
A dappled fawn in the forest hush,
Simple words and the song of the thrush,
Rose red dawns and a mate to share
With comrade soul my gypsy fare,
A waiting fire when the twilight ends,
A gallant heart and the voice of friends.

My only mistakes were "summer showers" for "fresh spring flowers", "breeze tossed" for "breeze blown", the article "the" for "a" in a few places, and one or two other slips that did not change the meaning or rhythm of the original.

Mr. Roth's publisher tells me that a half million people already are using Mr. Roth's memory system. I am not surprised, as you may imagine from the foregoing. There is not a man or woman in this United States who cannot get every real benefit, and astonishing results in memory improvement, from Mr. Roth's wonderful and fascinating course.

Don't fail to look into it.

RALPH GORDON

November 4, 1919 Toronto, Ontario

The publishers of the Roth Memory Course —The Independent Corporation—are so confident that it will also show you how to develop a remarkable memory that they will gladly send the Course to you on approval.

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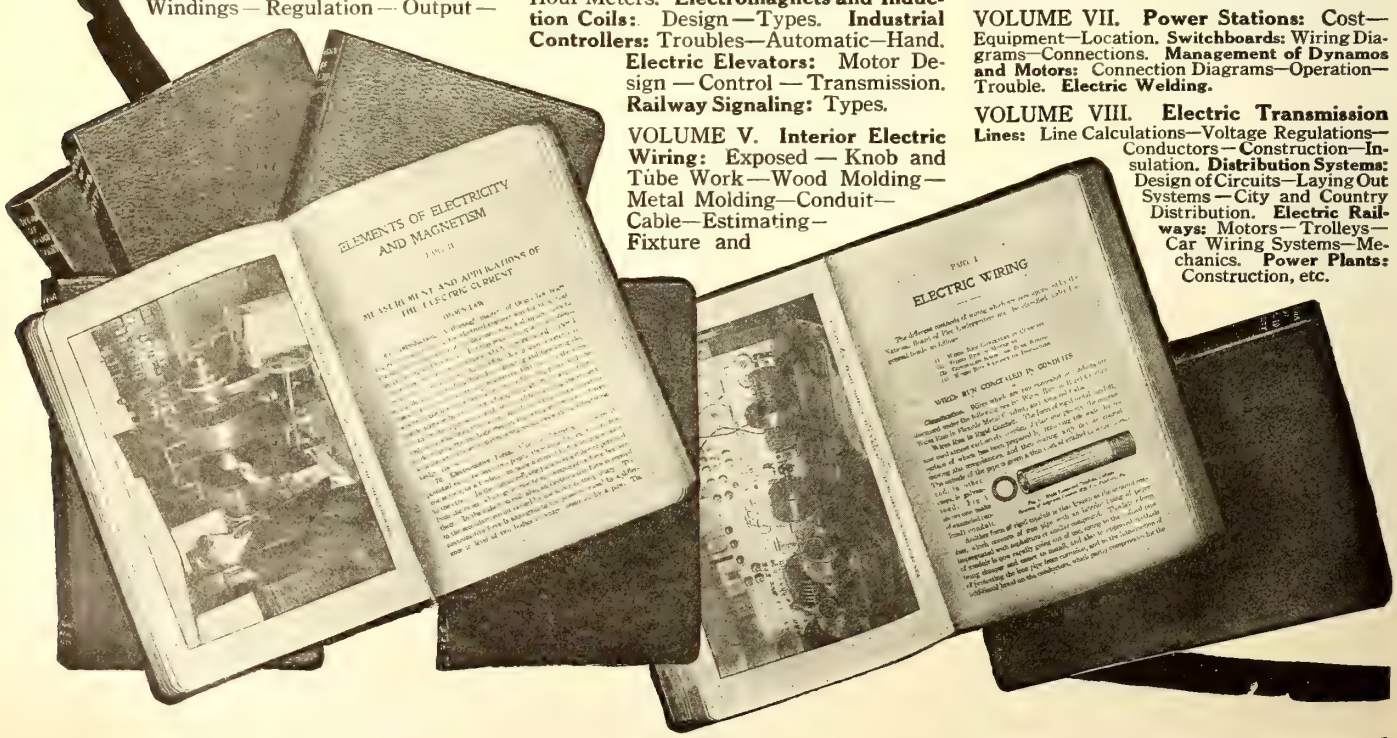
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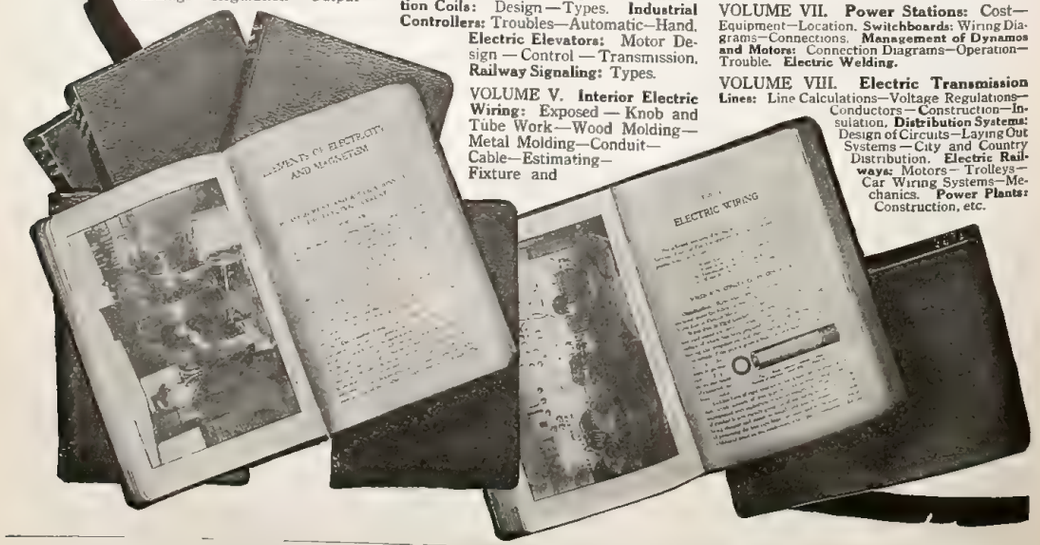
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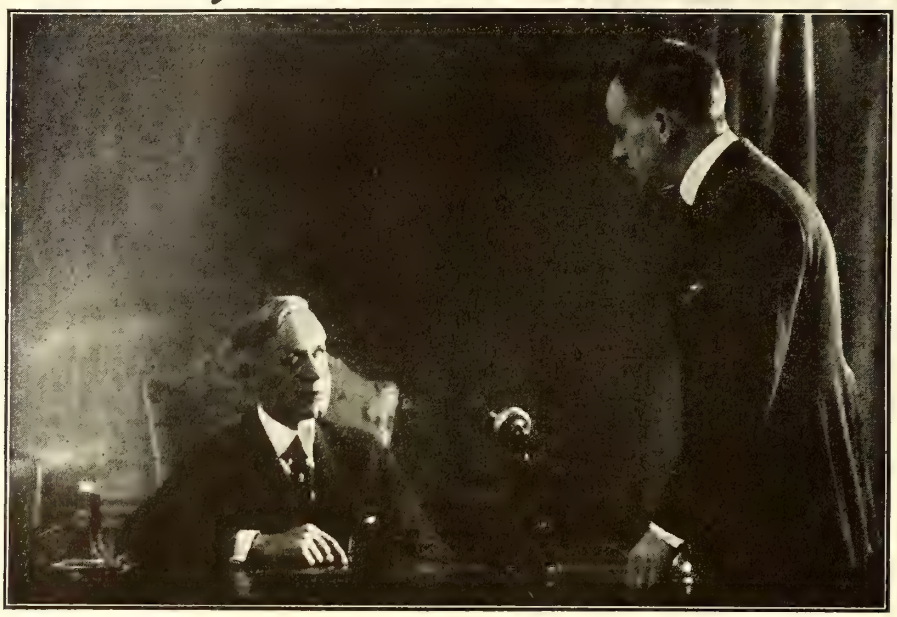
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"No, I do not!" My prospect turned abruptly aside to other matters, as I stood there fumbling my hat, and wondering what under Heaven I could say next, if anything.

I was beaten, completely. Mr. Farrelly was preparing to answer his mail. He had forgotten me completely. The incident was closed.

My second month as salesman for the Driscoll Casting Company, and another failure chalked up to my discredit!

The reason should have been as plain as day to me—yet I was just blind enough not to see it at all. But when I went back to our Sales Manager, I got enough food for thought to last me a long time. Said he, quite frankly:

"Collins, the office is the place for you. You are no salesman. You just don't know how to talk. For one thing you are too timid. You have no confidence in yourself."

"Imagine suggesting to Mr. Farrelly that there was the slightest chance of his not jumping at your proposition. Yet that is just what you did."

"NOW let me tell you something about selling goods. I won't tell you where I learned it till later."

"In the first place, do you realize that it is *instinct* that makes a man accept your offer as well as careful reasoning. If he thinks you expect him to buy—that you look upon this as a foregone conclusion, he is far more likely to sign on the dotted line. If he has the least suspicion that you doubt your ability to make the sale—especially if anything you say gives him that impression—you might just as well say goodbye right then to the order you have dreamed so fondly of taking away with you."

"The word of command is all important. It is absolutely essential, and the one thing above all others that brings home the bacon. When the trolley conductor announces 'all out, take the car ahead' everybody gets out and nobody asks why. They just do it. So, when you say 'Sign here' Mr. Prospect is more than likely to do as you say without further discussion, provided of course you have made it clear to him that your goods are what he can use."

"But these are only a few small points in the One Great Fact of Salesmanship which gave *me* the secret of making people buy what I wanted to sell them."

"HAVING plugged along for years with only indifferent success as a salesman, I suddenly ran into a big idea which I assure you has meant more to me in my selling career than all the other business things I ever learned put together."

And with that the Sales Manager pulled out a set of well-thumbed pamphlets, which I saw bore the title "The Newcomb Course in Super Salesmanship."

"If you will study these a few

evenings," said Mr. Beardsley, "you will make me take back what I said about your being a poor salesman—unless you have got different stuff in you from what I have been led to believe."

"Here you will find Arthur Newcomb's secrets of selling, which he has formulated as a successful salesman, and as a man who has taught thousands how to be masters of this paramount acquirement in business."

BEARDSLEY lent me that course then and there, and I hesitate to tell you what the result was, because it was so unbelievable.

Those seven lessons were a revelation to me. I'll say they were! It took me less than one hour to discover in them things that upset completely my earlier notions of salesmanship.

I had thought the title of the course pretty ambitious—"Super Salesmanship." It is a pretty big word, but absolutely right if my experience is any criterion. Judge for yourself by what I was enabled to do.

I studied the Newcomb course, and I studied it hard. Then I started out again and never lost a chance to apply what I got out of the lessons.

I had soon found out that all salesmen can be classified into three types: First, and in the large majority, are the incompetents. They generally go away empty-handed. Occasionally, one of them gets a little order. But all men of this type ever get from coldly efficient buyers is a quick application of high-bred freezing process. They have nothing but contempt for inefficiency.

The second class consists of the medium-grade salesman. These men are turned down, however, oftener than they get orders.

Out of all salesmen there are only a small percentage who nearly always make a sale. They seldom go away empty-handed. Nor do they talk much, nor work at all hard to make a sale. They make up the third class—the Master Salesmen.

How do they do it? From the lessons I found that consciously or unconsciously they use the One Great Rule of Successful Selling. Even though these men express themselves differently and are entirely different types of men, they all use The One Great Rule. And the men who fail to sell do not use this rule.

Then came the interest in the course that no novel can give. With the swiftness of lightning



"Right from the start I sold goods in substantial quantities"

I was well nigh paralyzed with Revelation. I possessed the one, the all-embracing Rule that would make me, failure at selling that I was, a super-salesman.

Though I may have a thousand future lives to live, I believe that I can never forget those wonderful moments when I first read of The One Great Rule of Successful Selling and Its Hundred Devices. It was mighty knowledge to have and use.

To make my story short, I soon proved to Mr. Beardsley that it would pay him to put me on the road.

Right from the start I sold goods in substantial quantities. In nine short weeks my sales topped the list of our entire selling force. You can well imagine my joy. I had actually out-distanced "Old Timers" and had become the firm's Super-Salesman.

On my return from my first trip, I remember that Mr. Beardsley called me into his office, gave me a cigar, and said cordially, with his hand on my shoulder:

"Collins, you've made me eat my words. I told you once you were a selling-failure. I'll take it back. As a salesman you're certainly all there."

Today I am holding down the job Mr. Beardsley did when he gave me that talk about the Newcomb course. He is now Vice-President of our company. But for what I have done I claim no special ability. I had only a grade school education, and never was considered anything out of the ordinary intellectually. I say this frankly, as I have no desire to pin roses on myself.

The point I want to make is this: If I, with these handicaps, could so quickly become a top-notch salesman, it is only reasonable to suppose that others can, too. The thing that so quickly made me a Master Salesman was a knowledge of The One Great Rule in Selling and Its Hundred Devices, told by Arthur Newcomb in his astounding 7-Lesson Course in Super-Salesmanship.

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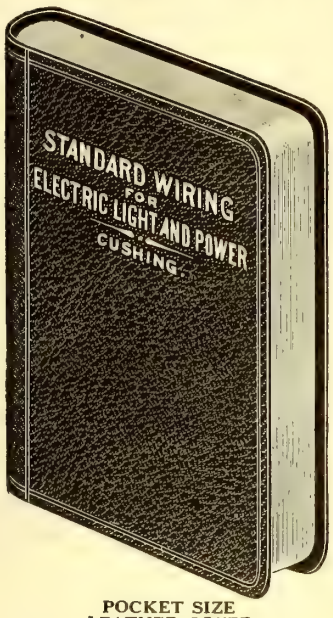
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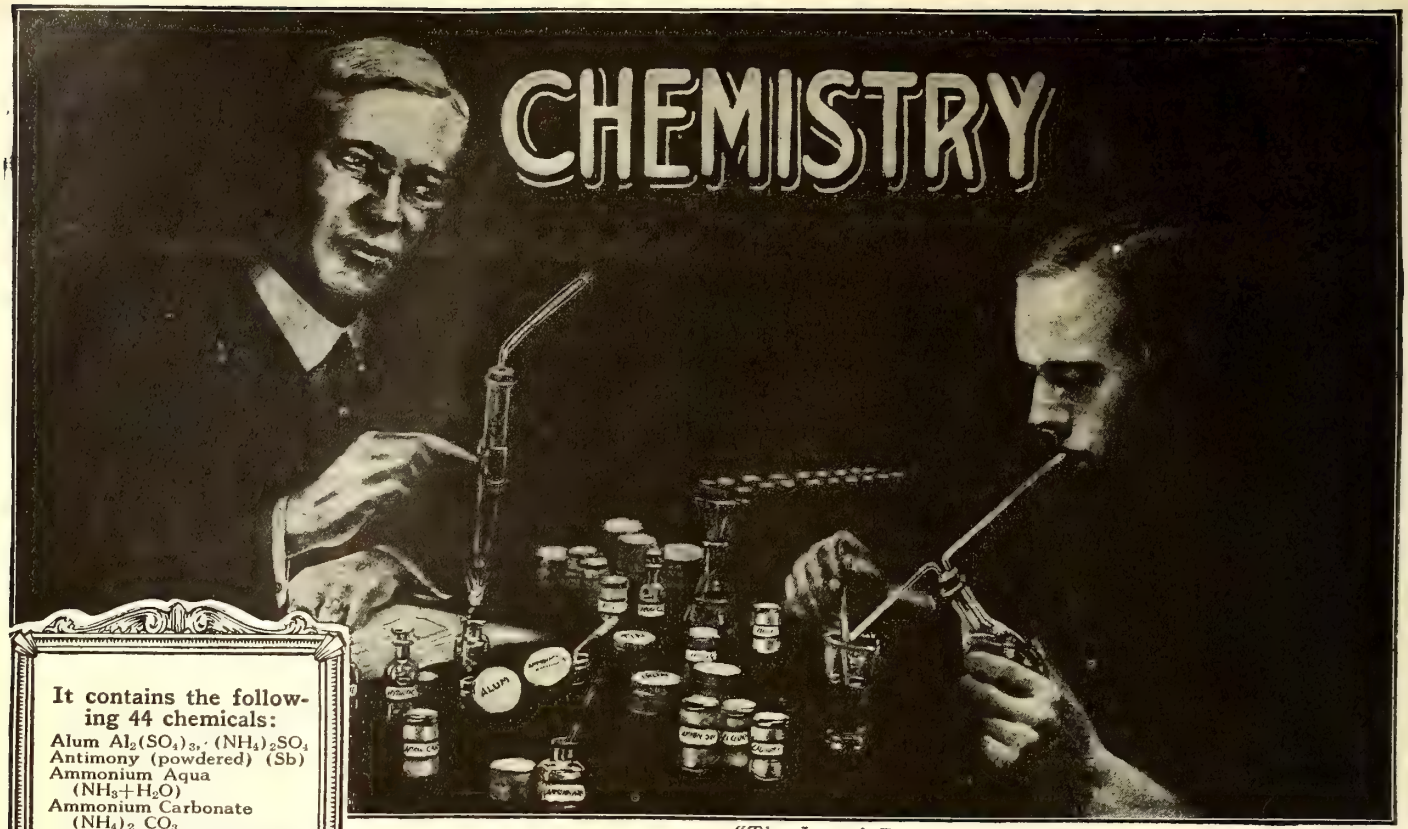
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Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride ($BaCl_2$)
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride ($CaCl_2$)
Calcium Oxide (CaO)
Calcium Sulphate ($CaSO_42H_2O$)
Charcoal (Carbon) (C)
Chloride of Zinc ($ZnCl_2$)
Copper Sulphate ($CuSO_4$)
Ferrous Sulphate ($FeSO_4$)
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_6(OH)_3$
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Iodine (I)
Iron Chloride ($FeCl_2$)
Iron Oxide (Fe_2O_3)
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How to Get Anything You Want By Talking Convincingly

by Roger Matthews

I NEVER felt so elated in my life. Mr. Hughes had granted me an interview, and had promised to tell me his secret of success. That meant something, coming from this giant in the great world of finance.

I will admit that I half expected to hear the same old story about "honesty, hard work and sticking to the big job." But I was elated just the same, and eager to hear how the boy with no college education had risen so swiftly and steadily to the millionaire class.

You may imagine my surprise when Mr. Hughes said, "My success is due to One Thing. I mastered the art of talking convincingly.

"All success in the great world of business, in the last analysis, is getting other people to think as you want them to think—in getting the conscious, willing and hearty co-operation, the loyal support, enthusiasm and esteem of the men you meet in business."

"You must see," continued the financier, "that there is only one way to bring that about, namely to be able to talk convincingly.

"Mastery of words—that is the thing! How can you expect to get ahead if you lack the power to say what you want to say, convincingly and effectively at the instant you want to say it?"

"You may have wonderful ability, great mental power and keen instinct for business; but if you cannot put your ideas into clean-cut, convincing words, you will never realize fully your greatest ambitions."

I knew he was right. And his words thrilled me with a new courage and ambition.

This interview with the man who had talked himself to the top was the beginning of great things for me. And the best of it is that he told me how to learn the secret and make it my own.

He told me about a wonderful new method of learning the principles of convincing speech.

When I returned home, I sent for the method Mr. Hughes told me about. I began to apply the method to my daily work, and soon I was able to wield some of the same remarkable power over men that Mr. Hughes had.

When you have acquired the knack of talking convincingly, it's easy to get people to do anything you want them to do.

This knack of talking convincingly will do wonders for any man or woman. Most people are afraid to express their thoughts; they know the humiliation of being ignored with casual nod or a "yes" or "no". But when you can talk convincingly, it's different. People listen and listen eagerly. You can get people to do almost anything you want them to do, and they think they are doing it of their own free will.

In committee meetings, or in a crowd of any sort you can rivet the attention of all when you talk. You can force them to accept your ideas.

Talk convincingly and no man—no matter who he is—will ever treat you with cold, unresponsive indifference. Instead you'll instantly get under his skin, make his heart glow and set fire to his enthusiasms. Talk convincingly and any man—even a stranger—will literally take the shirt off his back to please you.

You can get anything you want if you know how to talk convincingly. You've noticed that in business ability alone won't get you much. Many a man of real ability, who cannot express himself well, is often outdistanced by a man of mediocre ability who knows how to talk convincingly.

Now, I can say, as Mr. Hughes did, in that memorable interview that started me toward success, that I too have become a convincing talker, and while I have by no means reached the position of my millionaire adviser, I have made the most astonishing strides in business, as a result of my new-found acquirement. I can make others see my point of view as I never dared to hope before.

In short, I am getting ahead so fast, that it sometimes makes my head swim. My last promotion, to General Manager, carries me to the $10,000 mark.

It seems, as I look back to my old stuttering stumbling way of speech, as if I must be someone else instead of the same Roger Matthews.

I remember how scared I used to be whenever I had to talk to the chief. I remember how confused I used to be every time I met new people.

Now it is all so different that I hardly recognize myself. My success seems miraculous; even to me, but it was really very simple.

All I did was to secure a wonderful course of seven lessons called "Mastery of Speech". This was the method that Mr. Hughes advised me to send for. The course was written by a man named Frederick Houk Law, a good speaker himself and an authority on speech, but best of all, a man who knows how to make *others* convincing speakers.

Now I never stand fumbling with my hat and my words when I call on a man. It is just second nature for me now to choose the exact words for anything I want to say; to adopt instantly the most effective way of saying it; to make a good impression on my hearers.

But I understand that I am just one among thousands who have risen to greater success through the use of Dr. Law's wonderful course.

There was Mr. Ralph L. Leonard of 89 Bridge Street, Beverly, Massachusetts. I can sympathize with him; my knees used to knock together every time I had to speak to *my* boss. Mr. Leonard says. ". . . . The very day after examining Mastery of Speech I had the confidence to go up and ask my superintendent for a transfer on the planers . . . . And, to my surprise, he gave it to me. I had for months been wanting that change, but didn't have the confidence until your Course pointed out the easy way to talk to your 'Superior.' That is only one incident where your Course was of value."

Again and again I could have truthfully repeated on Saturday night the statement that Mr. H. R. Blackman, of 26 Stevens Street, Danbury, Connecticut, makes in the first sentence following: "I have just completed the busiest and most successful week in my business career, due to a very large extent to the help I have received from reading the invaluable little books. I consider this course the best investment I ever made."

Many more experiences of those who have found the "Mastery of Speech" lessons to be strong rungs in their ladders of success have come to my attention. I am naturally an enthusiastic missionary for Dr. Law's course myself and some of my best friends have duplicated my rapid climb in business by taking my advice to send for this remarkable course.

I advise you earnestly to send for "Mastery of Speech". You have nothing to lose—for the publishers will send you the entire course on five days' free trial. Just mail the coupon as I did, and see what a wonderful experience is in store for you.

Act now, and you will thank me some day not very far distant for doing you a great favor.

You needn't send any money—not a cent. Merely mail the coupon, or write a letter, and the complete Course, "Mastery of Speech," will be sent you by return mail, all charges prepaid. If you are not entirely satisfied with it, send it back any time within five days after you receive it and you will owe nothing.

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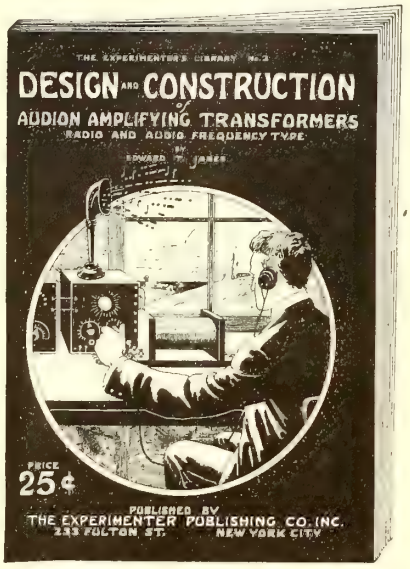
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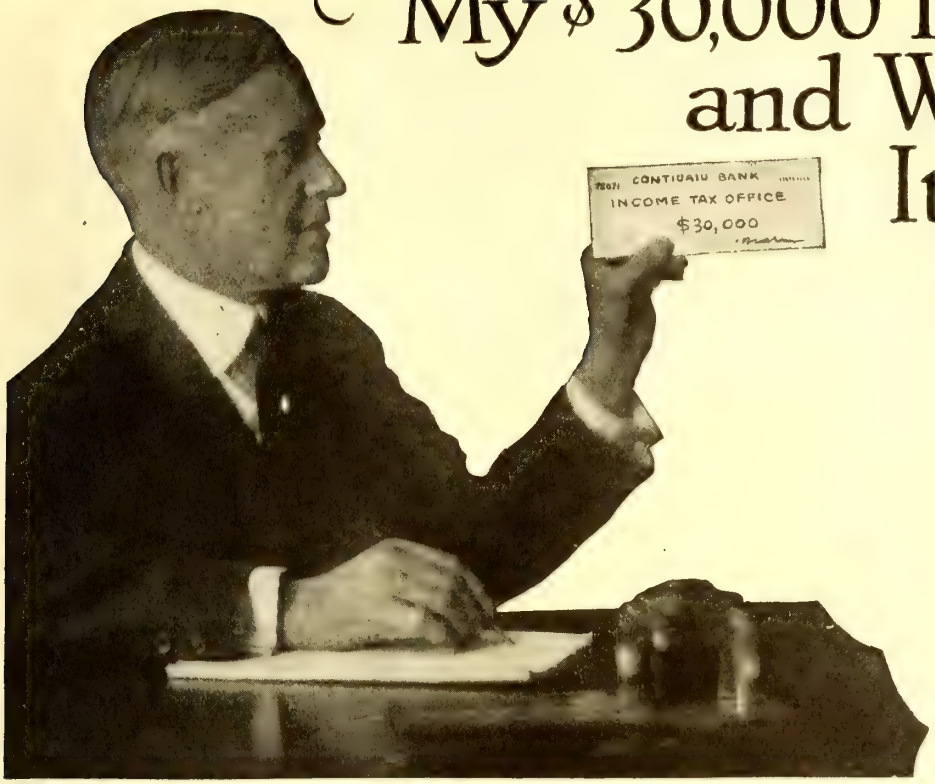
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"My $30,000 Income Tax and What Made It Possible"



by Vernon Howe

Mr. Howe is one of the most successful men of his age in Forth Worth, Texas, and from all I can learn of him, few others in that city are better liked by their business associates and friends in general. Mr. Howe attributes his success and his surprisingly big income largely to his recently discovered ability to read and understand the character of the people he meets and does business with.

This story is his own, just as he wrote it.

I AM rated as an excellent judge of human nature by those who know me. During the past year (1917) I have built up an organization of more than 250 salesmen. All of these men show an enthusiasm for their work, a loyalty to their organization, and an ability to sell our securities in large quantities which has attracted quite unusual attention and which has meant a great deal to me and my business house in income and prestige.

When I began my business career I little dreamed of the success that would come to me at the age of thirty years. But it did come and I want to tell you—for your own good perhaps—what it is to which I give the credit for my having "found myself" so early.

I should explain right here that I paid the Government last year an income tax of more than $30,000. From this you can easily figure how large my actual income was to justify a tax of that magnitude.

My previous annual income had never before reached $10,000, but from the day that I discovered a simple and scientific system of reading character from outward signs, and of reading my own character and discovering my greatest powers, I knew what the result would be. At least I never felt so confident of anything in my life as that I would turn this new found knowledge into dollars.

As I look back on it now it is a revelation —and quite unbelievable to anyone not "in" on the secret.

People have always tried to read their fellows, attempting to correspond certain physical characteristics, such as the high, narrow forehead of the specialist, the bulging brow of the scientist, the narrow, low brow of the tramp or idler.

This science of reading character at sight, which has meant so much to me, has been reduced to simple, everyday rules of work by Dr. K. M. H. Blackford. In my opinion it deserves a high place in any educational system it is far more important than any other science yet formulated. This is a strong assertion, yet I leave it to you. Do you know anything that is more important in life than knowing how to size up other people? Than knowing how to analyze your own character and make the most of it? Than knowing how to make other people like you? Than knowing how to make people work for you and do your bidding? Honestly—I don't know anything more important, or more likely to make us seize our great opportunities. Do you?

You know as well as I do, from your actual experience, that the men and women who have wasted their lives have usually done this because they were not fitted by nature to do the work attempted. Do you know any sadder tragedies of life? I don't.

Is it any wonder that the statistics show more than 70 per cent of the business ventures of today abject failures?

I am convinced from my own experience that Dr. Blackford's marvelous system of Reading Character at Sight will decrease the percentage of such failures—and therefore increase the percentage of human happiness.

At least I can say, positively, that Dr. Blackford's system has increased my income beyond the point of my fondest dreams.

Just as nature intended that the normal condition of our bodies is perfect health, so the normal condition of everyone is perfect success. We are all meant to be a success at something. We all have the capacity within us to achieve big things in the right line. If we are not a big success, it is merely because we are in the wrong occupation. Napoleon was a failure at authorship. Florence Nightingale failed as a social favorite. Grant was a failure at everything until he became a soldier. These were their wrong occupations. We all have the germ of success within us—the capacity to do big work in some one line. The thing to do is find out what your line of work is.

Dr. K. M. H. Blackford has helped thousands of men find out the work for which they were best fitted to achieve big success. This famous character analyst has been retained at record fees by such corporations as the Westinghouse Electric and Manufacturing Company, Scott Paper Company, The Laurentide Co., Ltd. and many other big concerns, to pick and place rightly the men they employ. And 98 per cent of Dr. Blackford's selections —regardless of their previous experience—made good at the jobs in which they were placed.

Dr. Blackford has helped thousand of others and is now ready to help you. A good many of us are just plugging day in and day out at work we are not naturally fitted to do, work we do not like, work we can never fully succeed at. We swim against the tide, trying to fit our given set of talents to the wrong job. But thru Dr. Blackford, we can now all judge in just what line our biggest success lies. And we can learn the worthwhile secret of knowing, in one quick survey of their features, physique, gestures, and habit of conversation, unerringly the character of every person we meet—of looking into people and thru them, instead of at them.

Thru the little course of lessons in "Reading Character at Sight" now being distributed by Dr. Blackford, we can know, the minute we lay eyes on people, how to make them our friends, in either a business or social way—how to talk to them, how to influence them to the best advantage. Thru the secrets given by Dr. Blackford, we can get a better line on the folks we meet than the friends who have known them for years.

Thousands have already benefited thru the course. Some have decided thru it just what their life-work really is. Others have saved themselves from business disaster and unscrupulous partners. Many others have avoided hiring men whom they knew at a glance to be dishonest and unreliable. Many salesmen use the knowledge they have gained to judge and approach their prospects. Executives use it to deal with and judge their employes. Doctor's use it in dealing with their patients. Lawyers find it of great help in their court work and in their actions, toward clients. Public speakers employ it in judging their audience, and in debate.

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This ability to analyze character immediately and without error can easily be yours. It is not a gift. There is not trick or second sight about it. It is not a supernatural or mysterious power. It is merely the immutable rules of science, practically applied. You can do it as infallibly as Dr. Blackford. This new course in "Reading Character at Sight" in seven simple and fascinating lessons will be sent to you without cost, for examination. You can judge for yourself just what the course will mean to you before you decide whether or not you want it. If you do not believe that it can be of tremendous value to you return it and forget the matter. Otherwise mail its reasonable cost of $5. The coupon printed below will bring you the entire course for free examination without obligation. Use it.

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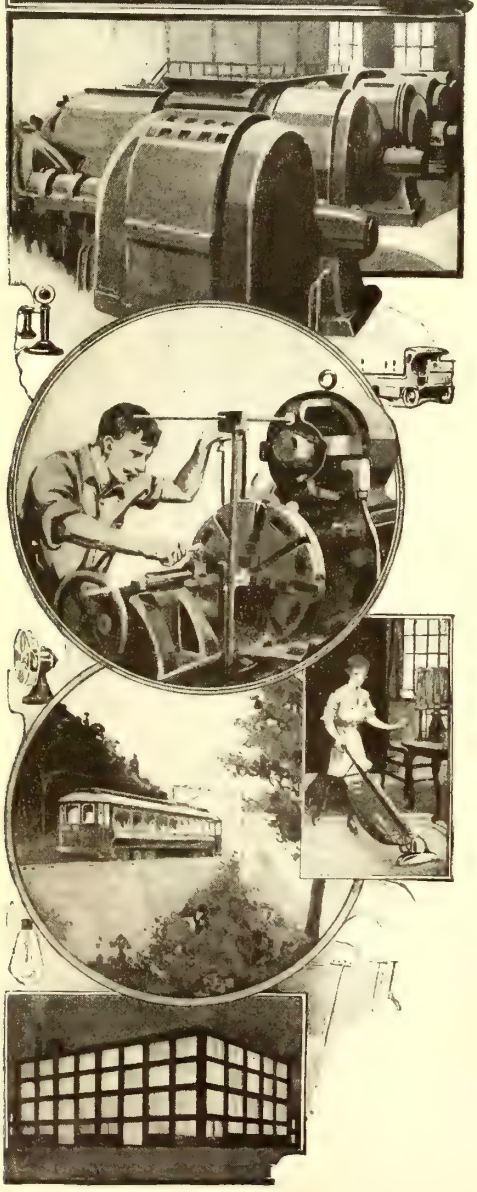
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The Airship Of Tomorrow

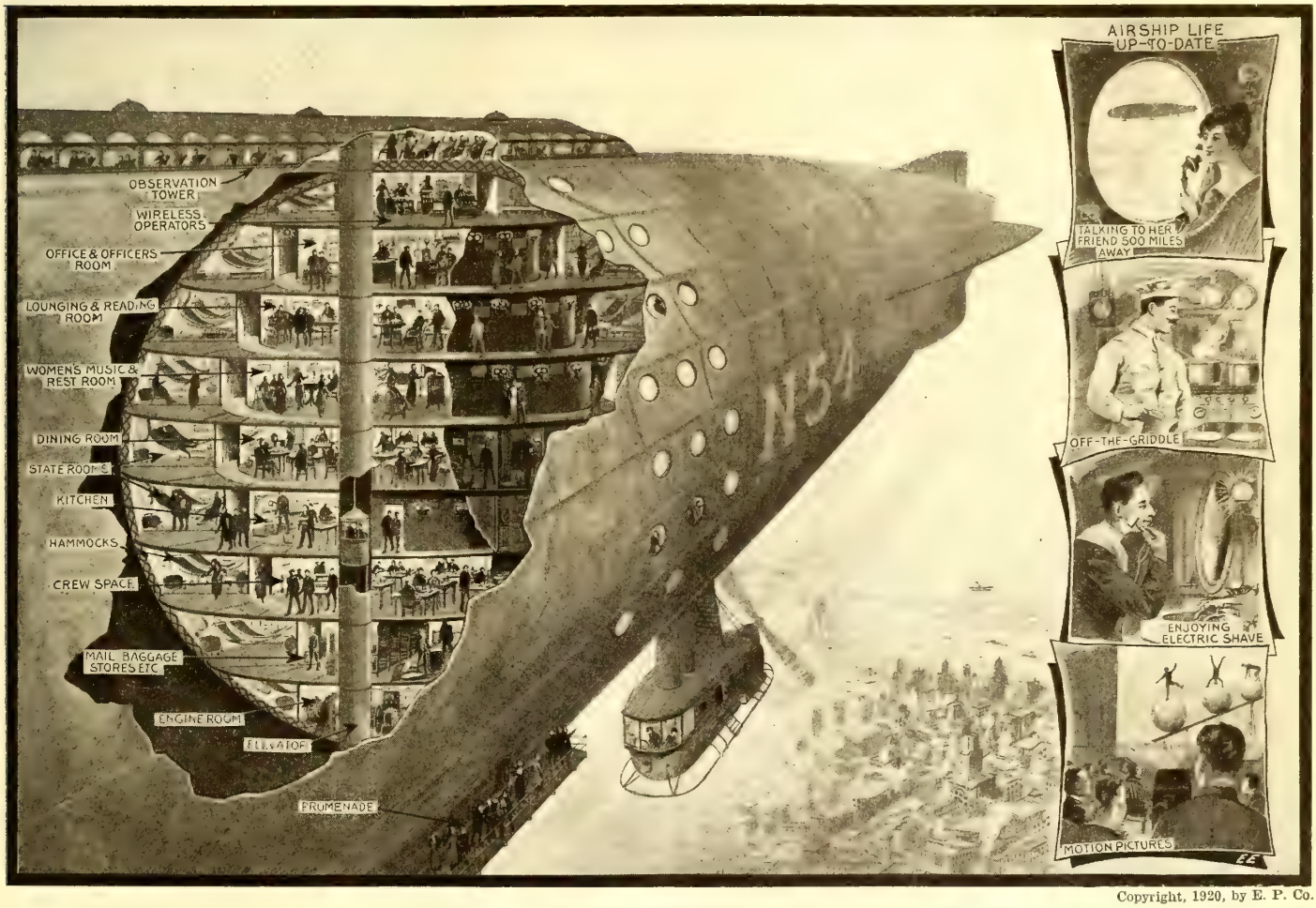
By GEORGE WALL

WE are gradually becoming accustomed to the sight of rapidly increasing sizes of aircraft, especially those of the lighter than air or Zeppelin type, and those who had the good fortune to see the R-34, the gigantic "gas bag" which successfully flew across the Atlantic Ocean from England to America and back, will perhaps expect most anything in the airship of tomorrow. However, there are many developments in a number of these huge aircraft now proposed and being built in various countries that will prove a distinct surprise to those who have not been following the progress of aviation in the past few months.

Already in England and France they have developed and built beautiful airplanes which have a capacity of from thirty to fifty passengers, that almost outrival our finest railroad train appointments in their luxurious furnishings, parlor-car chairs and even to a wash room such as one finds on the giant *Caudron* passenger-carrying plane, recently exhibited at the great aviation salon in Paris. Here we find carpet on the floor and curtains at the windows, with panelled ceilings and electric lights.

The accompanying illustration shows what engineering refinement has done in the perfecting of living conditions for passengers on the latest dirigible or Zeppelin type of aircraft. These gigantic "gas bags" are far larger than one would first imagine, as the picture clearly shows, their height easily accommodating nine stories, equivalent to a nine-story hotel, and they propose to fit the one or more passenger com-

(*Continued on page* 1168)



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All the Pleasures of City Life Are to Be Found in the Latest Giant Dirigible Aircraft—Even to an Electric Elevator. The Staterooms Are Arranged in Circular Fashion, Which Has Many Commendable Features.

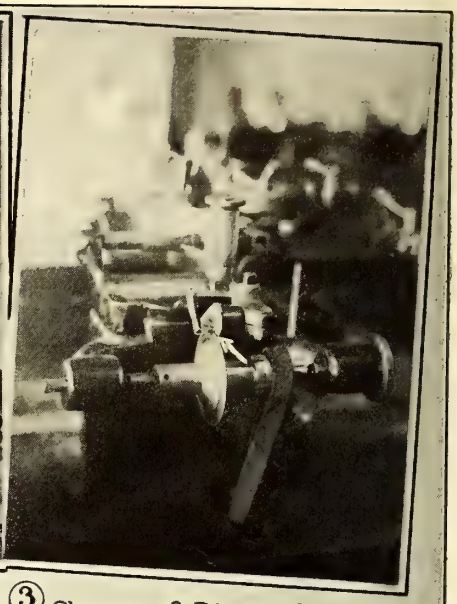
How Diamonds Are Cut



1 Cleaving the Rough Diamond



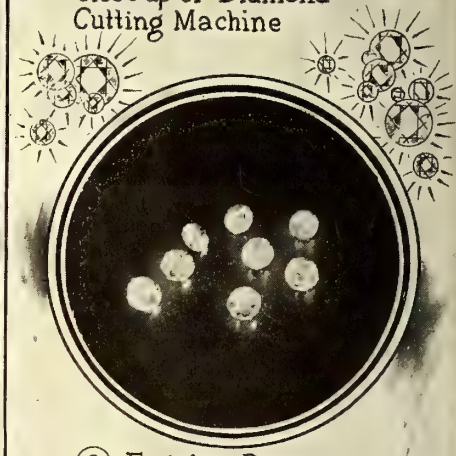
2 First cutting of Diamond



3 Close-up of Diamond Cutting Machine



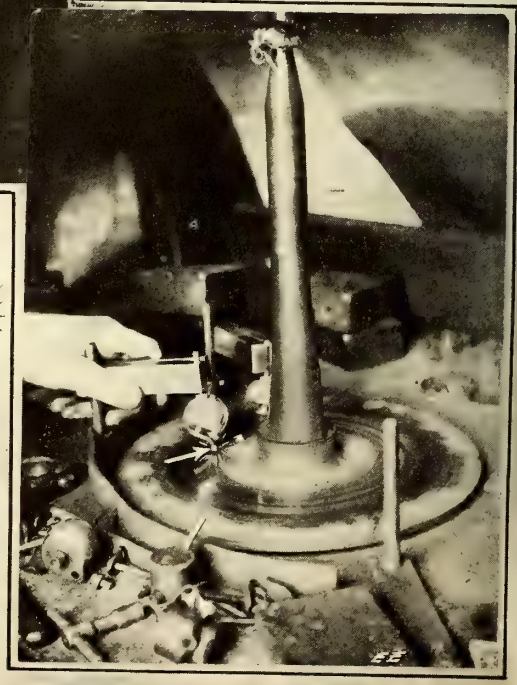
7 Rough Diamonds (1/4 actual size) from the De Beers Mines weighing 2500 carats. Value $500,000



6 Finished Diamonds



4 Grinding Round Edge on Diamond



5 Grinding facets and final polishing

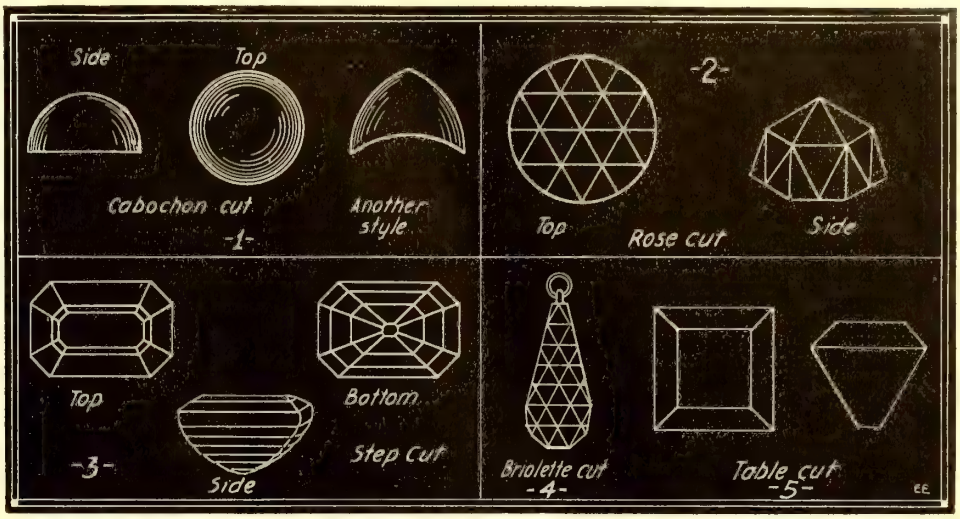
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All About Diamonds

By JOSEPH KRAUS

ONE of the most fascinating and popular scientific subjects is that of "diamond cutting," of which very little is known by the general public. The procedure and the amount of technical labor, skill, and remarkable accuracy are only a few of the small items absolutely essential for maintaining the standard of the present diamond trade. The beauty of these stones depends not alone on the stones themselves, but also the method of presentation. The writer has attempted to present here a brief discussion as to what the diamond is and what makes it so valuable, as well as a general description of the interesting procedure followed in cutting a diamond.

A diamond in the pure state is colorless and transparent, but stones of this nature are extremely rare, altho many of the commercial stones of today are purported to be pure white or blue white, when in reality



Here We See the Various Types and Shapes of Diamonds and Other Precious Stones Aside from the Full Cut "Brilliant"—the Standard Shape for a Perfect Diamond Invariably, and Which Is Illustrated Below.

HOW TO TELL A REAL DIAMOND.

(1) Mark the diamond with an aluminum pencil. If it is a real diamond and not a glass imitation the mark may be easily removed by rubbing it briskly with a moistened cloth; if glass, however, the mark cannot be removed, resisting even the action of acids. The surface of the stone for this test must be very clean, which is accomplisht by rubbing with a moistened cloth dipt in whiting.

(2) A nail file if drawn along the edge of a stone will not cut the diamond, while it will cut spurious glass imitations.

(3) The facets have sharp edges, whereas those of glass imitations have much duller edges.

(4) A small globule of water placed upon the table or flat top of a diamond will retain its globular form even if moved about by a pin. It spreads on glass.

(5) By looking at a point on a sheet of paper thru a diamond and a good triplex magnifying glass (i. e., a glass which has been corrected for spherical and chromatic aberration) only one point will be seen if viewed thru a diamond, whereas a number of points or blurred points will be visible if an imitation.

(6) If a doublet or triplet (that is, a false bottom with a genuine top cemented together or a stone made up of three parts), it is detected if placed in oil and viewed from the side.

(7) The finest test of all perhaps is the specific gravity test. This is 3.52 for the diamond. The procedure is described in detail in the article.

No ONE of these tests should be taken as positive proofs, but the entire number may be taken as a fairly good indication of the genuineness of the stone.

objectionable color exists in them which is quickly discernible by the experienced diamond expert. This color is caused by oxids which are present in the crystalline form, and from the chemical viewpoint are supposed to be held in colloidal suspension, altho invisible, even under a microscope.

The presence of iron oxid will cause a yellow or brown or sometimes even a red coloration. For examining diamonds it is necessary that a good North light be present and for the inexperienced, the examination of two stones at the same time will clearly differentiate between the good and the inferior. A clear day should be chosen and an hour between 10 A. M. and 2 P. M.

COLOR IN STONES.

Fancy diamonds are colored stones with well marked shades. Diamonds of this character bring very high prices, for colors are often sought for but what is very *undesirable* is the *slight* tint found in some diamonds which are supposed to be *colorless*. Shades in which the various stones appear are those varying between the following: Red, apple green, violet blue, rather pale saffire blue, absinthe green, golden brown, orange and canary yellow. As has been said before, a pure snow white diamond is very rare and a buyer must be prepared to pay a good price for it if he desires to obtain one.

In order to test for color the diamond is covered by a thin layer of mist caused by giving the same a quick puff of breath. It is then examined with a lens of about one inch focal length, the same being corrected for spherical and chromatic aberration. If held up to the light of an electric incandescent bulb, the stone which allows the filament to be seen the most clearly and which allows the greatest light thru it, is the better stone. Stones are classified according to color and are in order: (1) Rivers, (2) Jägers, (3) Blue Wesseltons, (4) Wesseltons, (5) Top Crystals, (6) Crystals, (7) Very Light Browns, (8) Top Silver Capes, (9) Silver Capes, (10) Capes, (11) Yellow, (12) Brown.

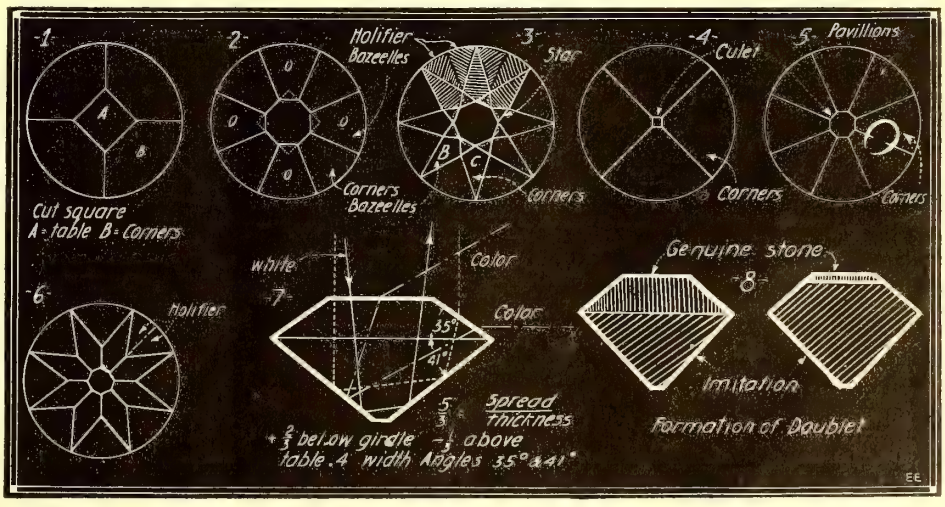
Rivers—these are the rarest, most beautiful Indian and Brazilian stones, altho a few African stones are clast among them. They are pure snowy white or blue white, and are the ones which command the highest price.

Next on the list are the Jägers, of a pale steely blue body color, which is the same thruout the stone. Then come the Blue Wesseltons and Wesseltons, both of which are of a *very slight* yellowish tint scarcely noticeable and together with the Jägers make up the stones of a very high class.

Crystals, however, are poor in comparison with the other stones. If compared with rock crystal or a synthetic white saffire, they appear yellow. Of course, the stone should be dimmed by breathing on it to make this test. Very Light Browns come next. Brown is an undesirable color in stones of this nature, as it absorbs too much light, and so for this reason the stone cannot command as great attention as a stone of a different class.

The Capes are next in order. They are yellow enough to be undesirable and are generally called *commercial white stones*. They are not yellow enough, however, to be pretty and hence, are not so much sought

(*Continued on page* 1172)



Stages 1 to 6—Successive Steps Followed in Cutting a "Brilliant," or Full Shaped Diamond. Fig. 7 Shows Reflection Rays in "Brilliant" and Fig. 8 Formation of a "Doublet."

Power From the Wind

By H. GERNSBACK

FEW people realize the enormous amount of energy locked up in the earth's atmosphere. The amount of latent horse-power available thru the moving air currents in our atmosphere amounts to billions of horse-power annually, and constitutes one of the greatest, if not the greatest, source of energy of unharnest power available to man.

We may say that we have reached the point today where the exploitation of coal is no longer very economic. The reasons for this are manifold.

What we are doing now is to mine the coal at enormous expense, tying up an enormous amount of man power to bring the coal to the surface of the earth. Then we load this coal into trains at great expense, move the trains to far-away points—the average distance being over 1,000 miles for every car of coal. In this we not only consume *more* coal for moving the coal itself, but we block railway traffic with our long coal trains and prevent other more profitable business from taking its due course.

Of course we *have* to do it now, coal being a necessity, and we are willing to pay the price because we must have power—and must heat our houses as well. Nevertheless, the cost incurred in shipping coal from the mine to the great centers is criminal, if we stop to figure out that at the end only *one or two per cent of the energy contained in the original coal is converted either into power or into heat,* the other 98 or 99 per cent having been wasted. As man power gets scarcer and scarcer and costs rise, there will finally come a time when we must turn to other sources for our power.

The writer has in past articles mentioned many other methods upon which man will ultimately fall in his battle against Nature, but in this article we are concerned only in the exploitation of wind power.

This is not a mere dream or a visionary scheme, but there is sound engineering behind it. Wind power has been used for centuries, and the old Egyptians had their crude windmills and propelled their ships by means of wind. In this country air motors or air turbines have reached a high perfection, but they are small affairs, and are only used for local purposes, such as supplying power for private houses, farms, etc.

It is quite practical today from an engineering standpoint to build huge windmills or air turbines which in size would rank with the Woolworth building or the Eiffel tower. Such 1,000-foot monsters, while they may appear somewhat fantastic, are quite within the bounds of reality and it is calculated that they can easily furnish 25,000 horse-power for each individual windmill.

It can readily be imagined what a battery of such monsters would accomplish. Even large cities would only need a few of these giants to keep the entire city supplied with heat, light and power, and the advantage is that it makes no difference geographically where the city is located. Right here the writer wishes to propose a somewhat novel idea which does away with the greatest objection heretofore considered in such "windmill power plants."

In some localities if the energy was to be derived solely from the wind power, of course no power would be had when there was no wind. Take for instance cities located in Arizona, New Mexico, etc., or in other localities where there is no wind for days at a time. Here such a plant, on the face of it, would appear ridiculous for the simple reason that the inhabitants of a city employing such a plant would never know from day to day whether they would have power or not.

Air Turbines Converted Into Hydro-Electric Plants

Of course in most localities this would not hold, but speaking generally, there is a time period in almost any locality during the year when there would be not enough wind to supply the power to the respective cities.

Of course, the idea comes to mind immediately that a solution would be found in the use of storage batteries whereby the electrical power could be stored for emergency purposes. As a matter of fact, most large power houses in the country work on precisely this principle, but if it became a matter of storing enough power in storage batteries to keep a large city going for days at a time, the cost of such a storage battery plant would run up into many millions of dollars. Hence such a scheme at once becomes impractical. Not only this, but the up-keep of such a large storage battery coupled with the great expense of renewing the plates every few years would make the project absolutely prohibitive.

How then are we to overcome this difficulty?

The writer proposes a novel plan to use the windmills or air turbines, not to furnish electrical power direct, but *indirect,* and the underlying idea is as follows:

We will build each air turbine or windmill so large that they will deliver approximately 20% *more power than we require.* Instead of driving our electrical dynamos or generators *direct,* the windmills are not at all employed in this way. *They are used to pump water* from a lower level to a higher one, and for no other purpose. In other words, we first raise the water from a lake, river or other source of water supply, then impound this water into a reservoir. *This then constitutes our supply of power.* From the reservoir large pipes lead to each hydro-electric power station as shown in our illustration herewith, and this water drives the generators of the power stations and from it we take our power.

Now it will become apparent why we have made the wind turbines larger than actually needed. The reason is that we wish to pump up more than enough water and keep a sufficient supply on hand that, even if there should not be any wind for days at a time, we still would have enough water impounded to assure us of a continuous supply of power even tho not one windmill or air turbine was moving.

By making the air turbines larger than necessary (or by using more of them), we accomplish the purpose of impounding an immense reserve of water upon which we do not draw except in an emergency. It is the old story of the honey-bee laying in honey during the summer, which is used during the winter. In other words, while our windmills and air turbines work overtime when there is plenty of wind, we will still have enough water in our reservoir to draw upon when there is no wind.

Basically this scheme is sound from an engineering standpoint. It is simply an engineering proposition, and there is only the first cost of the moderately expensive machinery and apparatus to be considered.

Such a plant should particularly recommend itself to localities far removed from natural water power, also cities along the coast where no water power exists and where the power that *could* be derived from tidal waves is not available as yet.

It is calculated that any company who would make it a business to furnish power from such a windmill hydraulic plant could easily compete with coal even if the latter were selling at a considerably lower figure than it is today.

In our illustration we have shown two types of machines that would lend themselves for the purpose of deriving power from the atmosphere, viz.:

Huge air turbines of from 200 to 400 feet high, each of which can readily furnish 25,000 horse-power while running in a medium wind. The large windmills shown in the insert are not quite as efficient as the turbines, but are much less costly and perhaps easier in maintaining.

We are certain that once such a windmill or wind turbine is built and one locality begins using these huge air machines, the whole country would no doubt follow suit very promptly when the economy of these machines has demonstrated itself. Remember—you get the energy for nothing!

For "April"

Weighing the Earth—Written especially for the ELECTRICAL EXPERIMENTER *by the man who did it—Prof. Louis Derr, Department of Physics, Massachusetts Institute of Technology.*

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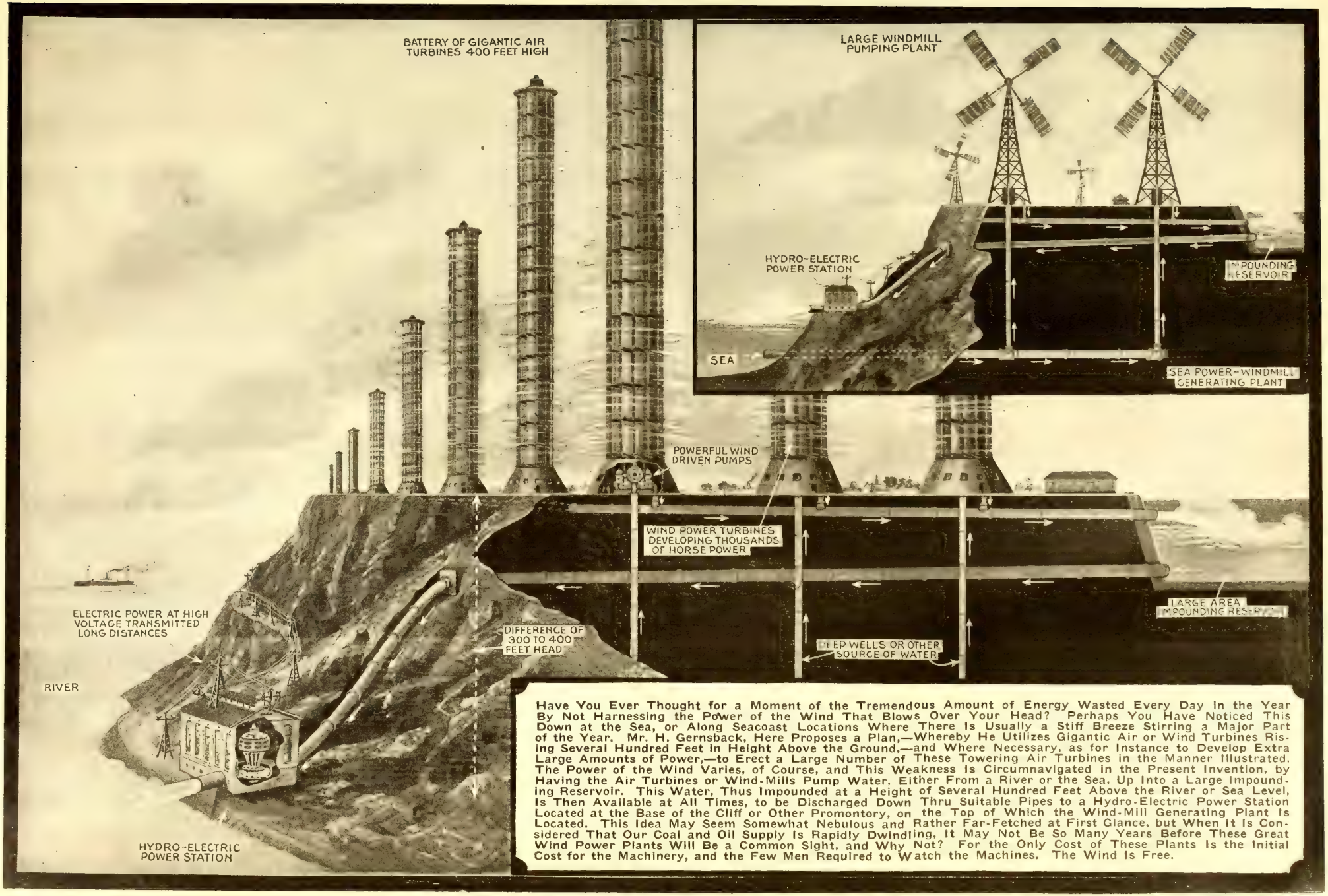
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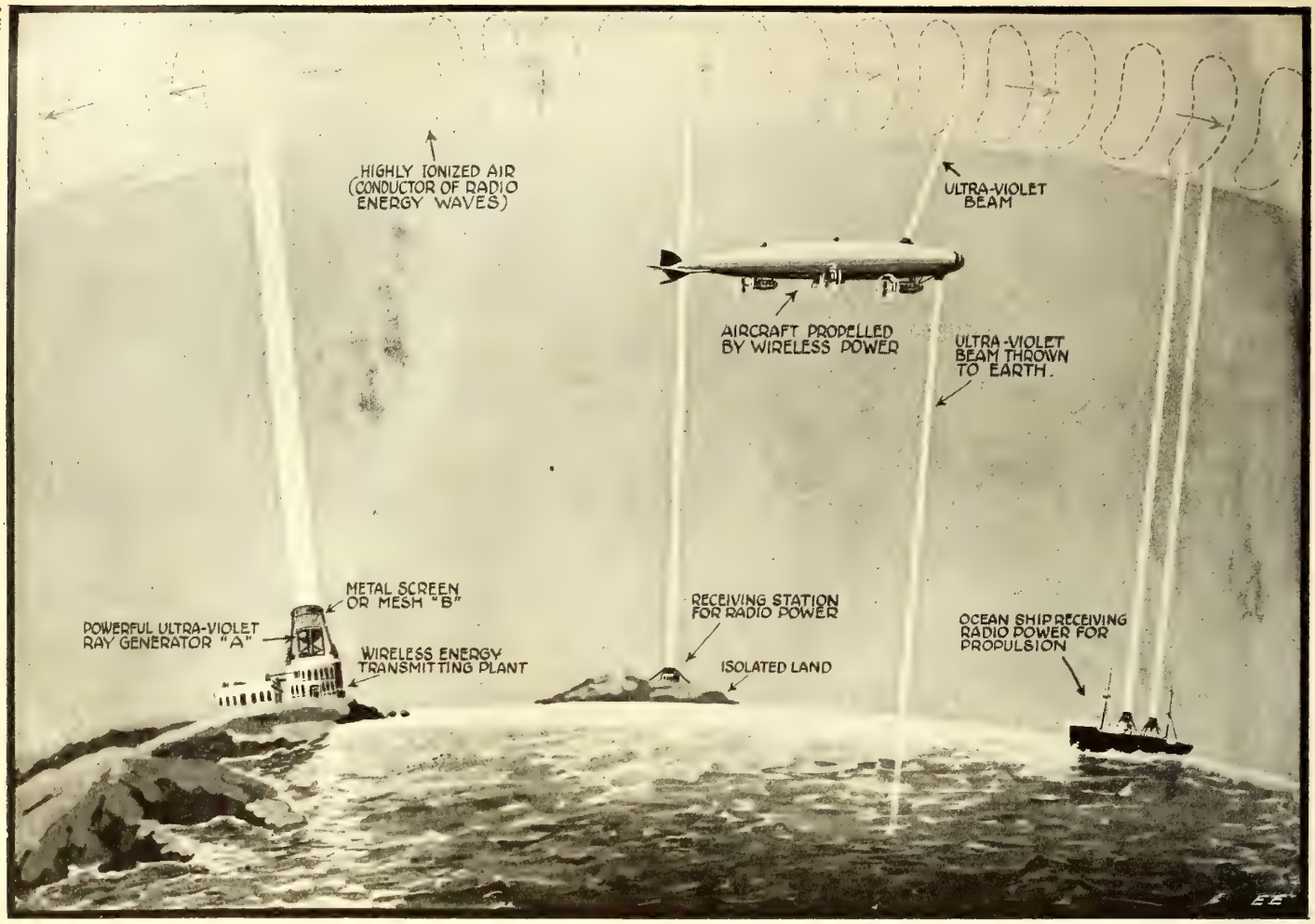
The Dark Searchlight—By Louis Yeager.

NEW HYDRO-ELECTRIC WIND-POWER PLANT



Have You Ever Thought for a Moment of the Tremendous Amount of Energy Wasted Every Day in the Year By Not Harnessing the Power of the Wind That Blows Over Your Head? Perhaps You Have Noticed This Down at the Sea, or Along Seacoast Locations Where There Is Usually a Stiff Breeze Stirring a Major Part of the Year. Mr. H. Gernsback, Here Proposes a Plan,—Whereby He Utilizes Gigantic Air or Wind Turbines Rising Several Hundred Feet in Height Above the Ground,—and Where Necessary, as for Instance to Develop Extra Large Amounts of Power,—to Erect a Large Number of These Towering Air Turbines in the Manner Illustrated. The Power of the Wind Varies, of Course, and This Weakness Is Circumnavigated in the Present Invention, by Having the Air Turbines or Wind-Mills Pump Water, Either From a River or the Sea, Up Into a Large Impounding Reservoir. This Water, Thus Impounded at a Height of Several Hundred Feet Above the River or Sea Level, Is Then Available at All Times, to be Discharged Down Thru Suitable Pipes to a Hydro-Electric Power Station Located at the Base of the Cliff or Other Promontory, on the Top of Which the Wind-Mill Generating Plant Is Located. This Idea May Seem Somewhat Nebulous and Rather Far-Fetched at First Glance, but When It Is Considered That Our Coal and Oil Supply Is Rapidly Dwindling, It May Not Be So Many Years Before These Great Wind Power Plants Will Be a Common Sight, and Why Not? For the Only Cost of These Plants Is the Initial Cost for the Machinery, and the Few Men Required to Watch the Machines. The Wind Is Free.

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Showing the Wireless Transmission of Power by Means of Ionized Searchlight Beams. Powerful Tesla Currents of High Potential and Frequency Are Imprest on the Ionized Beams and Received from Similar Beams as Shown.

Wireless Transmission of Power Now Possible

By THOMAS W. BENSON

RECENT developments tend to fulfill the old, old dream of power transmission without wires. For years men have labored in vain to transmit power without wires and thus solve a myriad of transportation problems, such as propelling vehicles, ships, trains, aircraft, etc., without having to include a source of power in their construction. It makes one's head almost reel to think of the possibilities in such an achievement and now the dream promises to come true.

By one bold stroke an English genius, Mr. John Hettinger, has unthinkingly opened up the way for its realization. Like numerous other inventions, the way lay before our very eyes, but we were all too blind to see it.

While working on a means for transmitting radio waves without material aerials, Mr. Hettinger hit upon the idea of using ionized light beams as elevated conductors. Obviously simple when one thinks of it.

It is a well-known fact that an ionized gas is a conductor; in fact, the conductivity of a gas is a measure of its ionization. Furthermore, it is possible to ionize a gas by means of a stream of ultra violet rays. Working with these facts, Mr. Hettinger devised means to utilize them for radio transmission in the following manner.

As shown in Fig. 1, a source of ultra violet rays, an arc or mercury vapor lamp, A, is arranged to throw a beam of ionizing rays vertically.

These rays result in an ionized stream of air that acts as a conductor, the surrounding un-ionized air being practically a perfect insulator. By making connection to this conducting beam with a metallic screen or mesh at B, it can be utilized as an aerial for radio communication.

We are perfectly aware that this ionized beam rapidly loses its conducting power

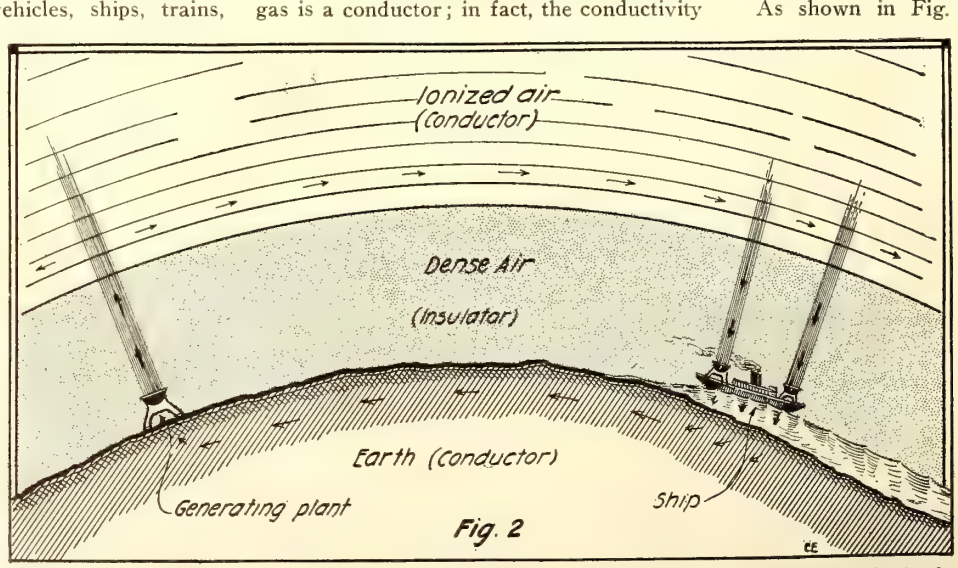


Diagram of the Author's Scheme for the Wireless Transmission of Power Thru Ionized Light Beams and the Upper Ionized Strata of the Atmosphere.

as the distance from the source increases, therefore the effective height of such an arrangement is determined by the intensity of the ray generator. So much for the idea as applied to radio communication.

But let us consider further. In studying the spectrum we find that the sunlight on reaching the earth contains few ultra violet rays of shorter wavelengths than 3,000 Angstrom units, yet we are able to generate much shorter rays with an arc light. It is unreasonable to assume that shorter waves do not leave the sun, and in view of the fact that it has been determined that the upper stratum of our atmosphere is ionized, it is accepted that the shorter rays are absorbed to cause this ionization.

It will now be apparent that a very good condition exists for the transmission of energy without wires. As shown in Fig. 2, we have the earth, a good conductor, surrounded with a blanket of insulating air about ten miles thick, beyond which, up to about a hundred miles, the air is highly rarefied and kept in a state of ionization by light from the sun and stars.

Hence, we have two good conductors separated by several miles of atmosphere, practically a perfect insulator, an ideal arrangement for our purposes. We have but to connect a source of current to the earth and to the ionized strata of air and energy can be transmitted entirely around the earth without wires. The energy could be utilized in any part of the earth by merely connecting to the pair of conductors.

This condition has been recognized for some time, but the difficulty lies in making connections to the upper layer of conducting atmosphere. It is hardly practical to construct towers six or seven miles high for the purpose, then again the energy could not be utilized without using a similar structure at the point of reception, which makes this scheme hardly feasible for aircraft or moving vehicles.

Return then to the ionized stream for radio aerials. We can easily construct arcs that will throw a beam ten or twenty miles. Then why not make connection to that upper stratum with an ionized stream of air? Wonderful in its simplicity.

In Fig. 2 the writer attempts to portray a generating station embodying these principles. In the main building will be housed the generating units for supplying the current to the arc and the primary of the high voltage apparatus for transmission of energy. Supported on the roof of this structure will be a monstrous arc lamp capable of throwing a stream of ultra violet rays for at least ten miles. In this beam is supported a conducting screen to make connection to the conducting stream of ionized air. The insulation of these parts present no great difficulties to modern engineering.

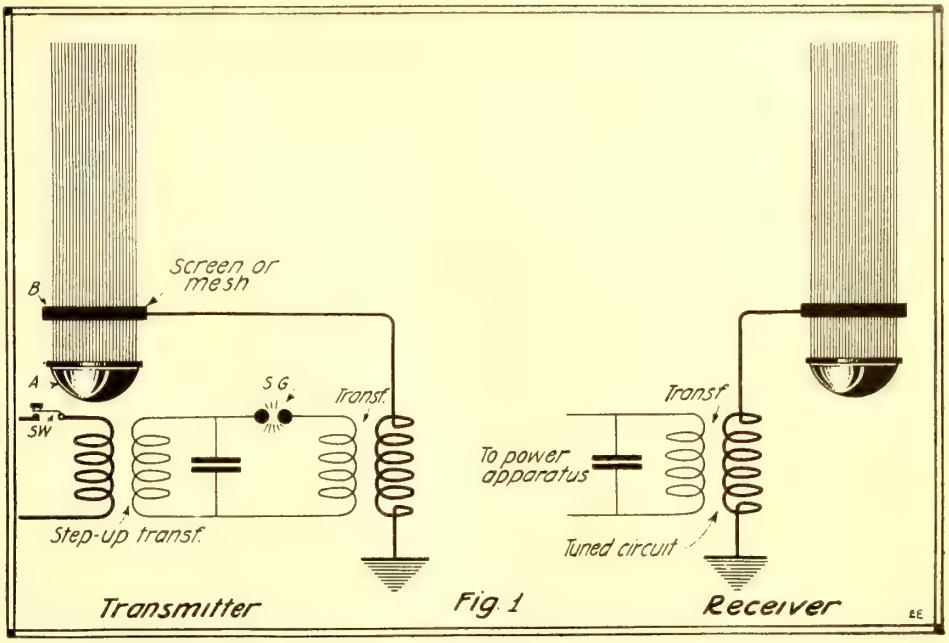


Diagram Showing the Transmitting and Receiving Circuits for the Transmission and Reception of Electric Power by Wireless.

The building will also house a huge step-up transformer, a set of high voltage condensers, a spark gap either of the rotary or quenched type and a huge oscillation transformer or Tesla coil. These instruments are connected in the usual manner and tuned so that the inductance in the circuit and the capacity formed by the earth and ionized upper strata will have a well defined oscillation period.

By these means the whole earth will become an electrified body, energy to be drawn at any point by simply making metallic connection to the earth and pointing a beam of light vertically, a screen being used to take the energy that will flow down the beam. An inductance coil being necessary in the circuit to insure resonance with the transmitter at the receiving set. After once started, the receiving energy can be used to keep the arc going.

Ships will have an arc and reflector mounted on the masts, aeroplanes have two arcs, one on top, the other below, and so on.

This scheme will not interfere with present short range transmission, it being hardly practical for each home to have an arc on the roof when one arc would serve for a town and several for a large city.

Rather its benefit will lie in the utilization of water falls far from civilization, now unused on account of difficulties in transmitting the power hundreds or thousands of miles.

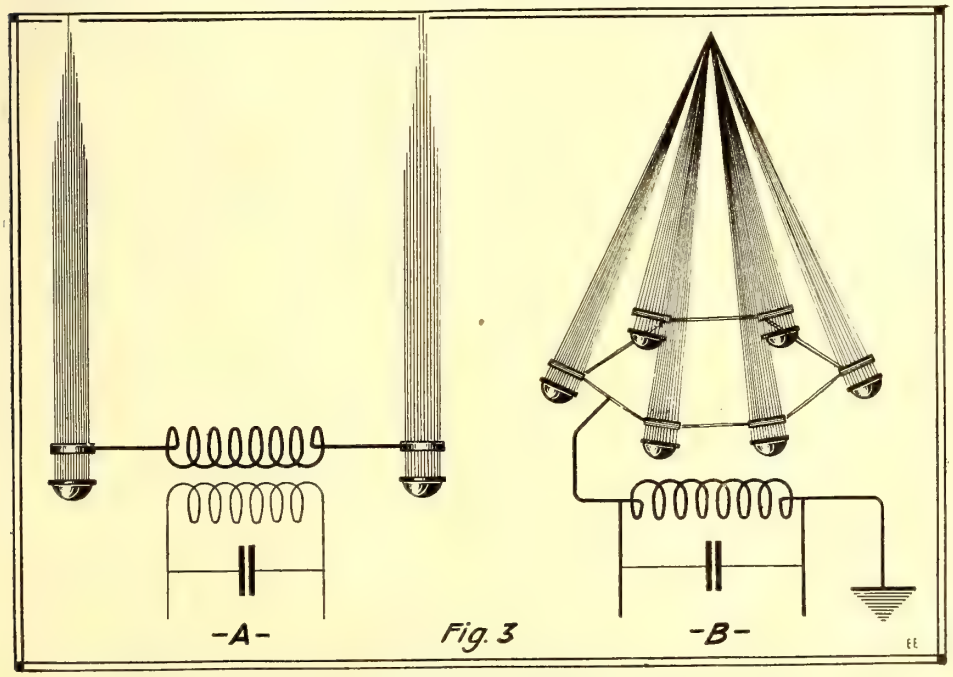
Aside from the transmission of power other advantages may accrue. Will such a stress between the earth and upper air strata reduce the presence of dust particles in the atmosphere? Or, again, cause the immediate condensation of fogs and moisture in the air to give us perfectly cloudless days? Perhaps it will become simply a matter of changing the frequency or voltage of the current to cause rain or to prevent it.

Then the question of effect on radio communication: will it make our present sets obsolete, a transmitter of the future being connected directly to the power set and acting by superimposing different frequencies on the power frequency? Or will radio-telephony work hand in hand with the power system, the voice currents being imprest on the power circuit and filtered out at the receiver?

There are a thousand and one things such an arrangement might effect. Will trees and vegetation increase in growth as experiments in electrical culture would indicate? What effect would such stresses have on germs and bacilli? Their numbers will be decreased by the destructive effects of the ultra-violet light. Will man grow to an unsuspected height and become uniformly healthier due to the electrical treatment he would be constantly undergoing?

And so on—conjecture is without bound, but the scheme is practical to all appearances; it requires but some financial genius to give it a trial.

And to think it all was within reach such a short time ago! Had Tesla but put a gigantic arc on top of the tower of his experimental station in Long Island accurate data would be at hand now—were it but even a promise it would mean another step towards the final mastery of all matter by man.



Two Optional Forms of Wireless Antennae Formed of Searchlight Beams—Ionized Atmospheric Streams.

War Inventions Disclosed

DURING the War, the various countries, as is well known, have developed a great many apparatus which have been found very useful in the pursuit of the enemy. Most of these ideas have been kept secret, and only of late is the veil being lifted degree by degree.

We take pleasure to present our readers today with four ideas little known before. Fig. 1 shows a device that was very popular with French airmen. It was used to facilitate landing of the fliers, particularly during the night time, when landing, as is well known, is particularly hazardous.

Several months before the war a German by the name of König invented an apparatus which was later improved on by the French, and which works as follows: Two iron or wooden circles are placed vertically one behind the other on the flying field, one circle being slightly smaller than the other. The two circles are parallel to each other, and are separated about 15 feet. The circles themselves are about 10 feet above the ground. Fig. 1 shows this scheme.

The circles during the night are illuminated by means of electric lamps around the perifery. Consequently, from a distance we see nothing but two luminous circles, and it becomes apparent when the aviator is at different heights or different levels, or in a position either to the right or to the left—he will see the two circles in different perspectives from one to the other.

In Fig. 1 in the small insert, the different positions of the rings as they appear to airplanes is shown. No. 1 shows that the aviator is too much to the left and elevated too high for correct landing. In No. 2 it will be seen that the aviator is too much to the left; No. 3 shows that he is too much to right, and No. 4 shows that he is in perfect alignment with the luminous circles and will make a perfect landing. This position would be considered ideal. No. 5 shows that the aviator is away too high—in other words, in the position shown of the second airplane in our illustration. The first airplane will make a perfect landing. The third airplane would be too much to the left as well as too high. By studying the figures in our illustration the result will become apparent.

Fig. 2 shows what has been termed the "Tele-Periscope." By means of this apparatus, first used by the Germans, it is possible to see at a great distance, inasmuch as the slender metal skeleton which is painted gray merges into the sky, and at a little distance the enemy has great difficulty in seeing the periscope. Furthermore, the entire contrivance is mounted on a sort of carriage which can be attached to an automobile moving from place to place, so there is little danger of an enemy shell reaching and destroying it. It will be noted that in the large periscope shown the light rays do not come thru the skeleton tube but pass thru the open air, as indicated by the dotted lines. This was found to be quite possible, and while the picture obtained in this manner is not absolutely perfect, still it was good enough to observe the enemy and his doings.

Fig. 3 shows an aerial signaling apparatus used a good deal by the French during the war. By means of an air blast and soot chamber it became possible for the pilot or his assistant to send Morse code signals *in smoke* to the observers below. This is clearly shown in our illustration, which also shows this apparatus in procedure better than words can.

The great trouble with this arrangement is that unless the aviator is well behind friendly lines the enemy, by means of powerful field glasses, can read the dots and dashes as well. Of course cipher messages were used mostly, and thus it made but little difference if the enemy saw the signals or not.

Fig. 4 shows the well known Le Boulangé chronograph to measure the speeds of shells and bullets. The principle of this apparatus is to measure the time which elapses between the rupture of two metal wires stretched between frames, which latter are in the line of a projectile as shown in our illustration. The frames are

(*Continued on page* 1168)

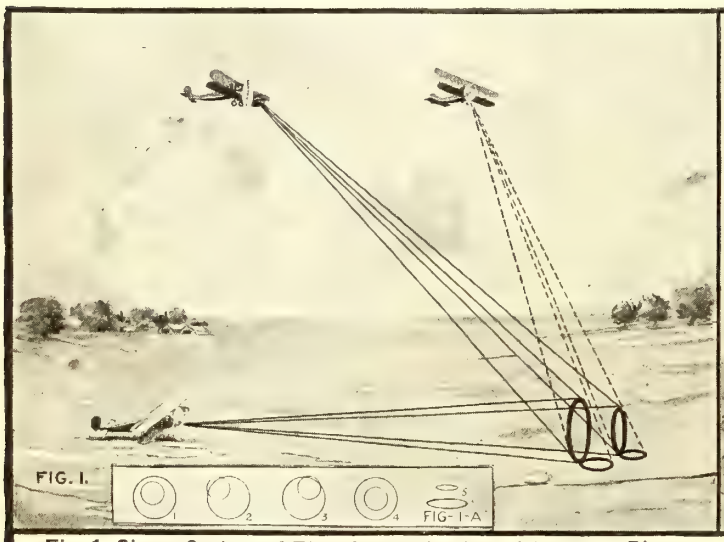


Fig. 1. Clever System of Electrically Illuminated Loops or Rings to Guide Airmen in Making a Safe Landing at Night.

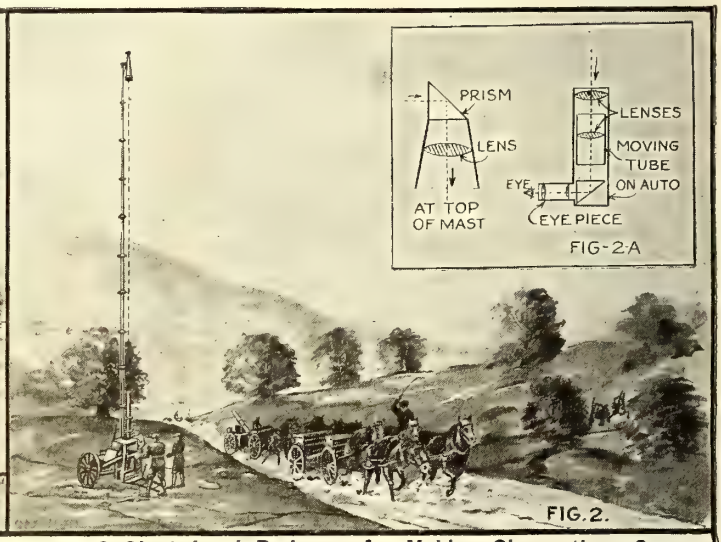


Fig. 2. Giant Land Periscope for Making Observations Over Long Distances. The Image Is Projected Between Lenses Thru the Air.

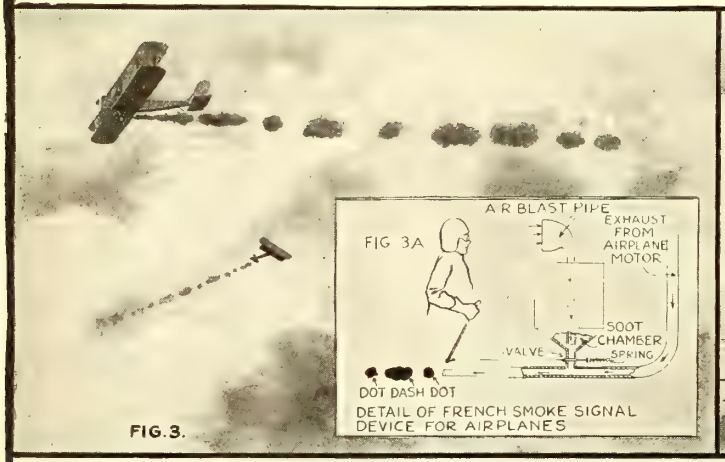


Fig. 3. A War Device—Aerial Signaling by Smoke Puffs Between Airplanes or Airplanes and Earth.

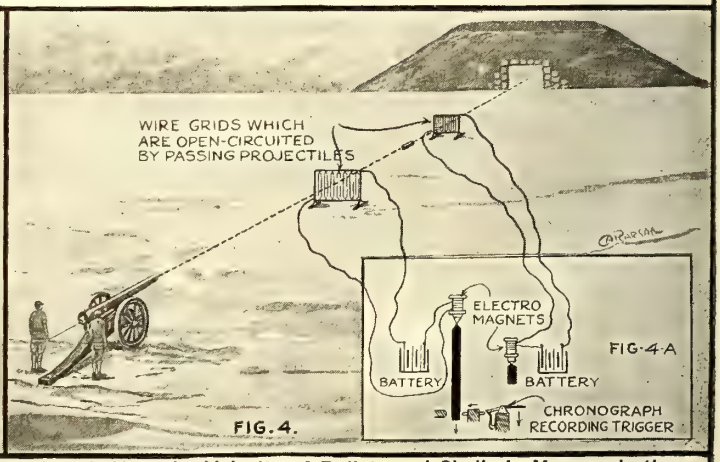


Fig. 4. How the Velocity of Bullets and Shells Is Measured—the Projectile Breaks Two Grids Consecutively, the Chronometer Accurately Registering the Intervening Time.

Huge Siphon Tidal Power Plant

By H. WINFIELD SECOR

How Sea Water is Siphoned into and out of Reservoir, Developing Electric Power Either Way

FROM time to time, some budding genius comes out before the world with a startling invention with which he proclaims that he intends to harness the power of the ocean waves or the power of the tides, whether these be created by ocean, river or lake action, primarily. Most of these schemes die a natural death while reposing in the vaults of the U. S. Patent Office, even tho the patents may eventfully be issued on the more or less successful looking inventions.

One of the most ingenious ideas that has been proposed recently in the realm of tidal power plants is the one illustrated herewith, and which has been invented and patented by Mr. Charles Herbert Talmage of New Bedford, Mass. The inventor certainly deserves a great deal of credit for the way in which he worked out the various details of this tidal power plant and the means for applying it in practise, especially in the clever construction of the collapsible dams, which are caused to rise and fall by water pressure.

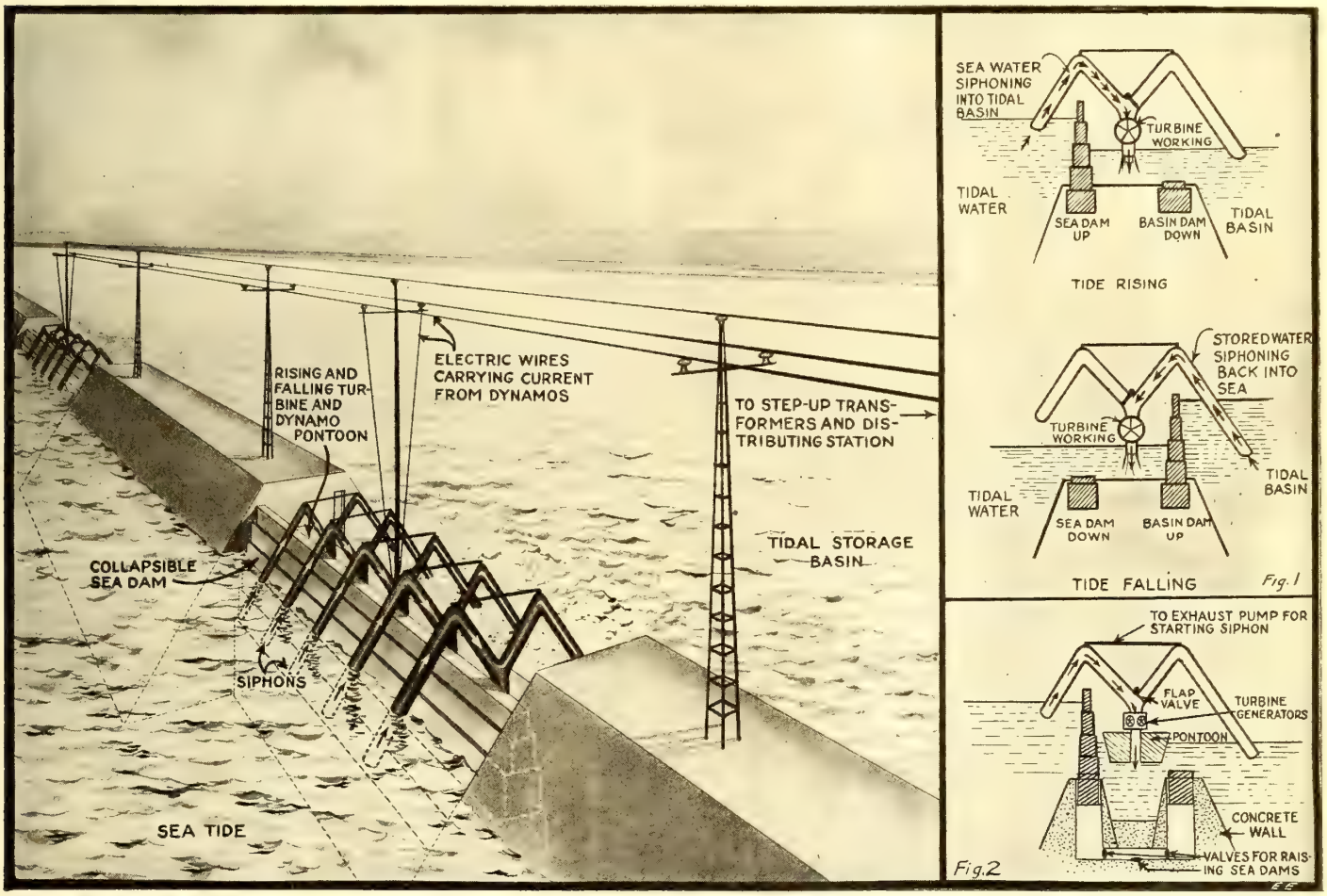
The accompanying illustration shows clearly just how Mr. Talmage proposes to reap useful power from the gigantic tidal actions occurring along our great sea coasts and other locations such as along rivers. In brief, the principle underlying the operation of this tidal power plant is as follows:

By referring to the small detail illustrations herewith, it will be seen that as the ocean tide rises, for example, that the water within the large reservoir or tidal basin will be at a lower level. As the ocean tide proceeds to slowly rise, the sea dam is raised by hydrostatic pressure or water pumped into it by suitable means, while the turbine float with its two or more attached siphoning pipes rises correspondingly. All the while water is flowing from the sea up thru the siphons and out thru the turbines into the tidal basin as shown by the arrows.

In the first place, the siphon action is created by exhausting the air from the left hand siphon, thru the small pipe connecting the tops of the two siphons, and which is joined to a suitable exhausting apparatus or machine, not shown. This action keeps up until the sea tide has risen to its highest level and shortly after which period the level of the water in the tidal basin will have risen to a similar height.

As soon as the sea tide begins to fall or ebb, then the reverse action is set up by opening the valve at the basin siphon just above the turbine, and closing off the left hand siphon, as clearly shown in the second detail illustration. A vacuum is created in this siphon by the action aforementioned, and the water is caused to flow from the tidal basin, into the right hand siphon, down thru the turbine and into the sea again.

The pontoon containing the turbines and dynamos falls with the sea tide, and the basin or right hand dam is slowly collapsed by emptying the water out of it. In this way power is developt practically all the time, while the sea tide is rising and while it is ebbing, and useful energy is thus realized from the tidal power itself, without any expenditure of money for coal or other source of energy, the only actual expense being that for the operating personnel and the initial cost of the installation of the machinery and dams.



Remarkable New Tidal Power Scheme Utilizing the "Siphon" Principle—the Water Is First Siphoned from the Sea Into the Impounding Reservoir and Afterward, on Falling Tide, Siphoned Back Into the Sea. Either Way the Turbines and Dynamos Extract Their Quota of Energy from the Flowing Water.

As the large perspective view shows, a substantial and adequately strong wall has to be erected along the sea front, to withstand the pounding of the waves and also to serve as a restraining wall for the impounding reservoir and the millions of cubic feet of water which would be siphoned into it from the sea. The inventor's designs call for siphon, turbine and generating units mounted in groups of five, which is a very good idea, and several of these units can be grouped along the sea wall in the manner illustrated.

At the present time, engineers and others are rather wont to scoff at what to them appear to be radical and impractical tidal

(*Continued on page* 1178)

Trapping With a Mouse Trap Camera

By HOWARD TAYLOR MIDDLETON



A Snapshot of Br'er 'Coon—One of the Hardest Animals to Photograph. It's Easy With the "Mouse - Trap" Scheme Here Described.

FOR a long time Mrs. Middleton and I had induced birds and animals to photograph themselves thru the medium of a bit of thread stretched from camera shutter to bait, and, while we had obtained numerous successful pictures, we often failed to get a good portrait, due to the blurring of the subject caused by movement. We used a Premo camera with rapid rectilinear lens, maximum shutter speed 1/100 second, and this was not fast enough to make a sharp image certain under all conditions. In order to overcome this difficulty, we realized we must use our Graflex camera which would shoot as fast as 1/1000 second if desired. However, here we met with, what seemed at first, an unsurmountable obstacle: The focal plane shutter of the Graflex does not release with a hair-trigger pull like the Premo shutter, but with a *steady downward pressure*, and we doubted very much whether a small animal or bird would have the strength to operate it.

What we needed was a piece of mechanism with a hair-trigger at one end and a strong pull at the other, and we have found this in a 5-cent mouse trap! Clampt in position directly beneath the Graflex, with thread running from wire loop of trap to camera shutter trip, and from pedal of trap to bait, the apparatus is ready for action.

We will not venture far afield to try out our mouse trap camera. There are barn rats down in the granary; we ask you to accompany us in an endeavor to induce one of the furry tribe to present us with his portrait. We set up our camera outfit just outside the granary wall, place the mouse trap in position, connect the thread, at the end of which we hang a tender morsel of meat, and depart for an hour or so. Upon our return, we find the thread broken and bait gone. Development of the negative brings up the image of Mr. B. Rat, Esq., in the act of partaking of our hospitality. He is a thieving rascal, no doubt, but he is a gentleman as well in so far as his table manners are concerned. (See illustration.)

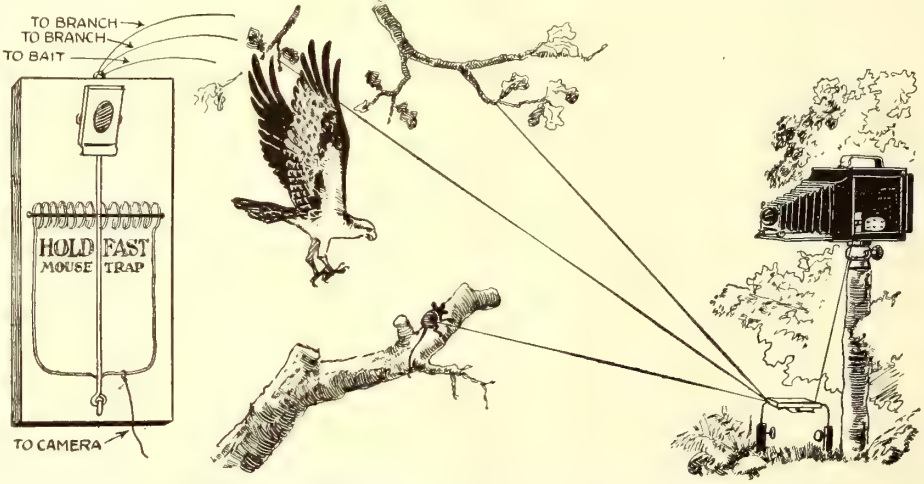
We know of a snug nest beneath a windbreak in the deep woods where Br'er 'Coon snoozes the daylight hours away. Let us set up our mouse trap camera along his trail. Then as he emerges from his den, stepping daintly forth to greet the golden rays of the westering sun, his hand-like fore-paw touches the thread. Thud-snap!



Mr. Barn Rat, Esq., Photographed in a Thoughtful Pose by the "Mouse - Trap" Camera. Lifelike, Isn't it?

goes the mouse trap camera, and with a whoof! of surprise a fluffy gray ball of fur flashes away thru the forest glade, flinging the autumn leaves in a multi-colored shower from beneath his flying feet. He has left his portrait with us, however, and we are satisfied.

Birds as well as animals can be trapt photographically as described above. That brigand of the air, the hawk will gladly pose for you if you will place a mouse or an English sparrow upon a limb for his benefit. In this case, use three threads instead of one, two running to overhead branches and the third to bait. (See sketch herewith.) By this method, if his wing should touch the thread before he reaches the bait, you will catch him in the air—a unique portrait, indeed.



By Rigging Up the Mouse-Trap With 3 Strings the Graflex Is Easily Operated by a Bird Attracted by Bait.

French Radio Station to Have 13,000-Mile Range

At an early date France will possess a wireless station capable of sending messages everywhere on the world's surface. This station, now nearing completion at Bordeaux, will have sufficient power to reach all stations within a radius of approximately 13,000 miles.

The Eiffel tower station and the immense government station at Lyons have been France's important stations thruout the war. The Eiffel tower was able to send messages up to a distance of 3,500 miles, while the new station at Lyons had an average range of about 7,000 miles.

An average of 10,000 words per day have been sent out from Lyons thruout the war. It was from this station that many parts of the world were kept informed of the war's progress, even the Far East getting its western front news from this station's messages which were picked up in Shanghai, and there given to the local papers.

The Bordeaux station has been jointly constructed by Americans and French. When General Pershing arrived in France he requested a station which would enable him to keep in touch with the United States at all times regardless of bad atmospheric conditions. The Bordeaux site was immediately suggested by the French government and work begun under the direction of General Ferrie, of the French telegraphic service. Nearly 1,000 French and American soldiers were assigned to the task of constructing the immense station.

In actual electrical power supplied the antenna the capacity of the Bordeaux equipment will be five times as great as the Eiffel tower and three times as great as the Lyons station. Fully 500 kilowatts will be available for transmitting the messages. This will be far the greatest electrical force ever devoted to the radiation of wireless news.

The famous German station at Nauen, heretofore the most powerful in Europe, will be greatly outdistanced, both in sending distance and in daily capacity. The Bordeaux station will be able to send 50 words per minute, or a total of 72,000 per day. The great capacity will be made possible by the employment of special equipment heretofore confined to wire telegraphy.

Sixty men will be needed to maintain and operate the station. They will work in four shifts, keeping open a continuous twenty-four hour service.

NOVEL ELECTRIC STUNTS



Did You Ever Play Phonograph Roulette? A Cardboard Wheel of Fortune Is Placed on the Disc and a Metal Stop Is Fixt at the Side. A Sewing Machine Motor Runs the Phonograph Electrically.

The Curling Iron Is Not Solely a Thing of Vanity. It May Be Brought Into Extremely Practical Use as a Presser of Garments. When Used Closed, the Curling Iron Makes the Hem In the New Skirt Look as Thoroly Prest As with a Sad Iron.

An Electric Curling Iron May Be Used to Advantage As an Immersion Heater After Thoro Washing of Course. The Bachelor Maid May Heat a Can of Peas Corn, Beans etc. Right In the Can

The Remarkable Heat of the Nitrogen Lamp Is Ordinarily Wasted. A Nitrogen Lamp Soldered Into a Dipper When Held Over Eggs Will Cook Them In Three Minutes. Butter Should Be Spread Over the Top of the Yolk So That It Does Not Harden Before It Is Cooked

Extend the Camera Tripod and You Have a Fine Floor Lamp for Reading or Piano

The Tripod Is Now Invading Other Fields Aside From That of Photography. It May Be Made Surprisingly Useful in the Home as a Reading Lamp for the Table

An Inexpensive Electric Heating Pad — An Electric Light Bulb Is Put Into a Mason Jar and the Wire Is Run Thru a Hole Made In the Metal Top. This Makes a Perfectly Safe Bed Warmer, as the Heat is Moderate.

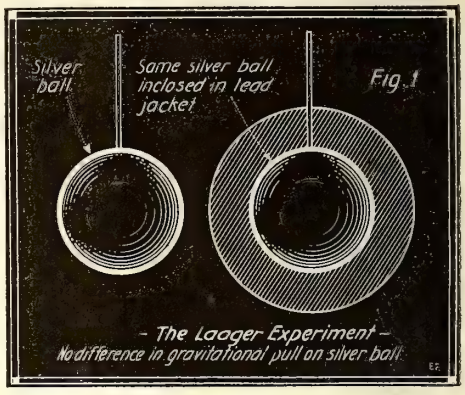
Lighting the Gas Electrically Is Now Made Possible By the New "Violet Ray" Generators on the Market Used to Relieve Pain. The Series of Small Sparks Does the Work Instantly

New Researches in Gravitation

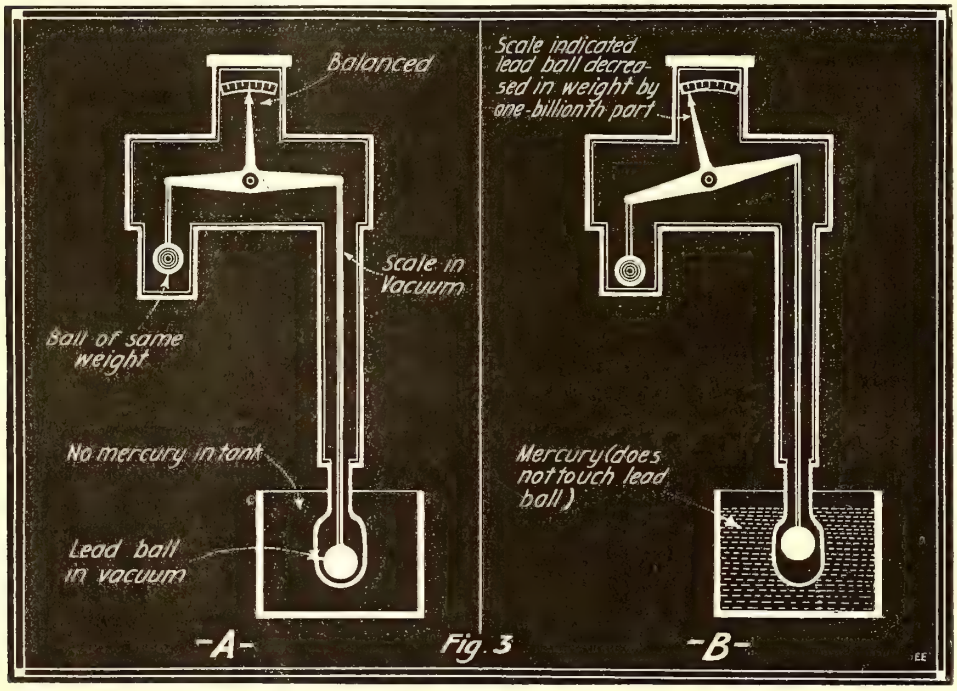
By PROF. QUIRINO MAJORANA

TRANSLATED FROM THE ITALIAN BY ARTHUR BENINGTON

THE new theories and new facts set forth here were brought out by considerations in the field of cosmogony as well as in that of physics, properly so-called. In the field of cosmogony it is possible to observe quite closely. It is well known that examination of the light emitted by celestial bodies enables us to classify these into white, yellow and red stars, in addition to double stars, stellar masses, nebulae, spiral nebulae, etc. Now we know from observation that the white (with very high temperature) are about 60 per cent of all the stars; the yellow (about 6,000 degrees, like our sun), 35 per cent and the reddish only 5 per cent. The temperature of the stars is deduced from spectroscopic observations—experiments with the various types of spectra, i. e., the continuous spectra and the bright line spectrum. The result is that the red stars are very few in number. On



In the Laager Experiment, the Lead Jacket Placed Around the Silver Ball Did Not Cause Any Decrease in Its Weight—Due to the Scale Not Being Sufficiently Accurate, Prof. Majorana Believes.



Simplified View of Prof. Majorana's Vacuum Scale and Mercury Container for Weighing a Lead Ball, First Without Mercury Surrounding It—Full Gravitational Pull—and Second, With Mercury Surrounding, but not Touching Ball; the Mercury Absorbing Some of the Gravitational Force.

what theory can this be explained? The idea most generally accepted by astronomers is as follows: The several suns of the universe had origins similar to that of our solar system; this is defined according to the hypothesis of Laplace; therefore, it is a matter of nebulae that, gradually condensing, give place to the formation of a central sun with its own planets and satellites. Now as these systems, with the passing of millions of years, go on progressively cooling, they should present themselves to us to-day with widely differing temperatures. So, according to this hypothesis, it seems strange that only 5 per cent are made up of red stars; that is to say, stars that are relatively cold or approaching the phase of extinction.

Besides, according to certain theories of thermo-dynamics that would compare the universe to a mass of worlds like the molecules of a gas, it seems we can exclude the possibility that dark celestial bodies, that is stars without light, exist in the heavens. This, be it understood, if we ignore certain small bodies in size about like our earth or, at most, like Jupiter (respectively 1/1,000 and 1/333,000 of the solar mass).

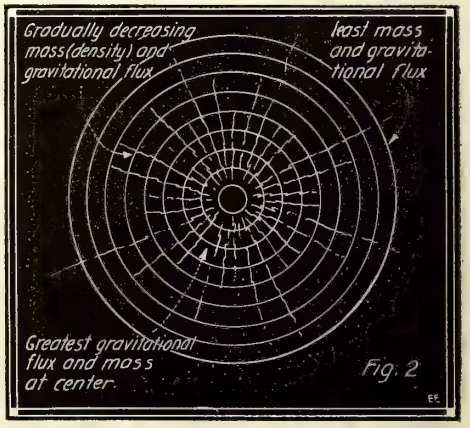
If the origin of the several solar systems of the universe had been accidental and had taken place at very different epochs, it would be logical to suppose that a number of stars much greater than 5 per cent would present themselves with the low temperature of the red color, and besides that many others would be completely extinct. To explain this state of things one willingly recurs to the idea of God; that is, to a supernatural hand which created the universe with all its worlds contemporaneously. But evidently this idea is exiled from the field of positive science; its introduction would constitute only a simple criterion and, altho I do not say that the naturalist must be an atheist, it is certain that he should not abuse this too convenient idea, for he would not further the progress of experimental science or of observation. Therefore, I say that we must seek another explanation of the constitution of the heavens.

Without leaving the field of cosmogony, let us turn our attention to the origin of solar heat. The controversy is well known; neither the theory of chemical origin nor that of the fall of meteorites at 616 kilometers a second can explain the enormous quantity of heat constantly emitted by the sun. It was Helmholtz who advanced the most generally accepted theory of solar heat: He supposes that the sun is gradually contracting, that this considerably slows down its cooling and creates a new source of heat. Unfortunately, physicists are able to calculate the extreme limits that the sun's life may have if such contraction be admitted. Poincaré has made the calculation and finds that the sun could not be more than fifty million years old. Now, according to Laplace's hypothesis the earth, having been detached from the central mass of the nebula which was the sun, must have an age certainly no greater than that of the sun. On the other hand, there are indications offered to us by the geologists and biologists which give us reason to believe that the earth may have an age notably greater than the 50,000,000 years deduced from Helmholtz's theory. These indications are based upon a study of the numerous sedimentary strata of the earth, of the corrosion of chains of mountains which once were like our Alps and now have disappeared, of the saltiness of the sea and, in another field, of the time required for the evolution of animal and vegetable species. Thus some have succeeded in establishing that the earth cannot be less than a billion years old. So Helmholtz's theory, the only acceptable one up to the present, is defective.

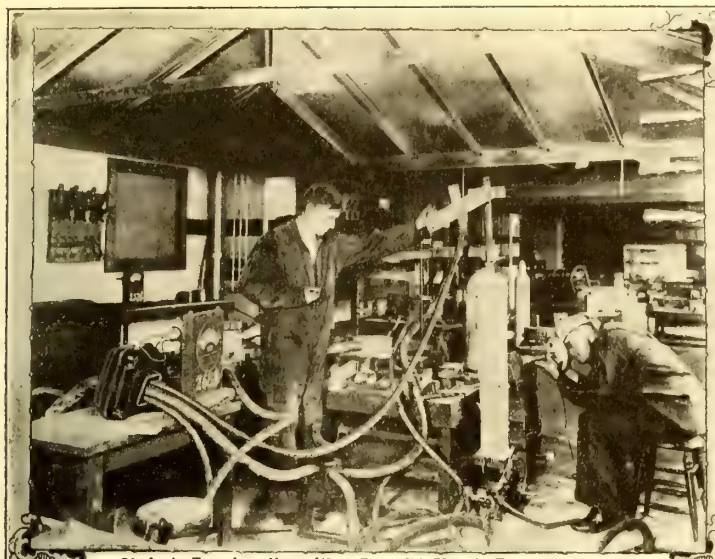
The considerations made by me in the field of physics are of an entirely different order of ideas.

They refer to the law of universal gravitation, the famous law of Newton. This law teaches us that two material masses attract each other in direct ratio to their mass and inversely as the square of their distance. This law governs the movements of the stars; to this law is due the fact of the weights of bodies. Cavendish, an English physicist, proved in the laboratory, after Newton, the phenomenon of the attraction between two masses. The Cavendish balance enables us to see that two bodies, one of about one kilogram, the other of about one gram, attract each other with a force of about 3/1,000,000 of a milligram; the force that the earth exerts upon this same gram is 300,000,000 times greater.

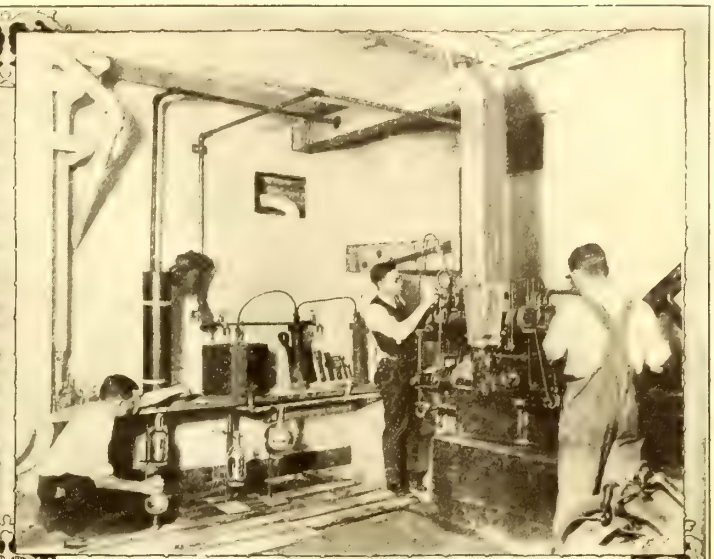
(*Continued on page* 1188)



The Author Believes that the Highest Density and Gravitational Flux is at the Center of the Mass as Here Shown.



Students Experimenting with a Powerful Electric Tube Furnace. The Man Seated Is Determining the Temperature of the Furnace by Means of a Measuring Instrument Known as an Optical Pyrometer.



Here the Students, in a Leading College Laboratory, Are Shown Experimenting with Liquid Air, About Which We Hear Very Little Just Now, But Which Is Destined to Solve Many Future Problems.

Modern Schoolroom Science

TWENTY years ago we studied Science in the schoolroom and college, to a great degree at least, from the textbooks. To-day the embryo scientists play around with such simple little things as "liquid air," "radio telegraphy," "electrochemistry," etc. The photos herewith show two interesting laboratory scenes taken at one of America's leading engineering schools.

The liquefaction of air on a commercial scale came with the invention of the modern high pressure air compressor. The compressor shown on the right in one of the photographs is compressing air to 3,000 pounds per square inch which is roughly 200 times ordinary atmospheric pressure. The air then cools by expansion in tubes immersed in cooling agents seen in the center of the photograph. The air is forced thru this process again until its temperature has been lowered to 310° F. below zero, at which point it becomes a liquid and is drawn from the cylinder at the left. The use of the liquid air in scientific research is as a cooling agent. By placing the substance to be experimented on in a tube and immersing the whole in the liquid air the behavior of different substances under various conditions at extremely low temperatures can be determined. A study of the properties of different substances at temperatures in the region of the absolute zero, i. e., the temperature at which gases cease to exert pressure, has been a fruitful source of information in developing modern theories of matter.

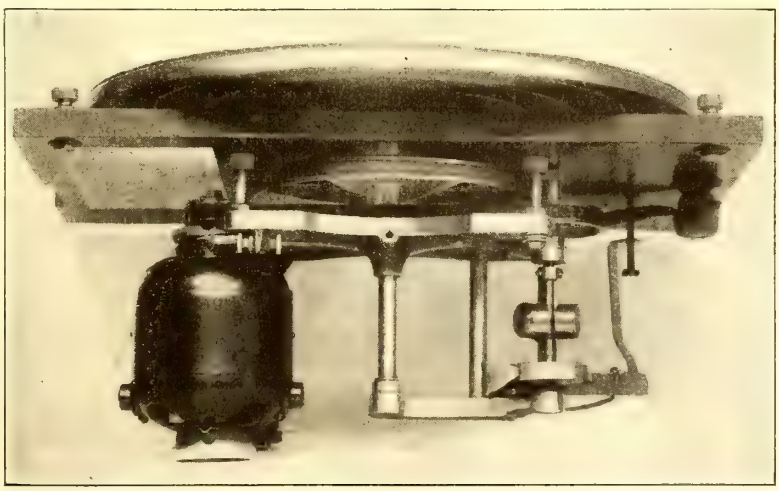
In industry liquid air is used as a source of pure oxygen, which is obtained by a process of fractional distillation in taking advantage of the different boiling points of liquid oxygen and liquid nitrogen which are the two principal constituents of air.

Liquid air and liquefied helium have done their bit toward helping to solve some of the world's greatest scientific mysteries. Onnes, by placing an electric circuit in liquefied helium, reduced its resistance to approximately absolute zero, and a current, once started in the circuit, kept on flowing, almost like perpetual motion, for over twenty hours. Liquid air freezes or solidifies mercury and is used extensively in exhausting X-ray and audion bulbs to the highest degree.

Our second photo shows industrial research with an electric tube furnace. A great industry has grown up around Niagara Falls, where enormous waterpower is available for transfer into electrical energy, in which application is made of the chemical effects of electricity. It is the so-called electrochemical industry and in it the electric furnace stands supreme as a magic crucible in which chemical wonders are performed. In the photograph students are shown operating an electric furnace of the "tube type" which they have themselves constructed. The man seated is determining the temperature within the furnace by an optical method, depending on the measurement of the light-giving power of an incandescent body under certain standard conditions.

Phonograph Runs 2500 Years

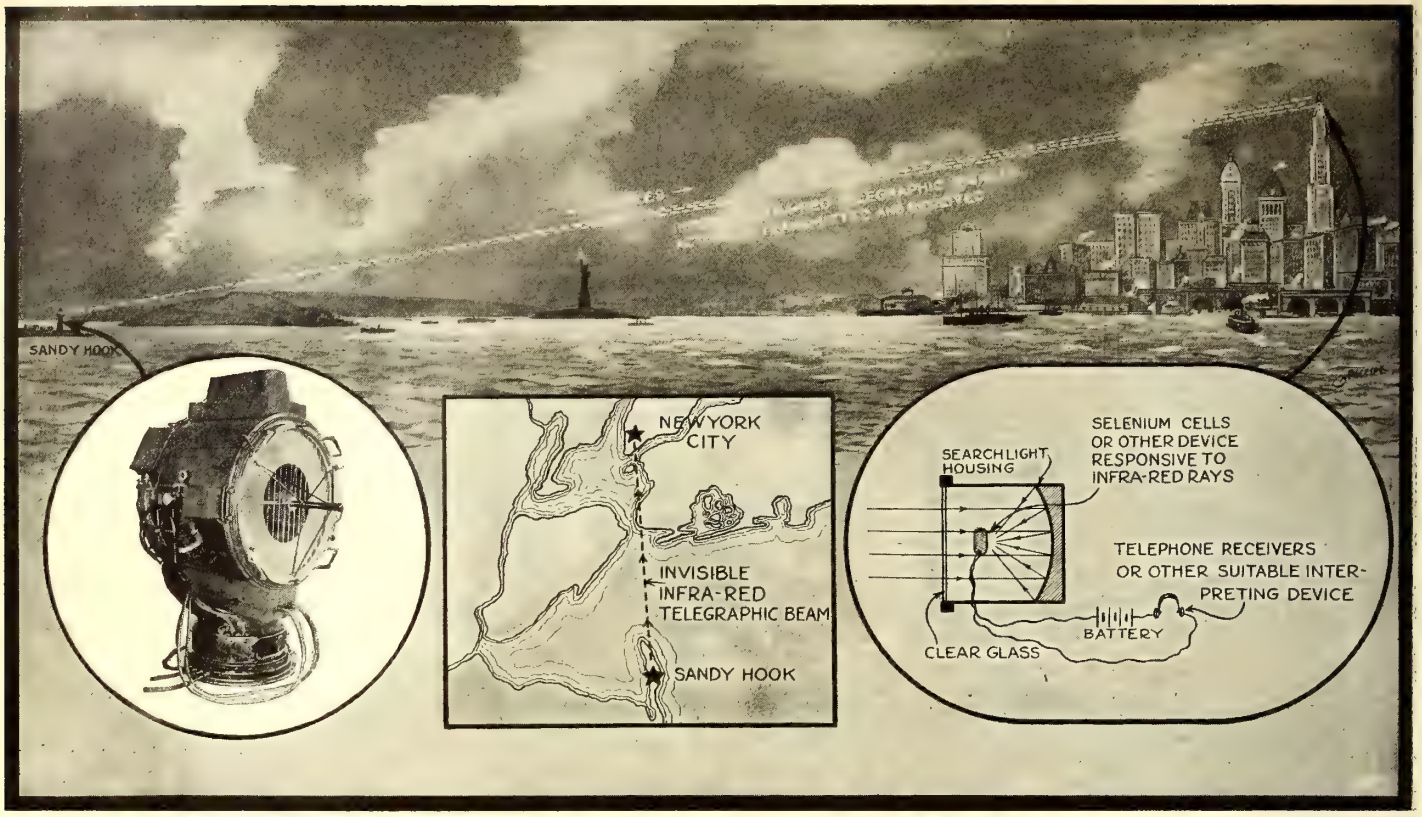
The accompanying photograph shows a new type of electric-driven phonograph designed by Dexter W. Allis, of Whitman, Mass. This invention was the outcome of numerous experiments in an attempt to construct a machine, simple, noiseless, and durable. It will be seen that gears are eliminated; the drive being transmitted from the electric motor at the left by endless belt to the governor and friction rolls. Provision is made for adjusting the belt, for keeping the friction-wheels automatically in contact, and for supplying the bearings with oil from saturated cushions.



This Electrically Driven Phonograph, on Actual Test, Ran Long Enough to Last the Average Man 2,500 Years, at the Rate of One Hour's Run Per Week.

One of these machines was started on a continuous-running test November 16, 1916, and ran continuously for eighteen months. At the end of this time it was operating quietly and perfectly in every way.

During this time the turn-table made over 64,000,000 revolutions, or enough to roll more than around the earth. The electric motor made over 1,475,000,000 revolutions. Allowing that the average phonograph is run one hour per week, this machine, at that rate, would (bar accident) have lasted its owner and his descendants over 2,500 years!



Not One Person In a Million Perhaps, If Indeed That Many, Ever Dreamed That During the War Invisible Searchlight Signals Were Shot Over Their Heads From Sandy Hook to the Tower of the Woolworth Building, New York City, a Distance of 18 Miles. Such Signals Were Actually Sent, However, by Invisible Infra-Red Rays From a Large Searchlight Like That Shown on the Left of the Illustration. A Selenium Cell or Other Suitable Device Indicates the Reception of These Signals.

Telegraphing by Invisible Light Beams

PROBABLY not one person in 1,000,000 residing in or near New York City are or were aware that during the course of the World War the government carried on some very successful and extremely interesting experiments in telegraphing by means of *invisible or non-luminous* searchlight beams—and these were not small searchlights or short-range beams, either!

The accompanying illustration depicts one of the successful experiments conducted by the government experts, in connection with one of the leading American searchlight manufacturers, in which case signals were successfully transmitted from Sandy Hook, 18 miles distant, to a receiving station located atop the Woolworth building tower, in New York City. Not the least sign or flicker of a searchlight beam was visible while this transmission was taking place—a very paradoxical and puzzling phenomena to be sure! And yet the answer is simple when once the principle on which it operates is known.

The answer is, "Infra-red rays." These rays, which are produced in abundance by many sources of light and particularly by high-power arc lamps such as those used in searchlights are invisible to the human eye. Thus, once we have the source of invisible rays, all that we require to transmit signals by telegraphy or otherwise is a sufficiently sensitive instrument which will be affected each time the infra-red rays are thrown on to it. Happily, there are several such instruments known to science.

The infra-red rays which are below the ordinary visible spectrum, as before mentioned, are invisible to the naked eye; they are moreover very penetrating and are subject to the same optical laws as ordinary light. The searchlight or other source of illumination used at the transmitting station is shielded or covered with a deep red glass, containing manganese—as stated by Mr. de Gallaix in his experimental article on this most interesting invention published below—or some other suitable material which will practically eliminate all trace of visible or radiant light, but which will readily pass the infra-red radiations.

Several substances which cut off visible light rays entirely, but which will let the infra-red rays pass almost perfectly, are vulcanite, iodin and bromin.

In the experiments above cited, in which telegraph signals were transmitted between Sandy Hook and the Woolworth tower in New York City, a distance of approximately eighteen miles, a specially treated selenium cell was used at the receiving station. The usual practice in designing a receptor for the infra-red rays is to utilize a housing similar to a searchlight, in one end of which is a parabolic reflector. The incoming infra-red rays pass thru a plain glass window, strike the reflector, which in turn brings them to a focus at a point just in front of the reflector, and at this focal point is mounted a responsive instrument such as a selenium cell, etc.

As Mr. de Gallaix points out, zinc sulfate treated tape may be used or also the Edison tasimeter, which will measure heat accurately down to the 1/10,000 part of one degree, and also the bolometer. If a selenium cell is used, it should be sensitized by the Abney process to render it particularly responsive to infra-red rays. The bolometer is recommended by several experts as probably the best means adapted for such purposes in interpreting telegraph signals, et cetera, where rapid changes in the resistance or other characteristics of the receiving element are necessitated.

The Edison tasimeter and the selenium cell are liable to prove too sluggish if very high speed is required in transmitting the signals. As the diagram shows, a suitable interpreting apparatus such as a loud speaking telephone receiver or a suitable relay and other indicating apparatus is connected with a battery in series with the selenium cell, or bolometer.—*The Editors.*

Invisible Optic Telegraphy by Infra-red Rays

By HENRY de GALLAIX

INVISIBLE optic telegraphy has been the object of long researches on account of the great advantages it possesses over the ordinary optic or radiant light telegraphy. Ordinary optic or light beam telegraphy has the inconvenience of allowing itself to be intercepted with extreme ease by anyone who cares to. As for wireless telegraphy, the use of a secret code is only a semi-efficient remedy. Therefore, the invisible telegraphy by infra-red rays is a remarkable improvement on all systems invented and used before. To solve the problem of invisible optic telegraphy, three methods could be applied.

First: By some sort of mechanical contrivance, make the rays, sent forth by the light source, invisible to human eyes.

Second: Create a source of rays invisible to one's eye (infra-red rays, for instance) and transmit them directly.

Thirdly: Obtain the invisibility by the physical nature of the rays coming from a light source, visible to one's eye.

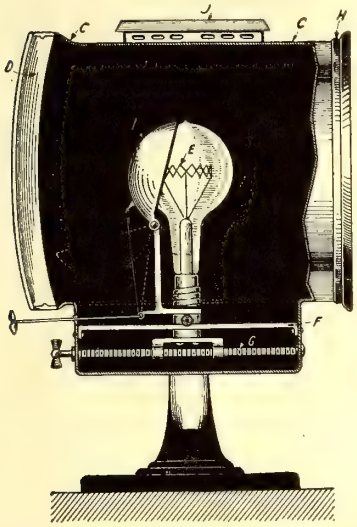
Such were the lines on which the question of invisible optic telegraphy had to be studied.

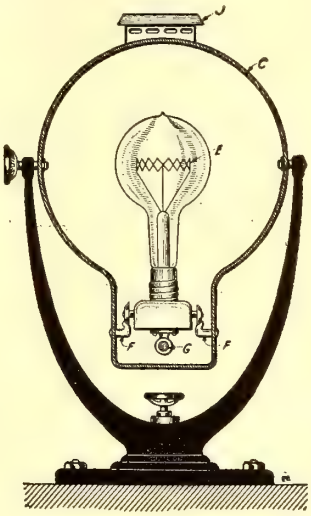
The first method gave no results, attempts were uselessly made to apply to the rays the theories of synchronism, the application of which to the electric current allowed Baudot to create his famous Multiplex telegraph system, which is called after his name.

The second method seems at first sight to be the simplest, and it would indeed be the solution giving the best results, if the emission of infra-red rays could be done as that of ultra-violet rays by a Crookes tube, for instance. Pursuing the researches made by Roentgen and Crookes on the extreme rays of the solar spectrum, a number of investigators tried to solve the problem in that way. I have no doubt they will succeed, but up to the present time only the third method has realized the invisible optic transmission. A detailed account of that method makes the subject of the present article.

THE INVISIBLE RAY TRANSMITTER.

The apparatus is composed of a transmitter sending forth the invisible signals, and of a receiver taking in the messages sent forth by the transmitter, which is but a powerful electric incandescent lamp, or else an electric searchlight to which some alterations have been made. If there is a need of transmitting at long distances, powerful searchlights are always used, but I will confine myself to the description of the standard transmitter, which has a diameter of one foot.

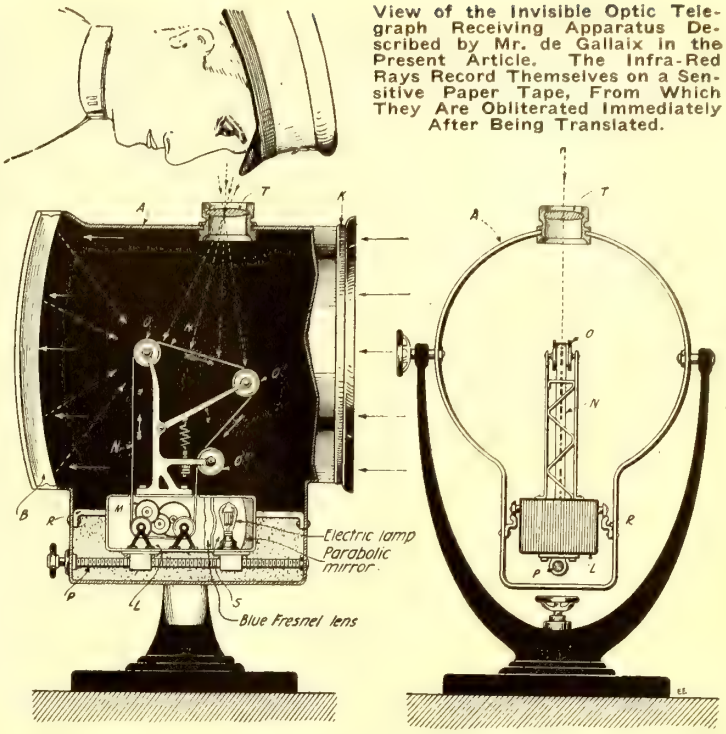




One Form of Infra-red Telegraph Transmitter described by Mr. de Gallaix, Using Instead of an Arc Lamp to Generate the Necessary Rays, a Concentrated Filament Tungsten Lamp. A Red Manganese Glass, or Else Ebonite, Is Used In Front of the Searchlight to Cut Off the Radiant Light Rays.

It is made of a metallic cylinder C, covered inside with black paint, light-tight, tho ventilated by the top and by the bottom J. A parabolic crystal mirror D is placed at one end of the housing. In the center is placed a special electric lamp E with a tungsten filament emitting the least possible blue light and a lighting power of 200 candles. The voltage of this lamp does not matter and is in connection with the voltage at our disposal. The lamp is placed in such a way that its maximum center of light is in the central longitudinal axis of the mirror and a contrivance—slider and dead-end screw F and G permits of moving the lamp forwards and backwards, so as to obtain the proper focus.

The forward end of the housing is closed by a *dark red colored glass,* opaque enough to be penetrated by no other rays than the infra-red ones. So, that looking from the outside the red glass of the transmitter which stops all rays visible to our eyes, the light from the electric lamp cannot be seen; *its unique object is to produce by its white light the infra-red rays, necessary to the invisible transmission.* The opaque, red glass H is a chemical glass in the composition of which enter several metallic salts, especially manganese salts. A hemisphere of blackened metal I, covers half the globe of the electric bulb, being a screen between the light source and the mirror. During transmission the lamp is kept burning steadily, that portion of infra-red rays coming directly from the lamp thru the manganese glass, without the refraction on the mirror being too little for the limited sensitiveness of the receiver. The hemisphere, at rest, between two Morse signals prevents the rays reaching and being reflected by the mirror and thence thru the manganese glass. Either electrically, by means of a Morse key acting on an electro magnet, or more simply by a wire thread, the hemisphere is made to fall down in the bottom of the cylinder, thus unmasking the lamp and allowing the rays to be reflected by the parabolic mirror, and sent back to the manganese glass, which by its composition makes way but to the infra-red rays, invisible to our eye. Such is the way in which luminous signals are sent with the telegraphic code. The transmitter of one foot in diameter, which we have just described, has a transmission power of one-half of a mile. When longer distances are to be covered, large searchlights are used. They have a voltaic arc, a diameter of three to five feet, and a manganese red glass is added either before or behind the *shutter,* according to their construction. The signaling process consists then in opening or shutting more or less quickly the above-mentioned shutter.

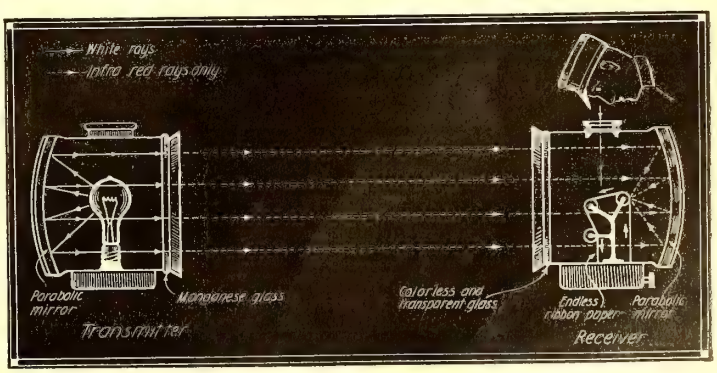


View of the Invisible Optic Telegraph Receiving Apparatus Described by Mr. de Gallaix in the Present Article. The Infra-Red Rays Record Themselves on a Sensitive Paper Tape, From Which They Are Obliterated Immediately After Being Translated.

THE INFRA RED RAY "RECEIVER."

The apparatus receiving the infra-red rays sent out by the transmitter, however great the distance may be, has always the same diameter and is, roughly speaking, of the shape and dimensions of the standard transmitting apparatus above described. It is composed of a metallic cylinder A, blackened inside and of a diameter of one foot. As is the case with the transmitter, a parabolic mirror B, of crystal, is placed at one end of the cylinder and at the other end there is a colorless and transparent glass, which has no other object than to close the apparatus and protect the internal mechanism against dust and inclemency. Under the receptor is placed a box of rectangular shape L, containing the mechanism M, destined to give a forward movement to the tape or endless ribbon N, made of special paper on which are to be printed the received telegraphic signals. The mechanism M setting the ribbon in motion is either a clock movement or a very small electric motor. The band of paper passes over a roller O situated exactly at the focus

(*Continued on page* 1214)

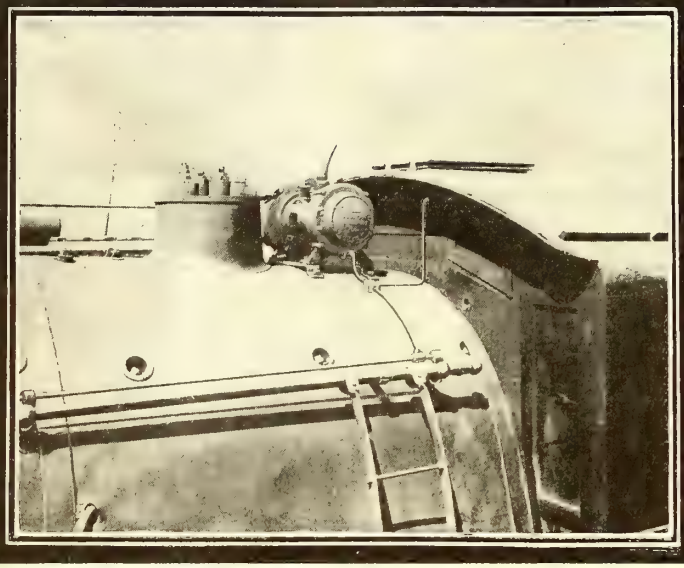


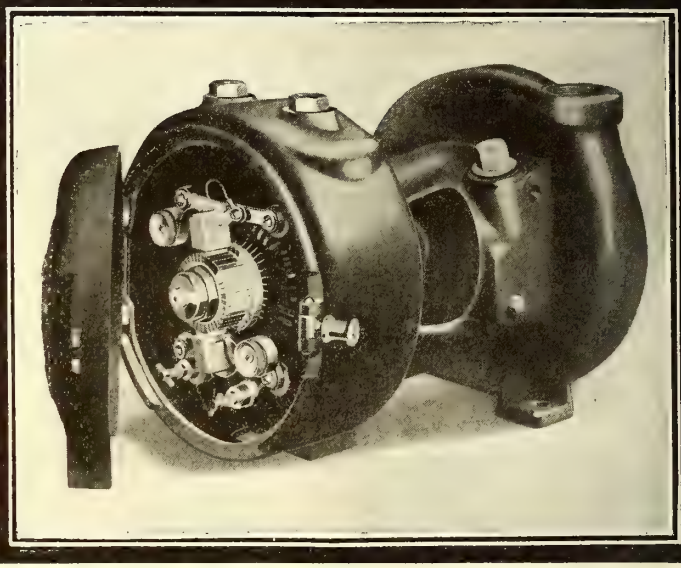
This Diagram shows the complete Infra-Red Telegraph System. The Transmitting Lamp on the Left, and the Receiving Instrument Containing a Moving Paper Strip Sensitive to These Rays, On the Right. No radiant Light Rays Are Transmitted or Can Be Seen, Which Would Expose the Position of the Instruments.

If You Have Traveled on Steam Railroads Very Much of Late, You Will Have Taken Note of the Fact That Locomotives Are Now Carrying Extra Powerful Headlights Which Are Capable of Throwing a Strong Beam of Light for a Distance of One-half Mile or More. At First You Would Think It Was Some New-fangled Form of Oil or Gas Light, But When You Come to Investigate, You Will Find That It Is a New Electrical Headlight, Developed in the Past Few Years, Especially for Locomotive Service. These Headlights Provide Approximately 1,000,000 Beam Candlepower.



Over 70,000 of These Steam Turbine Driven Electric Generating Sets for Locomotive Headlights, Have Been Adopted in This Country. One Method of Mounting the Turbine Generator as Well as a Close-up View of the Turbine and the Dynamo, with Its End Housing Open to Expose the Commutator and brushes, Are Shown Below. The Tungsten Filament Lamp Is Rated at 250 Watts and Gives 290 Candle-power. The Voltage of the Dynamo Varies from 32 to 110 Volts in the Different Types. The Dynamo Supplies All Running Lights and Marker Lights.





Locomotives Have Electric Headlights Now

IF you have traveled very much on railroads in the past two or three years, you will have undoubtedly noticed that many of the country's leading railroads are rapidly relegating to the scrap pile the one-time indispensable oil-burning illuminative headlight, and in its place there has come to stay a new electric headlight with its 1,000,000 beam candlepower.

The electric headlight was at first somewhat troublesome, especially in railroad yards, for like many other new appliances it was "too good." That is, it was too powerful and it blinded the enginemen and yardmen. This has been overcome, however, by the use of a special dimmer, and whenever the locomotive is passing thru railroad yards or when passing another train, the dimmer is used and the candlepower of the electric headlight is reduced to approximately that of the oil-burning headlight.

The accompanying illustration shows how the electric headlight equipment is installed on the locomotive as well as the remarkable illumination obtained from its 250 watt—290 candlepower tungsten filament.

To provide for the extra lights about the engine, including the electric light for the firemen, as well as the marker and classification lights on the front of the engine, the steam-driven dynamo mounted on the engine is rated at 500 watts. The engineer also enjoys the electric light nowadays, and by means of the switches and dimmer he can control the lights instantly just as desired.

As the illustrations show, the electric generating equipment is very compact and takes up but slight space on the locomotive. The dynamo is thoroly enclosed to guard against the elements, but is so designed that the electrician can swing open the cover and the brushes and commutator are made instantly accessible for inspection.

The dynamo and small steam turbine are driven and mounted on the same shaft, the turbine taking steam from the locomotive boiler thru an automatic regulator valve which compensates every variation in boiler pressures between 125 and 250 pounds, superheated steam, so as to keep the dynamo revolving at nearly constant speed. The dynamos are supplied in different voltages, from 32 to 110, for the requirements of different railroads. These outfits are very efficient, only sufficient steam to perform the actual work required being admitted to the turbine nozzle. The special rugged tungsten filament in the headlight bulb is enclosed in a nitrogen gas envelope, so as to give the highest efficiency possible.

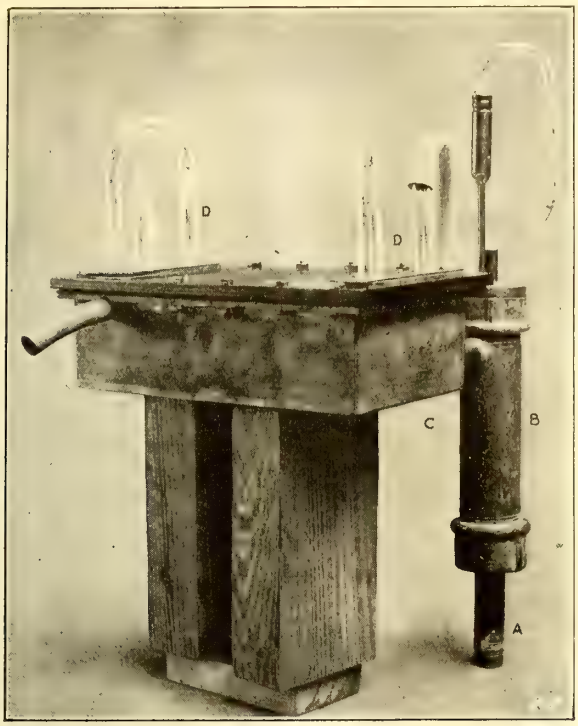
With regard to illumination in general, the 250 watt lamp, properly focust in the standard reflector supplied with the headlamp, under normal conditions, illuminates the track sufficiently for all headlighting purposes for a distance of from 1,000 to 1,500 feet.

For switching illuminative service about yards, et cetera, a 60 or 100 watt lamp in either a 14 or 18-inch reflector gives ample headlighting service. Over 70,000 of these locomotive electric headlights have been put into successful service at the present time.

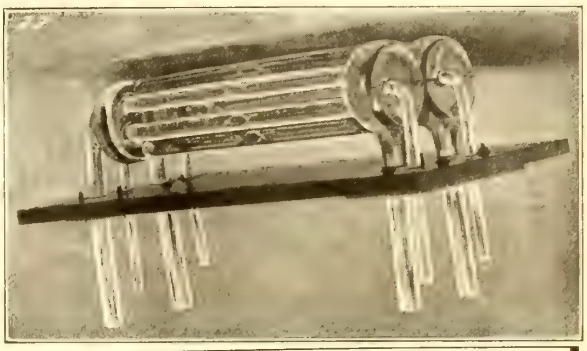
The February and present issues of the **ELECTRICAL EXPERIMENTER have been increased by eight pages of pure reading** matter. The magazine now consists of 128 pages and contains over 200 illustrations. Perhaps it is superfluous to mention that over ninety per cent. of the text matter is original in all respects. Such matter is not found in other magazines or publications. In this the ELECTRICAL EXPERIMENTER has become a dominant factor in its great field.

Nikola Tesla, the world's greatest inventor, has said many times: **"I have never seen a copy of the ELECTRICAL EXPERIMENTER which did not contain something of interest to me."**

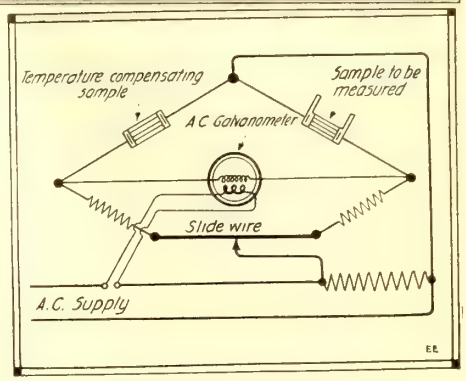
Detecting Icebergs by Measuring Salt in Sea



It Will Probably Come as a Surprise to Many That It Has Now Become Possible to Detect the Presence of Icebergs by Measuring the Amount of Salt in Currents of Sea Water. The Photo on the Left Shows the Apparatus Used for This Purpose. The Sea Water Is Pumped Into "A," Passes a Resistance Thermometer in "B," Into the Bath "C," and from There Into the Electrolytic Cell "D," and Then Out of the Apparatus.



The Photo on the Right Shows a Method of Mounting the Electrolytic Cells Beneath the Lid Which Covers the Bath. Practically All of the Apparatus Is Constructed of Glass, and It Is Really More Sturdy Than It Looks at First Glance.



The Diagram at the Right Shows How the Electrolytic Cells for Containing the Samples of Sea Water Are Placed in Each of Two Arms of a Wheatstone Bridge, Devised for Use with an Alternating Current. An A. C. Galvanometer Is Used. This Apparatus Has Been Developed by the United States Bureau of Standards, and Measures the Electrical Resistance of Ocean Water by the Aid of Alternating Current.

THE saltiness of the ocean varies from point to point, according to circumstances which are of great importance to navigators. The most popular interest in this is probably the fact that the amount of salt in sea water is used to detect and identify ocean currents which determine the paths of icebergs. In the work of the Government in connection with the study of fogs, icebergs, et cetera, it is necessary to obtain accurately the temperature of the ocean, and among other things the amount of salt present in the water. The work has been tremendously expedited by the development of proper instruments.

The determination of the quantity of salt in a given volume of water is now determined very rapidly by a device developed at the Bureau of Standards by Mr. A. L. Thuras and the late Captain Weibel. This apparatus is arranged to measure the salinity (saltiness) of the ocean by measuring the electrical resistance with the aid of an alternating current. By means of providing a sample of a salt water of a known salt content, forming a part of the electrical system, and which is placed in one receptacle immersed in a bath of the sea water similar to that being tested, the effects of temperature are automatically compensated for.

Great speed of operation and accuracy are claimed for this device.

Description of electrical connections: The electrolytic cells for containing the samples of salt water are placed in each of two arms of a Wheatstone bridge devised for use with alternating currents. The alternating current supply passes thru the field coil of the alternating current galvanometer and then thru a non-inductive resistance. The resistance furnishes at its terminals a potential which is in phase with the supply current passing thru the field coils of the galvanometer. From this source of potential is derived the current used for exciting the bridge, by means of the connections as shown.

A Land and Water Speed Demon

By EMERSON EASTERLING

To the rest of the younger generation, Electro-mechanical Bugs, via THE ELECTRICAL EXPERIMENTER:

DEAR SIRS, MESDAMES, ETC.

We all have heard about Silas (or Syrus) Green, the Wright Brothers, who had the *right* idea—Simon Lake, The Ancient Mariner and Bob Fulton—well, here's a new one on us.

Byron Fry, of Vancouver, Washington, is the "guilty guy." He figured out that a "Hod" motorcycle could be dissected, and with the addition of a specially built boat body, a special form of propeller—he says that the propeller has to do with the success of the invention greatly in extent; as you can see, it is peculiar—and by fitting out two out-riggers in the form of air compartments (these are set behind the rear wheels)



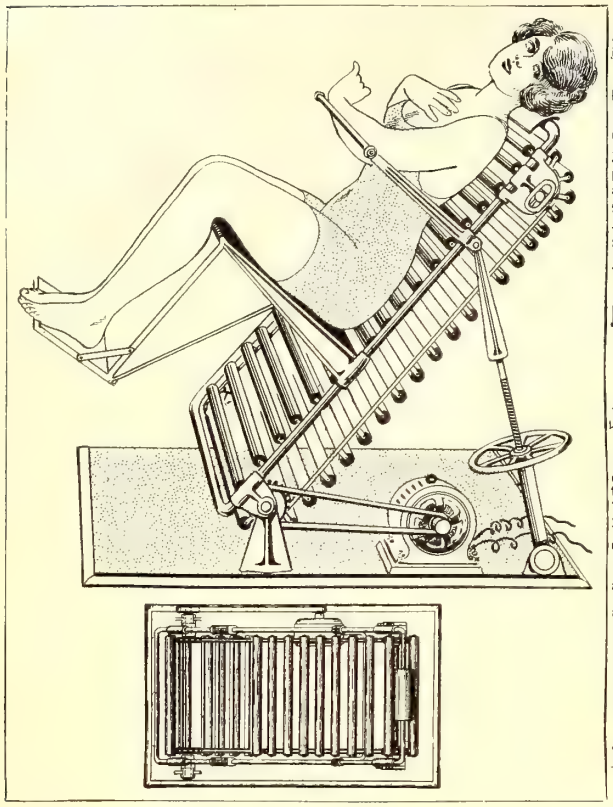
The "Hydro-Terra Firmamobile" is the Latest Device for Carrying Passengers Over Land and Water Out Vancouver Way. The Motorcycle Engine and Propeller Push the Outfit Over Land To the Tune of 70 Miles an Hour.

and filling the tank with gas and climbing into the machine, that the operator could go to see his "will be" in a truly romantic fashion—like Sir Lochinvar, ford the river, creek or slough, as it may be, not wind around the traffic and follow the trodden paths of commerce and travel.

The writer had the pleasure of riding in the—we will call it a *hydro-terra firmamobile*—from Vancouver over the inter-state bridge and to Columbia Beach on the Columbia River. We sure made time, and he was not letting the—you know what we call it—out. Byron has let her—the hydro, etc.—out to the extent of seventy miles per hour on land. *She* makes twenty-five or six on water. The wheels can be removed for extensive trips

(*Continued on page* 1219)

Electrical Back Massage



Left: Taking an Electric Back Massage in the Electric Roller Chair Devised by a Chicago Inventor, for Giving Body Treatments and Particularly Applications of This Nature to the back, Shoulders and Rear Portions of the Arms of the Patient.

THE electrically driven massage machine here illustrated is intended by its inventor, Mr. Glenn S. Noble of Chicago, Ill., for giving body treatments and particularly for giving such treatments to the back, shoulders and rear portions of the arms of the patient.

Among other purposes of this machine, as pointed out by its inventor, are the following: To provide an exceedingly simple and efficient machine for giving a rolling and massaging treatment. To provide means whereby the machine may be readily adjusted for different persons, and may be adapted to regulate the pressure, for the comfort or convenience of the person to be treated.

A small electric motor drives the wooden rollers at a more or less rapid rate, and this produces the desired massage applications to the back muscles of the patient in a manner readily apparent. If it is desired to increase the pressure, this may be done by the person pressing against the cross-bar which is supported in arms extending out from the side brackets on the machine. Likewise, the foot-rest may be moved up more or less in alignment with the seat so that the patient can push against the moving rollers.

While the chains may be reciprocated or driven in either direction, as the inventor points out, they are preferably driven, so that the engaging rollers will be descending or driven in a downward direction.

Girl Invents New Telephone

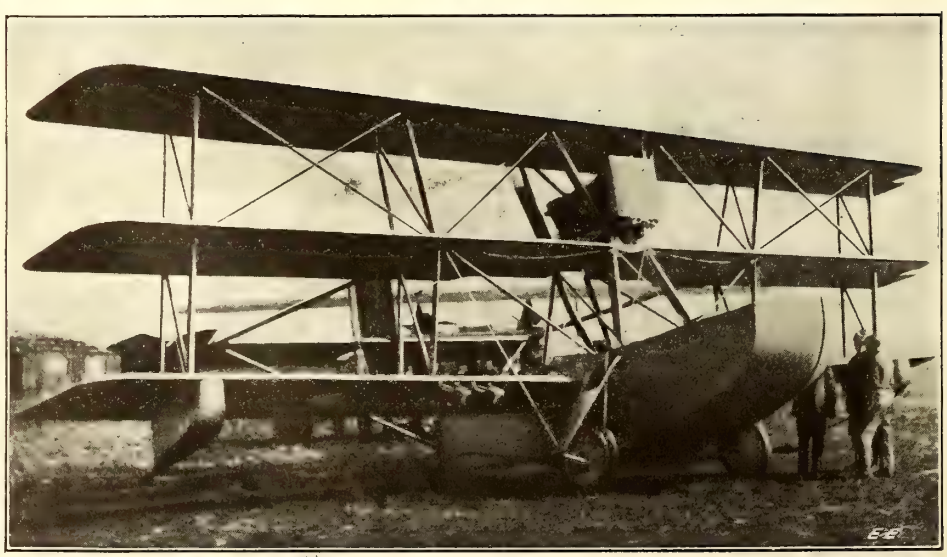


Right: Miss Katherine Nichols, Operator at the Cooper-Carlton Hotel in Chicago Has Invented This New Type of Combination Telephone, Which Has Been Examined by Telephone Experts and Declared To Be a Radical Improvement. As Will Be Seen, You "Hear" Thru Both Ears Instead of Thru Only One.
Photo I.F.S.

MISS KATHERINE NICHOLS, an operator at the Cooper-Carlton Hotel in Chicago, is the inventor of this latest type combination telephone. Experts declare that it will revolutionize the modern type of phone. It has a double receiver device which excludes all outside noises. It can be picked up and talked into as the ordinary desk telephone can. Because of the double type its efficiency in hearing is increased 50 per cent. The European type telephone contains both the receiver and mouth-piece in one combination. This is an improvement over the European phone. Practical demonstrations on wires by telephone experts results in reports that this telephone gives first-class transmission. The phone is perfectly suited to both the automatic and the future wireless phone.

Sperry Seaplane Alights On Sea Or Land

The accompanying illustration shows one of the latest and most important developments in the manufacture of aircraft,—the new Sperry Seaplane,



The New Sperry Seaplane Which Is Adapted To Alight Both on Land and Sea, an Innovation of Great Importance In the Development of the Manufacture of Seaplanes.

which is being tested by the United States Navy Department with a view to its adoption by the Government. The machine is fitted with a collapsible landing gear, designed to permit alighting either on sea or land, a marked innovation of great importance in the development of seaplane manufacture. As will be seen, the new Sperry Seaplane is provided with three wings, making it a triplane, and the fuselage of the body is made in the form of a float or pontoon. In the model shown, a single high powered airplane engine is used to propel the craft. The end carriage and wheels are built extra strong and the outer ends of the lower wings are provided with small pontoons.

"Whispering Ether"

By CHARLES S. WOLFE

I'M not a scientist. "Cans" is my line. Safes, you know, "soup," nitro-glycerine, that kind of thing, get me? "Shoemaker stick to your last." Them is my sentiments, and I stick to my own trade. But now that they got me tied up in this confounded jail, and I ain't got much to do with my spare time I got a notion to jot down what I know about that Proctor affair that you maybe read about in the papers. Reporters was after me thick when it happened, but I was the silent kid. It pays to keep your mouth shut in the circles I move in.



I Point It Right At His Head, and Makin' My Voice As Hard As I Can I Says, Tense-like, "You Speak One Word and You'll Eat Your Breakfast in Hell." And Proctor Smiles. Get That? With My Gat Aimed At His Head He Smiles. And, Fellow, When Proctor Smiles It Gives You the Creeps.

Proctor's in the bug house. Three alienists, or whatever you call those ginks that admit they're sane and prove you're not, pronounced him hopelessly insane. I ain't disputing no jury of my peers. If they say he's a nut, he's a nut, that's all. But——

I didn't get introduced to Proctor in the regular way. We didn't have no mutual acquaintances to slip us the knock-down. It all came about thru me droppin' in one night, casual like, to blow his safe. You might wonder what a yegg would want out of a laboratory safe. Maybe you'll wise up when I tip you it was a contract job. Not on my own, see? I'm namin' no names, but there was a gang of big guys that wanted old Proctor's formula for Chero, and thought it would be cheaper to buy it off of me than him. Anyway, I'm after the paper with the makeup of this explosive when I jimmied the laboratory window.

I'm sayin' this right here: Proctor may be a nut, but he's no boob. I was expecting burglar alarms, scientific thief traps, all that kind of stuff. And I was all fixt for an electrified box. Proctor put one over on me just the same. And if he didn't do it with the mind machine, how in Hell else do you account for it?

I was workin' on the old can. She was a fairly respectable affair, and I make up my mind to blow her. I was drillin' away when click goes a switch and the sudden flare of light dazzled me. Were you ever caught working on a guy's safe, brother? No? Well, take it from Oscar, it's like nothing you ever felt before.

Even before I can see right my mind's workin' overtime hunting for a way out. And then I can see again, and there stands Proctor, a long cord trailin' behind him and 'phones over his ears like the wireless men. And I notice with joy that he ain't got a gat—not that I can see.

Anyway, I risk it. Just as quick as I can draw I flashes my automatic. I point it right at his head, and makin' my voice as hard as I can I says, tense-like, "You speak one word and you'll eat your breakfast in Hell."

And Proctor smiles. Get that? With my gat at his head he smiles. And, fellow, when Proctor smiles it gives you the creeps. And then he says—s' help me—I'm not bullin' you—"Put your gun away, my man, its not loaded."

Can you beat that? It wasn't, either, but how did he know it? Bluffing? That's what I thought, and I sees his bet and raises him. "You move," I growls, "and you'll discover you're a bad guesser."

He smiles again. Say, I can feel my flesh creep yet. "It's not loaded," he says, very calm, and he walks a few steps toward me. I don't shoot. You can't, you know, with an empty gun, and I see that he's called my bluff.

"You win," I says. "It ain't. But I can beat the life out of you with it."

That smile again. His hand goes to his pocket. He pulls out a little bottle, just about the size they sell you pills in. "That, my friend," he says, "is full of Chero. If I just toss it at your feet, you'll never attempt to steal a formula again on this planet."

Does he win? He owns the building. "Call the officer," and I chucks the gun on the floor. "I'll go quietly."

"Sensible," he remarks; "very sensible. You possess judgment, even if you do lack courage. Who sent you here?"

"Call in the bulls," I growls. "I'm not squealing."

He takes no notice. "I know who sent you. I knew you were coming."

"Look here," I blurts, "if that gang framed me, I'll talk. They sent for me, I didn't go to them. I——"

"No one informed me, if that's what you mean," he says, coldly. "It is not necessary for any one to inform me of anything. The world is as an open book to me."

(That's just what he told that gang of saw-bones afterwards, and they said he was looney. But if they had seen him as I seen him ———)

(*Continued on page* 1208)

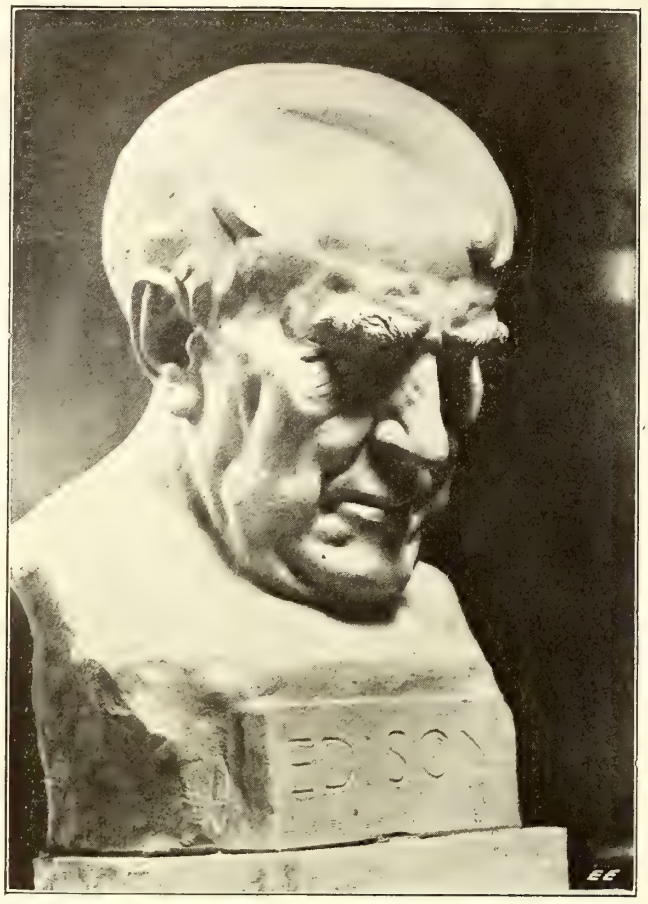
Thomas A. Edison 73 Years Old

HAVING been a telegraph operator in his youth, Thomas A. Edison, America's grand "young" man of science, knows that "73" is the code number for "all good wishes." On February 11th, which marked his seventy-third birthday, messages from all parts of the country arrived at the Edison laboratory in West Orange, expressing sentiments identical but less laconic than dash-dash-dot-dot, dot-dot-dot-dash-dot.

A little thing like a seventy-third birthday didn't keep the "Old Man" from getting up at 6 o'clock in the morning and, without thought of shaving, hastening down the hill to his laboratory to spend five hours intent upon a chemical and metallurgical problem that needed solving. Thomas Alva Edison's former associates, gray-haired men, now successful engineers and inventors themselves, who worked with him day and night in those lean days back in the late seventies and early eighties at Menlo Park, when no one knew where next week's payroll was coming from, waited patiently and let the "Old Man" putter around his laboratory at West Orange until noon, when they kidnapped him to make sure he would not forget his own birthday party.

The accompanying illustration shows an excellent marble bust of Edison, by Onorio Ruotolo, the Italian-American sculptor of New York City. This crystallizes in marble the spirit and energy of Thomas Alva Edison.

Ruotolo recently completed this study which he calls "The Brother of Prometheus." He is the sculptor whose recent "Red Cross group" and "Prince of Sorrows" bust of Cardinal Mercier brought him international fame.



Remarkable Marble Bust of Thomas A. Edison Just Completed by Onorio Ruotolo, the Italian-American Sculptor of New York City. It Characterizes Wonderfully the Spirit and Energy of the Great Inventor.

It wouldn't be Edison's birthday if he didn't spend a few hours at work and then go to the laboratory library to be surrounded by a dozen reporters who shouted questions in his ear ranging from prohibition and the Irish question to communication with Mars and Sir Oliver Lodge's spirits. He had some difficulty hearing the questions, but once he understood them his clear, blue eyes fairly snapt and he shot his answers back without hesitation.

"We don't need that stuff," he said of liquor. "The Irish mind is very complex," and he dismissed Home Rule. As to reaching Mars by wireless, he said: "It may be done, but how are we going to know whether a man or a chimpanzee receives our message?" And all he had to say as to the existence of spirits and making them talk was "fifty-fifty."

[Editor's Note.—In a later interview, however, Mr. Edison stated that he believed it possible and evident that powerful radio signals radiated from the earth pass out into interstellar space and reach the distant planets, the signals being carried by the etheric waves.]

"I expect to do as much work when I'm eighty-five as today. It will all depend upon the condition of the container," and he tapt his chest.

"Men are more efficient than they were fifty years ago. We have more machinery now and some day all our work will be done by machinery. Then we'll be more efficient still. The men will be paid high wages and will simply direct the machines. We'll even have automatic machinery make the machines. We're working on some of those things here now.

"No, I don't believe in a six-hour day if a man is interested in his work. If a man is interested in what he's doing, he won't keep his eye on the clock, but he'll see the thing thru. Hard work won't hurt anybody who likes it.

"A man to be efficient must take care of what he eats. Americans eat too much, anyway. Anybody who is clogged with food and gives his stomach too much work can't do good work himself."

"What do you think is your greatest invention?" he was asked.

"The phonograph or moving pictures—I don't know which."

At noon the employes of the West Orange Edison plants, led by their band, marched past Mr. Edison and pelted him with flowers. Then the Edison Pioneers, men who were associated with the inventor at Menlo Park before 1885, took Mr. and Mrs. Edison and members of their family to luncheon in one of the Edison work's buildings.

President Wilson wrote the following to T. Comerford Martin, Vice-President of the Edison Pioneers:

"I canont deny myself the pleasure of sending a message to be read at the celebration of Mr. Edison's seventy-third birthday. I am proud to count myself among the friends and admirers of Mr. Edison, and I beg that you will convey to him my warmest congratulations and my hope that he will see many very happy returns of the anniversary, marked by an increasing number of scientific triumphs."

New Inventors' Society Formed

The *National Laboratory Foundation* was organized at a convention of inventors held recently in New York for the purpose of developing American inventive genius. It is the purpose of the founders to establish a laboratory wherein promising inventions can be experimentally developed, protected and then marketed.

At the sessions held the frame-work of the foundation was laid, and the board of governors who will direct its development elected. Immediately after the election the board adopted the following resolution announcing the purposes of the organization:

"To secure and establish the ultimate right of the public to its heritage of intellectual property. Therefore, be it resolved, The object of the National Laboratory Foundation is to assist in the just and proper development of American inventions and industry by selecting, developing, testing and advancing the use of meritorious inventions to benefit the public, the inventor and the manufacturer and safeguard the interests of all."

The board of governors includes the following: Thomas Howard, executive chairman, an automobile and motion picture engineer; Professor W. H. Burr, former member of the Isthmian Canal Commission; Professor Charles F. Chandler, Columbia University; Dr. Charles P. Steinmetz, General Electric Company; Simon Lake, submarine inventor; John Hays Hammond, Jr., and Dr. Lee de Forest, wireless inventor.

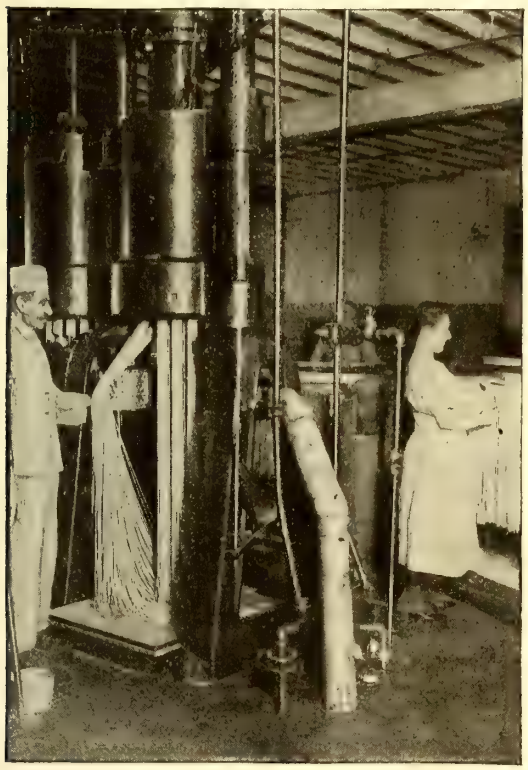
During a banquet held at the Hotel Astor, Simon Lake delivered a speech outlining the progress of invention from the earliest historical period, in which he said:

"The pirating of American inventions and designs as practised by certain countries for years is also something for the serious consideration of this convention, and American manufacturers should not enter into a league of nations treaty without a clause affording protection to American creative thought and inventions equal to that which we afford foreigners."

Major William J. Hammer, U. S. A., who had charge of all ideas submitted to the government during the war said that out of the vast number that poured into his department only 150 inventions were found sufficiently practical to warrant further consideration. He said the foundation could well carry on this work of selection and assistance in peace time.

Macaroni 'A L'Electricité

AN interesting example of the engineering service which a central station can render an industrial plant is that of a large macaroni plant at Libertyville, Illinois. When this plant was acquired, the electrical service company had the opportunity to make a study of the possibilities, and as a result a complete *electric drive* was installed, nearly all the apparatus being individually driven by motors.



Left: — Macaroni and Spaghetti by the Yard Being Made by Electrically Operated Machinery. Dies Form the Holes.

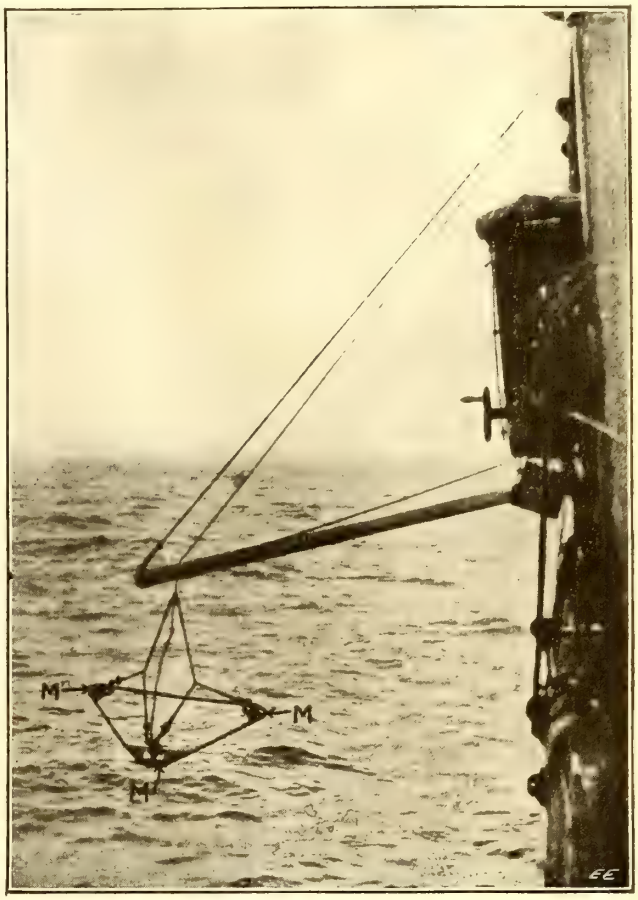
The process of making *macaroni* and other alimentary pastes is essentially one of *manufacturing* rather than *baking*. Flour is received in barrels and taken up a motor-driven conveyor to the sifting and storage rooms. Hence, it is run thru chutes in appropriate quantities to the mixers on the floor below. Each mixer has two curved knives which, revolving, cut and fold the flour as water is added by the operator. When finished, the dough is dumped into the pan of the kneading machine. As this pan turns under large toothed wheels, the dough is kneaded until all lumps have been broken up and the mass is of uniform consistency. The two newer units have 15 horsepower, squirrel cage, a.c. motors for the mixers and similar 10 horsepower motors for the kneading machines.

After kneading, the dough is cut into blocks and taken to the presses. Each of these has two cylinders, one to be charged while the other one is under the press. In the bottom of each cylinder is a die-plate with appropriate holes, thru which the dough is forced under a pressure of 3,400 pounds per square inch. See photograph here reproduced. Oil under pressure is used in the press cylinders; it is actuated by a battery of heavy-duty pumps driven by a 30 horsepower electric motor.

As the long strings of dough come out of the orifices, they are cut off and hung on wheeled racks, which are run into drying chambers. The drying operation is one requiring very close control of the humidity of the air; it is secured by passing the air thru a carrier air conditioner. *Photo Courtesy Westinghouse E. & M. Co.*

U. S. Submarine Detector

The accompanying photo shows a newly invented sound detector for discovering the nearby presence of submarines, which is being used by United States Navy destroyers. The device is a delicately sensitized apparatus, one part of which is drawn along beneath the surface of the water. The presence of any ship in the vicinity, and especially submarines, is instantly detected by this instrument. The device comprises three microphones mounted at the three corners of the triangular frame-work. These pick up the sounds of the submarine's propellers. Many a U-boat met its Waterloo on account of this ingenious detector devised by Uncle Sam's electrical experts.



Right:—Here's the Submarine Sound Detector Used by Uncle Sam During the War. The Microphones Were Submerged When Listening for the U-boats's Propellers. Photo (c) by I. F. S.

World's Tiniest "Turbine"

Herewith is a photo of a turbine I have just completed, that, so far as I have been able to ascertain, is the smallest that has yet been built. Your readers may remember that I built the smallest working electric motor and the smallest steam engine in the world; these were on exhibition at the P. P. I. E., San Francisco, also at the University of North Dakota.

The turbine I have just completed is several times smaller than any of these. The *rotor* or revolving part is made of steel and has six slots or pockets; the diameter of rotor is .032 inch, the shaft is .007 inch diameter, the weight of rotor and shaft is 2 milligrams. The diameter of complete turbine is .048 inch, or about *half the diameter of an ordinary pin head.* It weighs complete 12 milligrams.

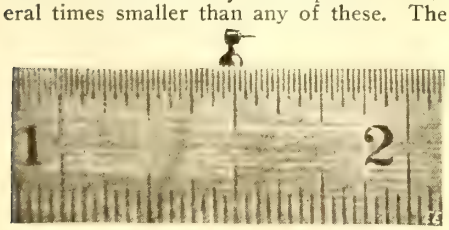


Photo at Left Shows the World's Tiniest Turbine. It Operates on Comprest Air and Is Made of Gold. It Compares Favorably with a Pin-head.

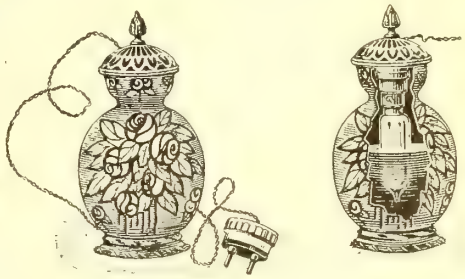
The turbine will not run with steam, as that is too heavy for it; it is mounted on a hollow pedestal so an air hose can be attached at the bottom, and runs at a very high speed when comprest air is applied.

The casing of the turbine is made of gold. The complete machine is built up of eight parts. The tiny turbine is kept in a glass covered case so that no moisture can get to it, as this will affect the running qualities.

IVAN T. MEDLAND.

Novel Perfume Vaporizer

Many perfumes which have an alcoholic base and many antiseptic solutions such as for instance those containing eucalyptol, menthol, etc. can easily be vaporized between 40° and 60° Centigrade. The new French perfume diffuser shown in our illustration heats the solution by means of an electrical current using nothing but an ordinary carbon lamp to supply the heat. These French perfume diffusers are made very artistically in the form of urns or otherwise of art glass or transparent porcelain thru which the light shines.



At the Right is Seen the Latest Electric Vaporizer From France. The Lamp Also Lights Up the Transparent Container.

The Positions of Atoms in Metals

By Dr. A. W. HULL, Ph.D.

When a narrow beam of X-rays passes thru a fine powder of any crystalline material, it produces on a photographic plate placed just behind the powder a pattern of concentric circles. These circles are produced by the reflection of the X-rays from the planes of atoms in the crystal, and their diameters are a measure of the distances between these planes of atoms. By measuring the diameters of the circles the exact positions of the atoms can be determined.

THE determination of the exact positions of atoms in solid bodies is the next to last of a series of discoveries that have made atoms as real as the bricks of which houses are built. The atom of twenty years ago was the "hypothetical smallest subdivision of matter." The atom of today is a real object of definite shape and size. We know what it is made of. We know its weight in grams. We can see its splash when it impinges on a plate of fluorescent material. We know its exact speed when it flies about as gas. And, lastly, we know its exact position when it forms part of a solid body. So spoke the author of this extremely interesting paper recently presented before a joint meeting of the American Institute of Electrical Engineers and the American Physical Society.

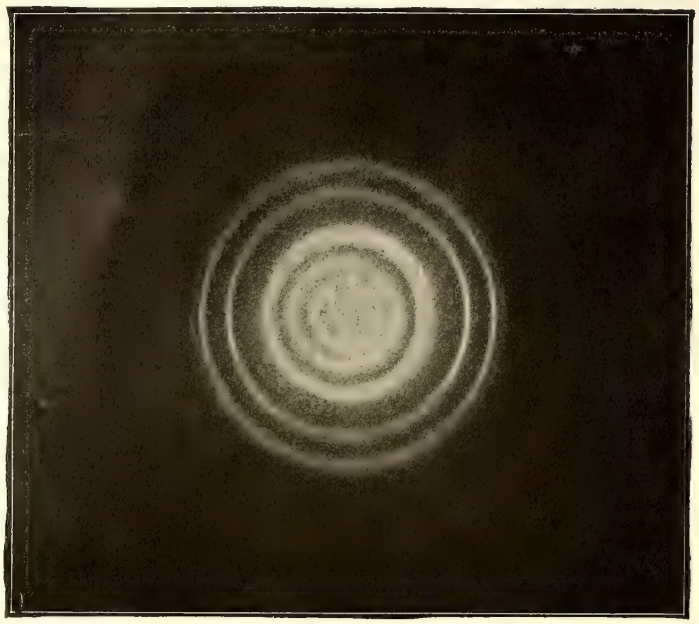


Fig. 3 Shows the Typical Effect of Aluminum Filings Taken by the Aid of the X-Ray Tube and Diafram, Illustrated at Fig. 2. The Distance Between the Lines or Circles on the Photo Enable the Scientist to Compute the Distance Between the Planes of Atoms In Various Materials.

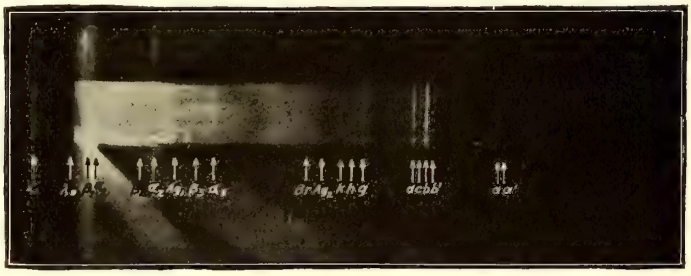
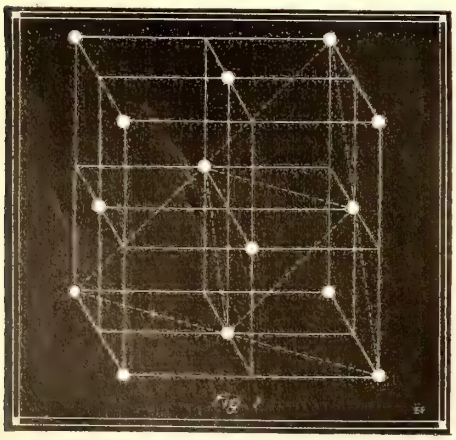


Fig. 4 Shows An X-Ray Spectrum Obtained From Tungsten.

First came the discovery of *dancing molecules.* Heat had been considered a substance. The "Kinetic Theory of Gases" proved that it is a condition, *viz.,* the motion of the molecules, which fly about like frenzied bees, bumping against each other and the walls of their enclosure. Thru this discovery all the store of facts and laws about gases can be correlated by the single picture of these dancing molecules. We believe in these dancing molecules as firmly as in the law of gravitation. Whenever we think of gas we see *dancing molecules!*



The Most Common Arrangement of the Atoms In Metals Is That Corresponding To the Face-Centered Cubic Scheme, Shown at Fig. 1, Above. This Is Also the Most Important, Since Most of the Useful Metals Have This Arrangement of Atoms.

The next discovery was J. J. Thomson's *streaming electrons.* Our text-books taught, and some still do, that electricity is not a fluid, tho it behaves in many ways like one. Thomson proved that electricity is a fluid, that its atoms are the electrons which constitute the atoms of matter, and that it flows thru wires just as water flows thru pipes.

Next came the *weighing of the atoms.* Faraday showed long ago how to determine the weight of an atom in terms of the charge it carries in electrolysis. There remained, therefore, only the measurement of this "unit charge," *viz.,* the charge of a single electron, by Millikan, to give the exact weight in grams of any atom that can be deposited electrolytically. As soon as the weight of any one atom is known, the weights of all the others can at once be calculated from the known relative atomic weights.

Then came the *counting of individual atoms.* This began with Sir William Crookes' "spinthariscope," and culminated in the beautiful experiments of Rutherford and Geiger, in which they counted one by one the helium atoms (the so-called "α particles") as they emerged from the surface of disintegrating radium; and then allowed them to pass, one by one, into a thin-walled glass tube, until enough had accumulated to form a gas whose pressure could be measured and spectrum analyzed.

These counting experiments led directly to the determination of the *composition of the atom.* J. J. Thomson had proved that every atom contains electrons. Rutherford proved that it also contains a positively charged kernel or *nucleus,* very small compared to the whole atom, but so dense that it contributes nearly the whole weight of the atom. The hypothetical atom thus became a concrete thing that can be visualized; a tiny (but large enough to be studied) solar system, with *nucleus sun* and *electron planets. The only respect in which one kind of atom differs from another is the magnitude of the positive charge of the nucleus, which determines how many electrons it can hold in its planetary system, and hence all its physical and chemical properties.*

Finally came the discovery, by the Braggs, of the method of determining the *positions of the atoms in solid bodies.* The beautiful "point lattices" of the crystallographers were hypothetical. They enumerated possibilities but could not point out the reality. The Bragg measurements of atomic distances give the actual arrangements. They are as accurate and reliable as those of the surveyor or astronomer. The only assumption made is that the arrangement of atoms is a regular one which repeats itself, and this assumption can be checked by experiment. The method consists simply in the measurement, by means of a special "measuring rod" which will be described, of the distance between atoms in three or more different directions. From these measurements a model can be constructed, which can then be checked by further measurements. The model must also agree with known physical properties of the substance, such as density, atomic weight, and crystal habit. A model which contains but one kind of atoms and satisfies all these tests may be regarded as very reliable. The reliability is still further increased by the fact that all the models investigated thus far have turned out to be very simple. In cases where there is more than one kind of atom, *i. e.,*

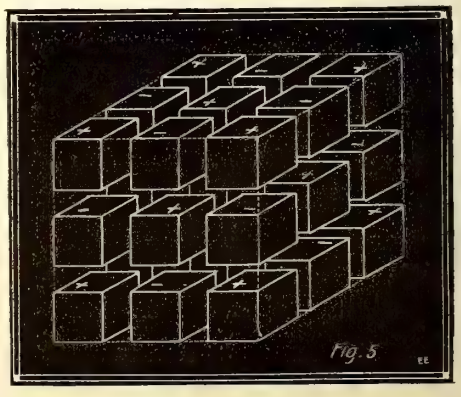


Fig. 5 Shows the Arrangement of Atoms In a Magnetic Structure Such As That Found In Iron.

compounds or alloys, an additional factor, *viz.,* the size and shape of the atoms, must be taken account of. There is one type of

(*Continued on page* 1193)

. . . AUTOMOBILE NEWS . . .



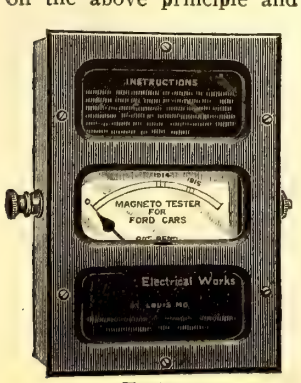
Here Is the Newest Way of Identifying the Car—the Electrical Way. Electric Lights Shine Through Stenciled Initials in This Little Metal Device. Two Small Red Lenses Are at Either End of the Device Which Serve as a Standing Lamp for the Car. (On Use on New Flat Car)

FORD MAGNETO TESTER.

With this device you can test Ford magnetos without removing them from the engine. You can check them exactly and ascertain whether or not there is anything wrong.

The principle of its operation is a neat little problem in the phenomenon of alternating current. The voltage supplied by the Ford magneto is alternating and increases directly as the speed of the engine increases. Now if a resistance and ammeter are connected in series across the magneto terminal, the current which would flow would vary directly with the speed and unless the speed of the engine can be accurately determined, this method could not be used to determine the strength of the magneto. Now if a reactance coil be used in place of the above resistance, the ammeter will indicate a constant current at all engine speeds. The strength of the current depends directly upon the strength of the magneto. The reason that a reactance coil in series with an ammeter will give constant current is due to the fact that as the engine speed increases, both the voltage and the frequency of the magneto increase directly. But the opposition of the reactance coil also varies directly as the frequency. But as the current which flows depends on both the voltage and on the opposition of the reactance coil, which increase and decrease at the same rate with the speed of the engine, therefore, the current which flows is independent of the engine speed.

The Magneto Tester here shown is built on the above principle and consists of a properly designed reactance coil and an alternating current ammeter, mounted in a neat wooden case. The scale is calibrated to show the proper strength of the 1915 and later Ford magnetos, also 1914 and earlier Ford magnetos.

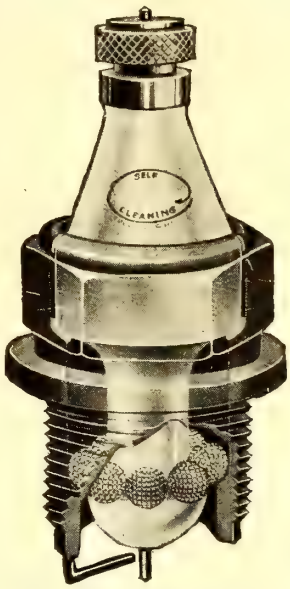


Useful Ford Magneto Tester.

A SELF CLEANING SPARK PLUG.

Anyone who has had anything to do with spark plugs knows that most trouble is caused by short-circuits on the inside of the plug. The accompanying sectional view of a new self-cleaning spark plug invented will show how the cleaning is accomplisht. The plug is made with a special size inner chamber, in which a number of little porcelain balls are placed. With each impulse of the engine, either compression or explosion, these little balls are forced up and down in the inner chamber with the result that their rough surface completely cuts away the soot, oil and carbon and keeps the insulator and inside walls entirely clean of any deposit. This, of course, insures a perfectly operating spark plug so long as the necessary charge of current comes from magneto or battery in the usual way.

The practicability and efficiency of this self-cleaning spark plug has been fully proven by many thoro tests it is claimed. One of these plugs was in constant use on a car for 78,000 miles—more than 3 times the distance around the world—and the plug worked perfectly all that time. Not once was it necessary to remove it for repairs or cleaning. Other tests have been made on passenger cars, service cars, heavy service trucks, and even on cement mixer engines, all with the same perfect results. One test was made on a truck on which it had previously been necessary to change spark plugs every day for cleaning. One of these self-cleaning spark plugs was installed and has now been in use four months without need of change for cleaning or repair.



New Self-Cleaning Spark Plug. The Porcelain Balls Are Constantly Moving and Thus Keep the Plug Clean.

THE STEINMETZ ELECTRIC VEHICLE.

Dr. Steinmetz's latest accomplishment has startled the automotive industry. In a word, he has produced: An electric vehicle that requires 30 per cent. less battery than any other of like capacity, is manufactured for one-third less, is 25 per cent. lighter in weight, runs 45 miles on one charge, costs but 35 cents a day to operate and recharges its own battery on down grades.

After 15 years of experimentation, Dr. Steinmetz has perfected an industrial truck and a delivery car with these long-sought advantages



Filling the Battery According to Hoyle Does Not Need an Expensive Equipment. Water May Be Put Into the Battery Safely Without Spilling Over the Cells by Pouring Water From a Glass or Cup Down a Screw Driver, Whose Tip Is Placed in the Cell to Be Filled.

GEAR SHIFTING DONE AWAY WITH.

A recent device exhibited at the automobile show in New York City was a clever turbine drive affair which threatens to revolutionize the automobile industry.

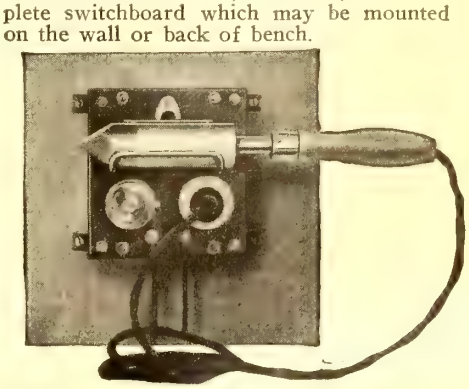
With this new transmission, the power is communicated to the driving axle, by means of a turbine which pumps a liquid to a hydraulic motor, the liquid being returned to the turbine chamber and pumped over and over again.

AUTOMATIC SOLDERING IRON RACK.

It consists of a small slate panel arranged for wall mounting and carrying a support for the iron which acts on the principle of the telephone receiver hook. When the iron rests on the cradle or hook the weight bears it down, and resistance which is mounted on the back is cut into circuit with the iron. The current is reduced and the temperature held at a safe value, but ready for service just as soon as the iron is lifted from the hook. This operation automatically disconnects the resistance from the soldering iron circuit and allows full current to again be applied to the heater coil in the iron until the iron is again placed in the cradle hook.

Below, on the same panel, there is a push-button snap switch and a standard receptacle, to which the plug of soldering iron cord is connected.

This automatic rack, therefore, is a complete switchboard which may be mounted on the wall or back of bench.



Handy for the Autoist—an Automatic Soldering Iron Rack.

Popular Astronomy

By ISABEL M. LEWIS, M.A.
Of the U. S. Naval Observatory

Astronomy in Our Everyday Life

THE opinion is quite generally held that astronomy is an abstract and theoretical science far removed from practical everyday affairs.

Yet a knowledge of astronomy is absolutely essential in navigation, exploration and surveying. Even in our civil life the settlement of some legal questions may hinge upon the knowledge of an astronomical happening and in the regulation of our clocks astronomy touches the daily life of everyone, for it is from observations of the stars *alone* that our time is determined.

The rotation of the earth upon its axis is the nearest approach to invariable motion known, and is for that reason employed as the basis for all determinations of time.

As a result of the earth's daily rotation upon its axis from *west* to *east* there is an *apparent* daily rotation of the heavens from *east* to *west,* and so we speak of the sun, moon, stars and planets "transiting" the meridian when it is really the meridian that is passing by these objects in the opposite direction.

The interval between two successive "transits" of the same star, or of some fixt point over the same meridian is called a *sidereal day,* and it is the fundamental unit in measuring time. This sidereal day is divided into twenty-four sidereal hours and there are clocks known as sidereal clocks which keep sidereal time. The driving clocks of equatorial telescopes are always sidereal clocks. By means of such a clock it is possible to impart to a telescope a motion equal to that of the earth on its axis and in the opposite direction, thus nullifying the effect of the earth's diurnal motion and keeping the object observed always immovable in the field.

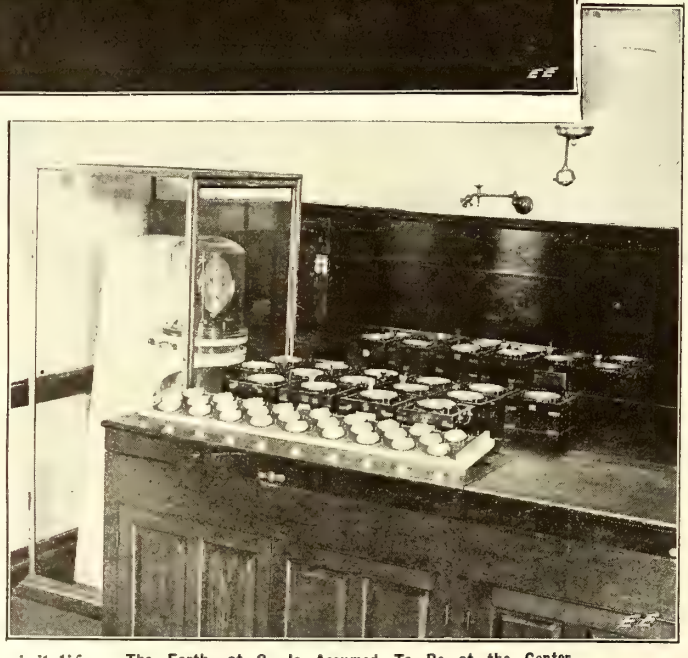
The zero point for the sidereal day is the vernal equinox or the point in the heavens where the ecliptic and the celestial equator intersect. When the vernal equinox is on the meridian it is sidereal noon, and when it has moved one hour past the meridian it is *one hour,* sidereal time. The angular distance of the vernal equinox from the meridian measured along the celestial equator toward the west thru 360°, or, when exprest in time, thru 24 hours, is called the "Hour Angle" of the vernal equinox and it gives the sidereal time at any moment. (See Fig. 1.)

It is not practicable to run our clocks on sidereal time for the reason that sidereal noon falls at all hours of the day and night in the course of a year, and we prefer to have our noon agree as closely as possible with the true *solar noon* which occurs when *the sun is on the meridian.* To run our clocks by true solar time is impossible, for the interval between successive transits of the *true* sun over the meridian is not invariable in length. This is due partly to the fact that the motion of the earth in its orbit is not uniform and partly to the fact that the earth's path around the sun is inclined to the equator along which the time intervals are measured. The range of the variation in the length of the true solar day in the course of a year from these combined causes is over half an hour. No clock could be regulated, therefore, to keep this true solar time, *or sun-dial time,* as we may call it, since it is the kind of time indicated by a sun-dial.

To obviate the difficulties presented, both by sidereal and true solar time, recourse has been had to a *fictitious* body known as the *mean sun.* This body is assumed to travel at a uniform rate in the celestial equator, instead of in the ecliptic, completing a circuit of the heavens in the same time as the true sun. Since its motion is uniform we can regulate our clocks by it. A mean solar day is the interval between two suc-



U. S. Naval Observatory, Washington D. C. Main Building from Which Time Signals Are Sent Forth to All Points East of the Rockies.



Torpedo Boat Watches and Ships' Chronometers Sent to the U. S. Naval Observatory To Be Tested and Rated. The Clock Mounted on a Stone Pier in the Glass Case to the Left Is a Standard Mean Time Riefler Clock.

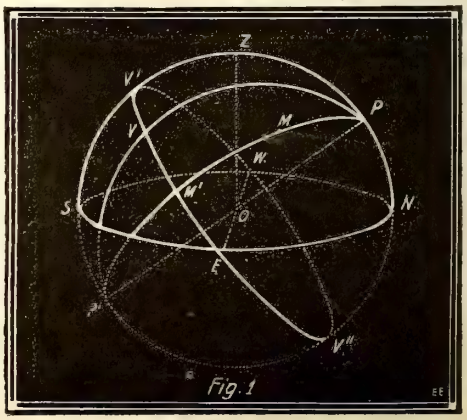
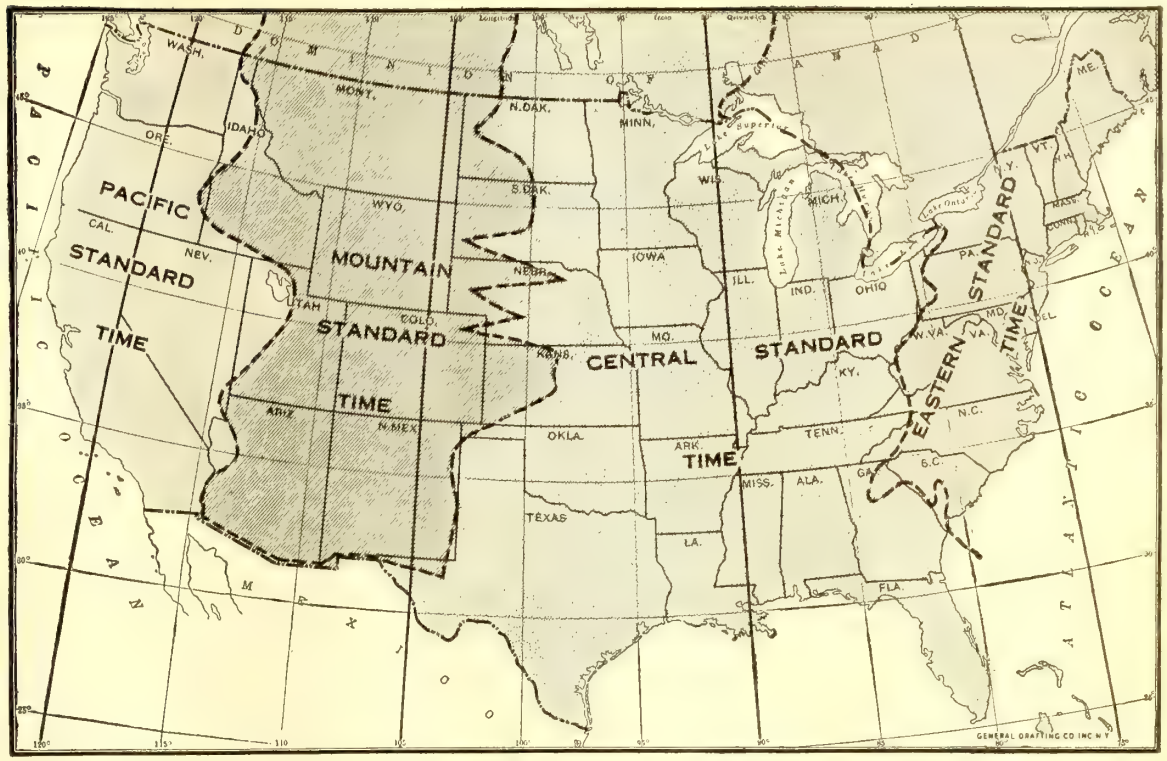


Fig. 1

The Earth, at O, Is Assumed To Be at the Center of a Sphere of Infinite Radius Called the Celestial Sphere. The Plan of the Horizon of the Point of Observation Intersects This Celestial Sphere In SWNE (the Four Points of the Compass) and the Earth's Polar Axis Produced Intersects the Celestial Sphere in P and P', the North and South Poles of the Heavens Respectively. The Celestial Equator EV'WV" Is the Intersection of the Plane of the Earth's Equator With the Celestial Sphere and the Planes of the Terrestrial Meridians Intersect the Celestial Sphere in Celestial Meridians or Hour Circles, see PVP' and PMP'. The Hour Circle That Passes Thru the North and South Poles of the Heavens and the Zenith is the Meridian of the Place of Observation (NPZS). The Direction of the APPARENT Daily Rotation of the Celestial Sphere Is East to West in the Direction EV'W. The "Hour Angle" of Any Point in the Heavens Is the Distance of its Hour Circle East or West of Meridians, Exprest in Time Usually, Just as the Longitude of a Point on the Earth's Surface Is Its Distance East or West of the Zero Meridian (Greenwich) and May be Exprest in Time Also (as a Place 75° West of Greenwich is FIVE HOURS West of Greenwich. Now the SIDEREAL TIME at Any Instant is the Hour Angle of the Vernal Equinox V, Which is the Point Where the Ecliptic or Apparent Path of the Sun Thru the Heavens Intersects the Celestial Equator. This Sidereal Time Is Measured from the Meridian Westward Thru Twenty-four Hours Along the Celestial Equator. (In the Fig. V'WV"V is the Arc Expressing the Sidereal Time.) V Makes One Complete Revolution in Twenty-four Sidereal Hours. The Mean Sun is also Assumed to Move at a Uniform Rate in the Celestial Equator EV'WV", and Its Hour Angle at Any Instant Gives the Mean Solar Time.



The Accompanying Map Shows the Four Standard Time Belts Into Which the United States Has Been Divided (as Readjusted by the Interstate Commerce Commission and Made Legal by Act of Congress, Approved March 19, 1918). Eastern Standard Time is the Mean Time of the 75th Meridian and Is Five Hours Behind Greenwich Mean Time. Central Standard Time is the Mean Time of the 90th Meridian and is Six Hours Behind Greenwich Mean Time. Mountain Time Is the Mean Time of the 105th Meridian and is Seven Hours Behind Greenwich Mean Time. Pacific Time is the Mean Time of the 120th Meridian and is Eight Hours Behind Greenwich Mean Time. By Act of Congress the Legal Time for Each Belt is the Time of the Standard Meridian for that Belt. A Person Traveling From One Time Belt Into the Next Adjacent Belt Must Change His Watch Time by One Hour, SETTING IT FORWARD ONE HOUR IF HE IS TRAVELING EASTWARD and Back One Hour If He is TRAVELING WESTWARD to Agree With the Time of the Belt Into Which He is Passing. The Legal Standard Time for Alaska Is That of the 150th Meridian and is Ten Hours Behind Greenwich Mean Time.

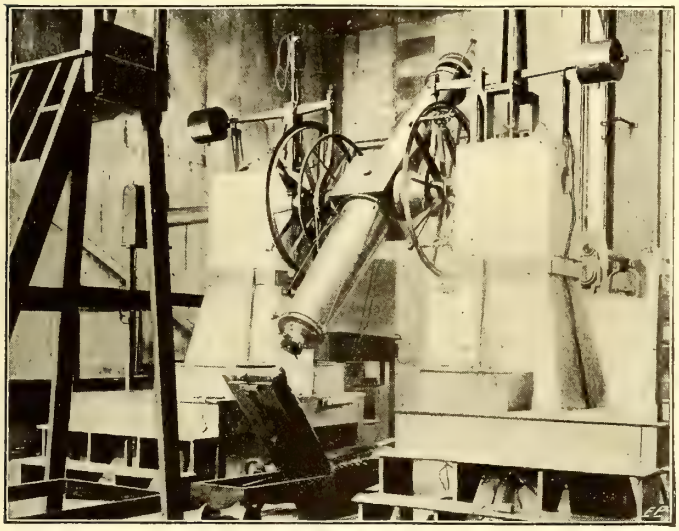
cessive transits of the mean sun over the meridian, and it is mean noon when the mean sun is on the meridian. The interval from the transit of the mean sun to that of the true sun or vice versa never amounts to more than sixteen minutes, and it is spoken of as the *"Equation of Time."* Four times a year its value becomes zero, and then mean noon and true solar noon coincide.

It is, of course, impossible to make observations of a fictitious body, but mean solar days are as invariable as sidereal days in length and sidereal intervals can be converted into mean solar intervals, and vice versa. A mean solar day is longer than a sidereal day by approximately three minutes and fifty-six seconds. So the vernal equinox or a star comes to the meridian three minutes and fifty-six seconds earlier each day, and sidereal noon, therefore, occurs earlier each day by this same amount.

In practise the determination of time takes the form of finding the correction to a sidereal clock by recording the time it registers when some star, whose position is accurately known, crosses or "transits" the meridian. The star's "Right Ascension" when on the meridian is the sidereal time at that instant (see Fig. I), and a direct comparison of this time with that shown by a sidereal clock at the same instant gives the correction to the sidereal clock. The corresponding mean solar time is then found by a simple conversion from sidereal into mean solar time.

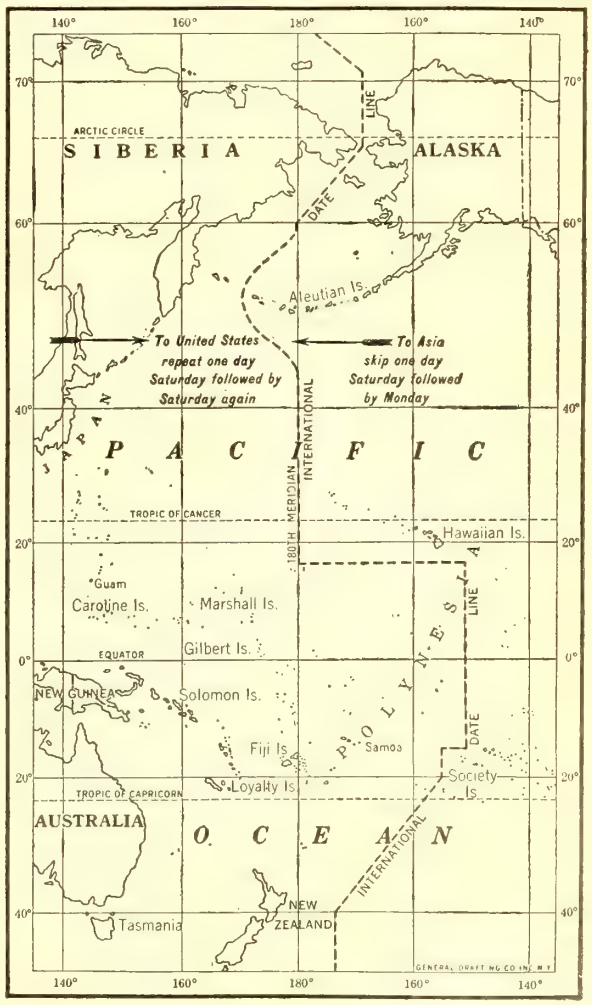
To make this determination of time as just outlined, the astronomer needs,—the accurate positions of the stars to be observed, which are to be found in the Nautical Almanac, a transit telescope, which is designed for the express purpose of ob-

(*Continued on page* 1170)



The Nine-Inch Meridian Transit of the U. S. Naval Observatory Used for "Time Sights" and Also for Regular Observations of the Meridian Passage of the Sun, Moon and Planets.

As the Sun Moves From East to West In its Daily Circuit of the Earth, It Is Evident That It Will Cross the More Easterly Meridians First. When It Is On the Meridian of Greenwich It Is Greenwich Mean Noon There, But It Is Not Yet Noon On Meridians West of Greenwich and It Is Past Noon On Meridians East of Greenwich. That is the Time of Places West of Greenwich Is Behind Greenwich Time Or "Slow On Greenwich" and the Time of Places East of Greenwich Is Ahead of Greenwich Time or "Fast On Greenwich." Of Course the Greater the Difference in Longitude the Greater the Difference in Time. The Farther West We Get the More We Fall Behind Greenwich Time and the Farther East We Get the More We Get Ahead of Greenwich Time. This Change In Time Is One Hour For Every Fifteen Degrees of Longitude, So By the Time We Have Reached the 180th Meridian West of Greenwich We Have Fallen Behind Greenwich Time By Twelve Hours. If It Is Greenwich Mean Noon When We Reach the 180th Meridian It Is By Our Clock Twelve Hours EARLIER or the Preceding Midnight; But If We Have Traveled Eastward From Greenwich to Reach the 180th Meridian We Find We Are Twelve Hours Ahead of Greenwich Time. It Is Therefore Midnight. As in the First Case, by Our Clock But the FOLLOWING Midnight Instead of the PRECEDING. That Is, It Depends From What Direction We Are Approaching the 180th Meridian Whether Our Clock Is Twelve Hours SLOW on Greenwich Time or Twelve Hours FAST on Greenwich Time. Two Ships Approaching the 180th Meridian From Opposite Directions Will Therefore Find a Difference of Twenty-four Hours In Their Time.



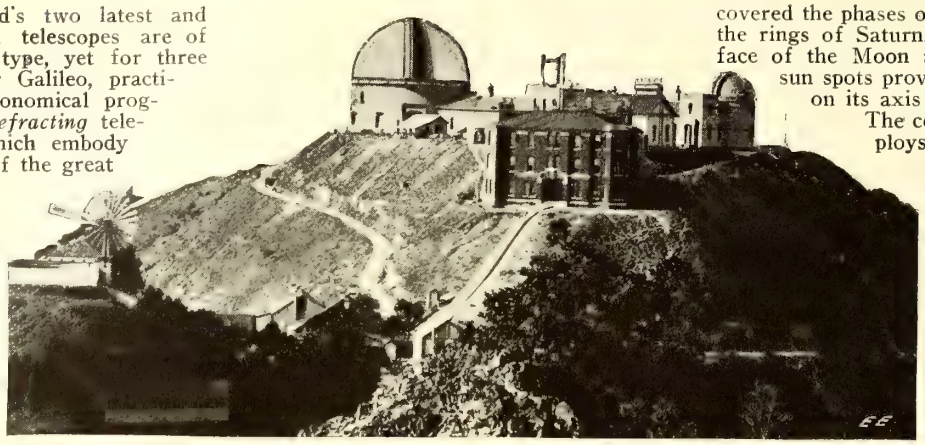
World's Big Telescopes

By FLOYD L. DARROW

Head of Science Department, Polytechnic Preparatory School, Brooklyn, N. Y.

No. 3 REFRACTING TELESCOPES

ALTHO the world's two latest and most powerful telescopes are of the *reflecting* type, yet for three centuries after Galileo, practically all astronomical progress was made with *refracting* telescopes, instruments which embody the optical principles of the great Italian physicist and astronomer.



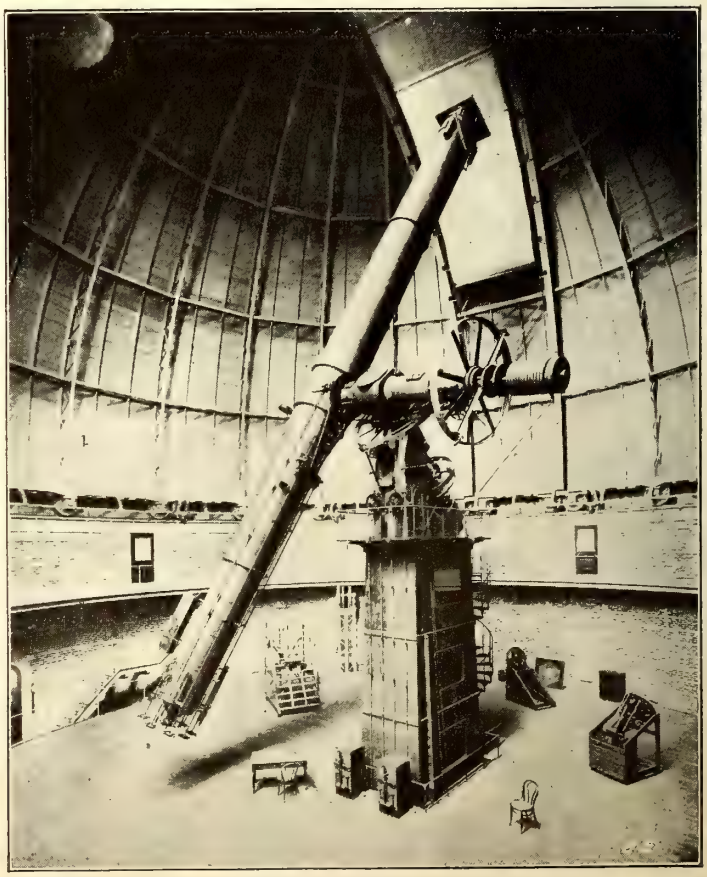
The Famous "Lick" Observatory, Situated at Mt. Hamilton, California.

Galileo's "Optical Tube," as he called his telescope, consisted of a lead tube, in one end of which was a double convex object glass and in the other a double concave eyeglass. With this first crude instrument he brought objects *three times nearer and made them appear nine times larger.* He quickly made other glasses, each of higher power than the preceding and in a short time had a telescope that brought objects *thirty times nearer* than when viewed with the unaided eye. With this instrument Galileo made his epoch-making discoveries in astronomy. To his amazement, he found that he could count ten times as many stars as he was able to detect with the naked eye. He came to the conclusion that the stars were not all equidistant from the earth. The stars revealed by his telescope must be at greater distances than those seen without its aid. Turning his magic tube on the beautiful *Milky Way,* he resolved this belt of hazy fire mist into a myriad of stars too faint to be distinguished without optical aid and at such measureless distances that they literally seemed to rub elbows with each other. And yet we know that this galaxy of stars represents innumerable blazing suns separated from each other by millions and millions of miles! A little later Galileo made the first real astronomical discovery, that of the four moons of Jupiter. Here, indeed, was a miniature solar system with its central sun and family of revolving planets. Surely, the teaching of Copernicus, making the sun and not the earth, the center of our solar system must be true. Quickly following this Galileo discovered the phases of the planet Venus and the rings of Saturn. He studied the surface of the Moon and by observation of sun spots proved that the sun rotates on its axis as does our earth.

The common opera glass employs the same system of lenses as did Galileo's telescope. To understand how images are produced by its aid we must know the meaning of *refraction of light.* Everyone has observed the fact that an oar placed obliquely in water appears to be bent at the waterline, or that a line of type viewed thru a thick piece of plate glass seems to be shifted. These and many other similar effects are due to the bending of light rays as they pass from a medium of one density to a medium of greater or less density. When a ray passes from a medium of greater density to one of less density, it is bent away from the perpendicular at the point of incidence or emergence but in passing from a less dense medium to a more dense one it is bent toward the perpendicular. The point from which the light proceeds seems to be in the direction of the refracted ray which enters the eye and consequently above its true position. Now it is in the power of glass similarly to bend light rays that its optical properties lie. The accompanying figure,



The Great 36-Inch Refracting Telescope of the "Lick" Observatory, Shown Above. Note Size of Men.



The Giant 40-Inch Telescope of the "Yerkes" Observatory. Note Comparative Size of Chair.

Fig. 1, shows the refraction of a ray of light in passing thru a triangular glass prism. In principle a double convex lens with which images are produced is really two triangular prisms placed base to base.

There are two kinds of images which lenses produce—real and virtual. A stereopticon picture is an illustration of a real image, for it may be focust upon a screen and is produced by the actual meeting of the refracted rays of light at the place where the image appears to be. A virtual image is not formed by the actual focusing of light rays, but by diverging rays which would meet only if produced in the opposite direction. A *virtual* image cannot be caught on a screen and is upright, whereas a *real* image is always inverted in respect to the object. An ordinary plane mirror gives an example of a virtual image. Both types of images are illustrated in telescopes.

Lenses are of two main types, converging and diverging. The convex lens is of the former class and the concave of the latter. As shown in the diagram, Fig. 2, of Galileo's telescope the object glass converges the rays of light from the object AB, tending to form a real, inverted image at ab. But before the rays reach this point they are diverged by the concave eyepiece, thus preventing the rays ever from actually meeting. In looking thru the eyepiece, however, they do seem to meet at A'B', and therefore produce a virtual magnified image in that position. *The object glass always produces a REAL image and the eyeglass a VIRTUAL image.*

Very early in the making of *refracting* telescopes a serious difficulty presented itself. White light, which is ordinary sunlight, is composed of all the colors of the rainbow and Sir Isaac Newton discovered that prisms and lenses bend rays of different colors unequally. The violet rays are refracted most and the red least. Therefore, when light is reflected into a telescope it is dispersed by the object glass into its component colors and the violet rays are brought to focus sooner than the red. As a result the whole image is surrounded by a troublesome *color fringe*. To overcome this difficulty lenses were ground almost flat and of very great focal length, but an even more serious obstacle immediately appeared. Such flat lenses necessitated very long and unwieldy telescopes, awkward to manipulate and requiring a prodigious amount of time and patience in their use. There were instances of telescopes over two hundred feet in length and with no tube connecting object glass and eyepiece.

The first achromatic lenses, which overcame this difficulty, were made by two English opticians, Chester More Hall and John Dolland about the middle of the eighteenth century. They accomplisht this by making an object glass of two lenses instead of one. They cemented a double convex lens of crown glass to a plano-concave lens of flint glass. The flint glass being more dense has greater refractive power than the crown glass. Therefore the concave flint glass diverges the rays of light just enough to neutralize the color effect of the converging crown glass, and yet not enough to prevent the formation of an image. With this most important discovery progress in the construction of refracting telescopes became rapid and certain.

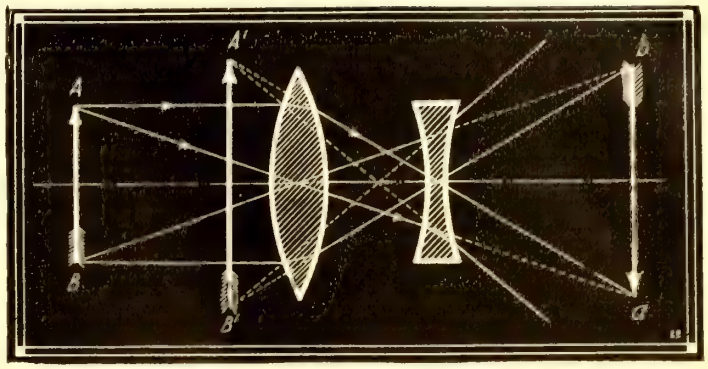


Fig. 2. System of Lenses Used in Galileo's Telescope.

In the accompanying figure No. 3 is shown the lens system of an astronomical telescope. The object glass gathers light from some distant object and bring it to focus within the focal length of the eyepiece, producing there a *real inverted image*. The light, however, does not stop there, but passes on thru the eyepiece, which diverges the rays and therefore produces a virtual image, seen only by looking into the eyeglass. An astronomical telescope will magnify only in the case of heavenly bodies within our own solar system, such as, the Moon, the planets and their satellites, the asteroids and comets. Even the nearest star is so distant that our largest telescopes are utterly powerless to magnify it in the slightest. *What a big telescope does is to gather more light and produce a very bright image.* It also makes visible many millions of stars that would otherwise be unseen and by celestial photography discovers millions more. The big 40-inch lens of the Yerkes telescope gathers 40,000 *times as much light as is possible with the unaided eye.*

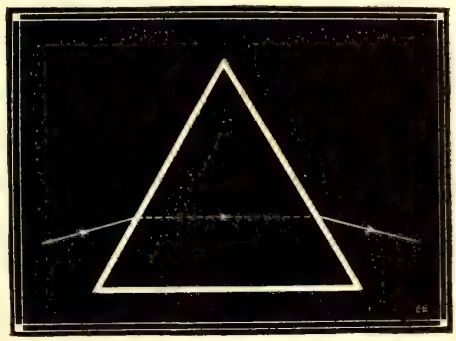


Fig. 1. Illustrating Refraction of Light Thru a Glass Prism.

An astronomical telescope gives an *inverted* image, which of course is unobjectionable in viewing heavenly bodies. The terrestrial telescope, however, contains a third system of lenses for reinverting the image so it will appear upright. This system in an astronomical telescope would cause needless loss of light.

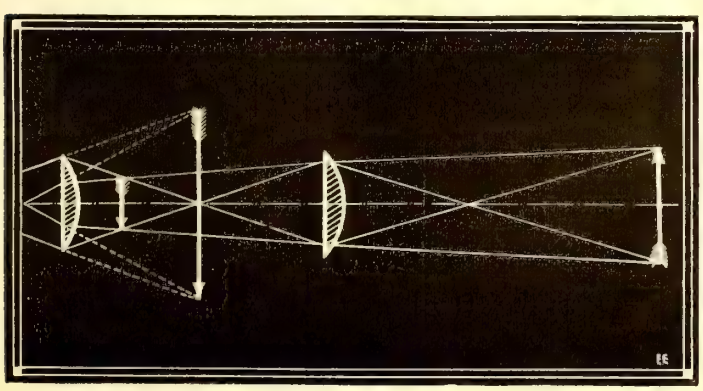


Fig. 3. Here We See the System of Lenses Used In an Astronomical Telescope.

TWO GREAT REFRACTING TELESCOPES.

Among the world's great refractors there are two of such surpassing size and power that they deserve especial mention. I refer to the 36-inch glass at the Lick Observatory, Mount Hamilton, California, and the giant 40-inch lens at the Yerkes Observatory, Williams Bay, Wisconsin.

The sight of the Lick Observatory on a plateau at the summit of Mount Hamilton is 26 miles from San José, and is reached by a road from the foot of the mountain to the summit, costing $78,000. The donor of this instrument, Mr. James Lick, in 1874, gave $700,000 for the undertaking. He hoped that not more than $400,000 would be needed for the telescope, housing and buildings, thus leaving a fund of $300,000 for maintenance. The cost of construction, however, was $600,000. Tedious delays followed the announcement of the gift and actual work did not begin until 1880. The observatory was completed in 1887 and formally turned over to the University of California in 1888.

Feil and Company of Paris cast the glass from which the lenses were ground in 1882. But the crown glass was cracked in packing and two years more were spent in recasting the block. It was shipt to America in 1885.

Alvan Clark and Sons of Cambridgeport, Mass., the most famous lens grinders of all time, were engaged to do the very exacting work of shaping and figuring the glass. It was stipulated that this objective should exceed in size any other previously made. The largest glass at that time was the 30-inch lens in the Imperial Observatory at Pulkowa, Russia. The Clarks finally agreed to undertake the grinding of a 36-inch glass, but could not be induced to go beyond that limit. The consideration for the work was $50,000 and they spent a year in doing it. In the meantime the Warner and Swasey Company of Cleveland were constructing the dome and mounting. The telescope and its accessories cost $200,000.

The telescope is 60 feet long and the tube alone weighs 4 tons. It rests upon an iron pier 37 feet high, the base of which contains the sepulcher of the benefactor who made possible this splendid work of science. So perfect is the adjustment of the mechanism that it may be manipulated as easily as an opera glass. The observatory dome comprises 89 tons of movable structure and is 87 feet in diameter. The sight contains 2,581 acres and the broad plateau comprising it is reached by a series of stairs from the flat below. From this high elevation unrivaled views of mountain, plain and sea greet the eye and the clear air of this region is unexcelled for telescopic "seeing."

The observatory is fully equipt with spectrographic and photographic attachments for the big telescope, besides all other necessary accessories. One of the notable discoveries made at Mount Hamilton was that of the minor planet, *Eros*, in 1898.

The Yerkes Observatory, which contains the world's largest refracting telescope, is located on a tract of 53 acres at the summit of a succession of hills on the shore of Lake Geneva in southern Wisconsin, 75 miles from Chicago. The center of motion of the telescope is 240 feet above the surface of the lake and 1,800 feet distant from the shore. The observatory is far

(*Continued on page* 1207)

The Amateur Magician

By JOSEPH H. KRAUS

THE "TALKING SKULL"

ON one of these fine mornings when the snow and slush prevents traffic in the city streets, an ideal way for killing time (which I never have) occurred to me, namely, to see about another—er—bit of news from Professor Hargrave. Scurrying to his room in a New York hotel, where he lives during the winter season, as the railroad traffic was abominable, I found him busy over the remains of some departed friend.

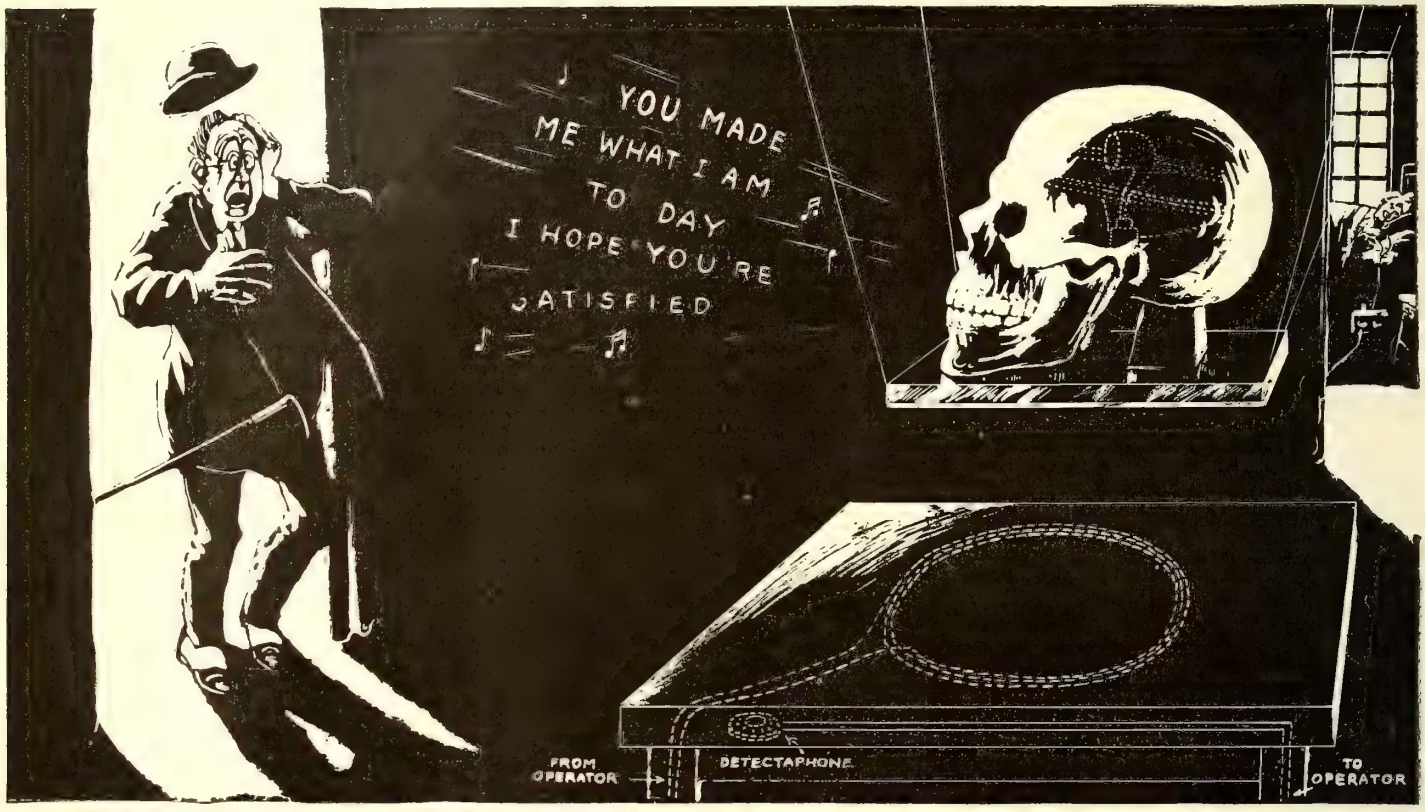
There on the table with tools lying all around it, rested a "skull"—of what he claimed to be that of his Mother-in-law (sob stuff). After the casual greeting, he begged me to be seated while he proceeded to dismember the cranial vault and then tinkered around it some more. All the while not saying a word. Finally, he exclaimed, "There now, I've got it," and then looking toward me, he remarked—"I didn't expect you this early, but I finally got it all set up for you. How do you like it?" I must say that the skull seemed very impressive. There it stood with its teeth grinning at me and the most villainous look upon its face. It was reposing quietly on a glass shelf, suspended about six inches above a polished table by means of four wires coming down from a bracket-like arrangement.

The point of its chin resting well forward and the back of the head in the region of the great foramen on a sort of a block. You could look all around it. After this cursory examination, I turned to the professor and said, "It looks mighty fine but kind of scarecrow like. What does it do?" "N-O-T-H-I-N-G." This in a loud weird voice which I knew never came from the professor. The voice was in that very room—in front of me—on the sides—all around me! I trembled a moment and then exclaimed, "What was that?" Again the sound and a pleased twinkle in the eyes of the professor. Ah! Now I knew what it was! Tip-toeing up to the skull, I lifted it easily in order to disconnect the wires which I thought were leading to it. To my amazement, it emitted a fearful howl which came from right within the inside. Did I drop it? Well I should say so. To go into a dimly lighted room and see a skull and in lifting it up hear it talk is enough to make anybody depart, rather in peace than in pieces.

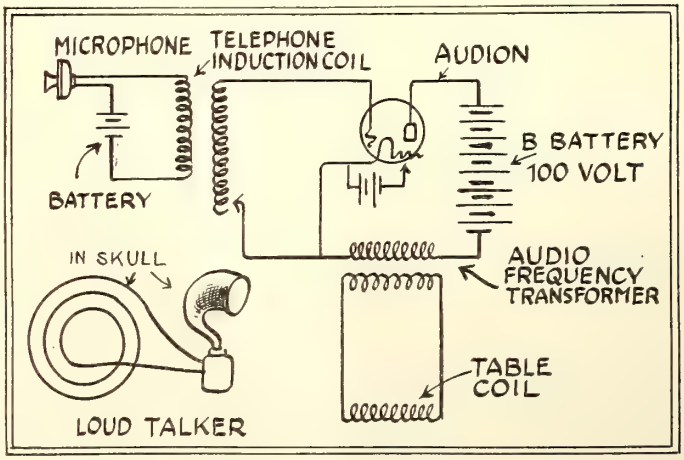
In my haste to get away, I was caught by the professor, just as I stumbled over a little footstool. Turning me around quickly, he stated, "That is my new trick and it's extremely simple, too. You see, you can use this in conjunction with any card trick, clairvoyant act, or in fact any fortune telling or other scheme."

"The skull has absolutely no electrical connections to it of any sort," he continued as he lifted it from the table, passing his hands all around it, back and in front, and allowing me to examine it. Then continuing, he stated—"Still, when I talk to it, it will answer back," and addressing the skull, said, "How do you do, Mother-in-law?" "How do I do what?" came back

(*Continued on page* 1198)



What the ———? ———? Exclamations of This Nature and Then Some, Emanate from "Friend Hubby" When Wifey Tries the "Talking Skull" Trick On Him. This Is One of the Finest Tricks (Undetectable) for Parlor Magic.



A Detectaphone Tells the Operator What Is Going on in the Room. The Operator Then Transmits His Answer Which Is Amplified In the Audion Cabinet. By Induction the Loud Talker in the Skull Answers. No Connections Lead to the Skull.

Rabbit Contest Awards

PRIZE WINNER $20.00.

In explanation of the phenomenon associated with the "Rabbit Film" on page 798 of the ELECTRICAL EXPERIMENTER, I submit the following:

The moving picture machine that exposed this film took the pictures at the rate of about sixteen per second. The time of exposure, i. e., the time the shutter was open, was a small fraction of a second, probably 1/100 of a second or less. The corona occurs only when the A.C. supply wave nears its maximum value, for then the spark gap breaks down and the condenser charge is released thru the Tesla coil. This discharge sets up the oscillating current of high frequency and high potential producing the corona effect. The camera exposed but a small part of about every fourth cycle. Some of the pictures, therefore, were taken while the A.C. wave was passing thru its zero value—hence negative was blank. Others were taken when the wave was nearing its maximum value and therefore some of the pictures showed streamers. The one with the rabbit shown plainly *was taken at exactly the right time*, i. e., while *the wave was passing thru its maximum value* and when the oscillating current and consequent corona were at their best.

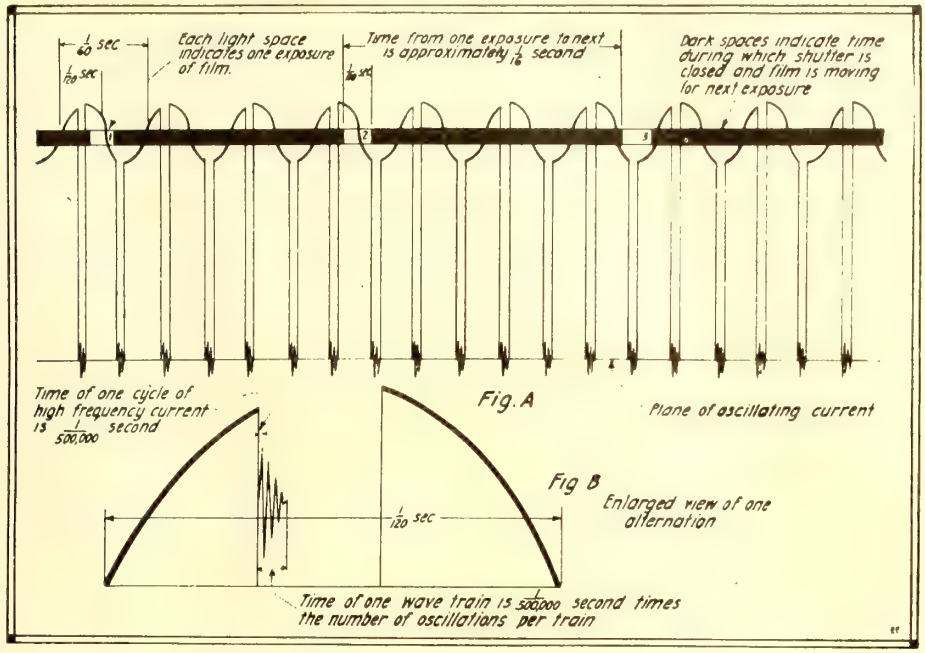


Diagram to Accompany Mr. Leffler's Prize Winning Solution.

This phenomenon is illustrated graphically in Figs. A and B. Fig. A shows the A.C. wave, also the time during which the camera shutter was open. The third exposure is at the right time to give a good picture on the negative, like for example the sixth picture of the film under discussion. The second and first exposures, however, were not at the right time and therefore only the streamers would show.

Fig. B gives an exaggerated illustration of the length of time occupied by the high frequency oscillating current in comparison with one alternation of the A.C. supply.

RALPH H. LEFFLER.

105 Wurst Ct.,
Elyria, Ohio.

FIRST HONORABLE MENTION.

The frequency of 200,000 used in electrifying the rabbit means that the alternating current used alternated 400,000 times per second. To the eye such an electrical discharge appears as a continuous and even light, but it is well known that the light is not continuous but fluctuates from light to darkness 400,000 each second.

The moving picture camera that photographed the experiment took approximately sixteen separate pictures per second, each one of these pictures having an exposure of perhaps 1/200 of a second.

The reason that each picture in the film doesn't give full details of the rabbit is because the various exposures of the film didn't come at the same time that the light from the rabbit was at its height or peak of intensity—that is, several of the pictures were exposed between alternations of the current producing the light.

In the first five pictures the opening of the camera shutter happened either at the beginning or end of an alternation, thus causing an incomplete picture to be recorded. In the fifth picture the exposure came at the time when the alternation was at its peak of luminosity, thereby producing a detailed photograph.

If the camera exposures could be timed to coincide with the alternation peaks, the film would show a series of complete photographic impressions—that is, if the camera could open its shutter 400,000 times per second and each opening took place at the exact instant that each one of the 400,000 alternations was at its peak, each picture would then be fully exposed and complete; or a camera shutter having 1/200 of a second exposure would have to be timed so that each exposure would catch each 100th alternation at its peak in order to have a complete picture upon each frame of the film.

WALTER CHARLES MICHEL.

1023 Summit Ave.,
Jersey City, N. J.

The Mysterious Rabbit

In our December issue we offered a prize for the best solution of a section of a film which we made of a rabbit.

We said in the December issue:

"Turn to page 633 of our November issue. We told you last month how we electrified a rabbit with 500,000 volts, and how he never batted an eyelash. Well, sir, the Gaumont Film people who got wind that we were pulling off a stunt were duly on hand with their trusted film cameras, and while we made the experiment the operator cranked away merrily. Of course, we wanted to see what the film looked like and we had our wish. The very mysterious sample slightly enlarged from the original is printed alongside here. At first we were somewhat puzzled and could not quite make it out how the long streamers after the third picture died away into a mere brush and in the fourth picture had almost entirely vanished only to bloom forth in a wonderful corona effect, showing the rabbit very plainly in the sixth picture. In the seventh and eight, however, nothing can be seen. Now what do you think happened?

Five hundred thousand volts at 20 kilowatts with a frequency of 200,000 was used in the film printed here, which is absolutely authentic. WE WILL PAY $20.00 FOR THE BEST ANSWER EXPLAINING THIS PHENOMENON. Anyone familiar with alternating current should have little trouble in solving the problem. The contest is open to all and will close promptly on February 1, 1920. Not more than 300 words should be used. Answers will be publisht in our March issue. Address all replies to Rabbit Editor, care of this publication."

In answer to this contest we received no less than 1,675 letters, all of which tried to explain the interesting phenomenon which took place. Only very few, however, came up to our expectation, most of the contestants having an entirely erroneous interpretation of what took place.

There really was nothing mysterious about the film. It simply resolved itself to a thoro knowledge of alternating currents at high frequency as well as an intimate knowledge of the workings of a moving picture machine which operates at sixteen pictures per second.

In awarding the first prize to Mr. Leffler, we were led to this consideration due to the fact that the article was very clear and to the point as well as because he illustrated his letter with the best drawing that was sent in. The letters from the contestants follow.

SECOND HONORABLE MENTION.

The strange phenomenon which you recorded in your "Rabbit Film" was due to non-synchronism between the camera shutter and the alternations of the current. If the shutter had operated at a speed bearing a simple definite ratio to the frequency, the film would have been exposed at the instant of maximum discharge. The shutter speed was evidently not an exact multiple of the frequency, hence the progression from a minimum to a maximum in vividness and vice versa. A similar phenomenon would be observed in winking the eye out of synchronism with a spot on a rotating object. The object would appear to advance or retard in its rotation as the rate of winking changed. If an alternating current illuminates a fan and the speed of rotation of the fan is accelerated or retarded, the fan will at one speed appear to travel backward, at another to stand still and at still a third to accelerate. This is due to the fluctuations of the intensity of light due to the alternating current. The maximum intensity is reflected by the fan blades at varying positions in advance or behind the former position depending on the ratio between the speed of the fan and the alternations. Conceivably if the shutter in the case of the movie had operated at a certain speed maximum and minimum intensity of discharge would have resulted.

A similar picture with the slow movie would no doubt reveal the phenomenon still more vividly.

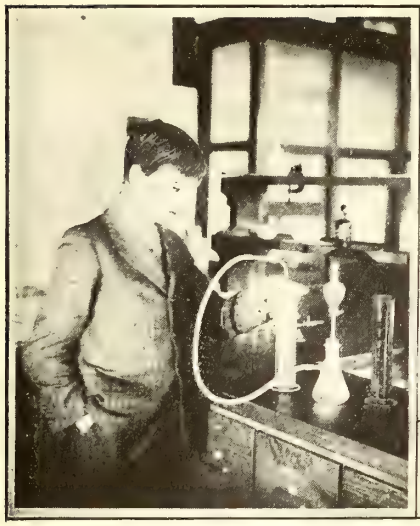
ARTHUR J. MACER.

3722 M St.,
Westfield, New York.

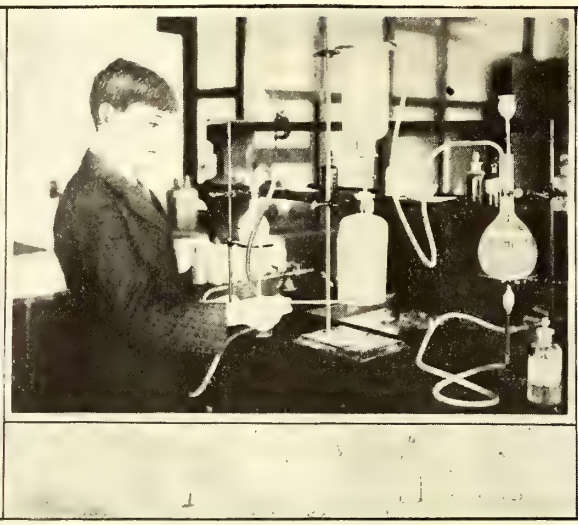
(Further letters will be publisht in the April issue.)

Practical Chemical Experiments

By PROF. FLOYD L. DARROW



A Baffling Color Change Trick. Fully Described in the Test.



Performing the "Smoke Ring" Trick. A Most Interesting Stunt.



Siphoning Carbon Dioxid Gas. The Candle Test Proves the Experiment.

No. 2.—Chemical Stagecraft

THE Amateur Chemist, working in his home laboratory, probably derives more pleasure from entertaining his friends with experiments in "chemical magic" than he does from any other part of his laboratory work. Such demonstrations, too, are so easy to perform and so mystifying to the uninitiated that *chemical stagecraft* affords a never failing source of amusement, both for the demonstrator and his audience.

In this paper and perhaps in a succeeding one a number of very striking experiments of this nature will be described.

THE MAGIC WAND.

A color change requiring a considerable time to make its appearance and which may be so timed as to take place at the exact passage of the demonstrator's wand over the magic mixture never fails to make a most profound impression.

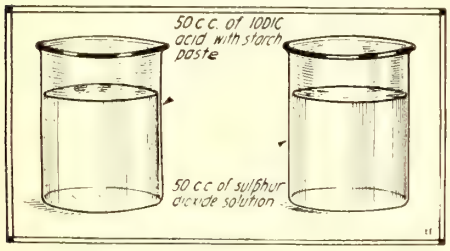


Fig. 1. Apparatus for the "Magic Wand" Trick.

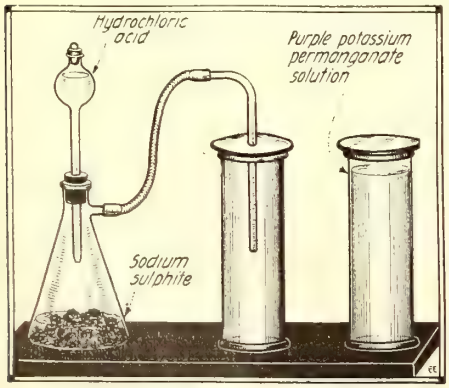


Fig. 2. Apparatus Used in "Baffling Color Change" Experiment.

Two solutions are required. One is made by dissolving 10 grams of iodic acid in a liter of water, which may be preserved in a glass-stoppered bottle for a series of demonstrations. To make the other solution, saturate 50 cubic centimeters of water with sulfur dioxid by bubbling the gas thru it for a few minutes. The best way to generate the sulfur dioxid is by allowing concentrated hydrochloric acid from a dropping funnel to fall onto sodium sulfite in a hydrogen generator. Of this saturated solution of sulfur dioxid, 25 cubic centimeters are diluted to a liter and preserved in a stoppered bottle.

In each of two beakers place 250 cubic centimeters of water. To one add 50 c.c. of the iodic acid solution and to the other 50 c.c. of the solution of sulfur dioxid. Now make a thin starch paste by boiling as much starch as can be placed on the point of a small knife blade in 25 c.c. of water. Add a few drops of the starch paste to the solution of iodic acid. Stir the contents of each beaker thoroly and rapidly pour the two together into a large cylinder or beaker capable of holding 700 c.c. With a clean glass rod stir well to insure thoro mixing of the liquids.

Nothing appears to happen for about a half minute and then instantly the contents of the whole cylinder will turn a deep blue. By trying the experiment in advance *the exact time interval, almost to a second,* may be determined, and when the psychological moment arrives, the demonstrator may wave his wand and behold the contents of the cylinder become subject to the magic spell and the color change occurs. See Figs. 1 and 1-A.

What happens is this: The sulfurous acid reduces the iodic acid, liberating free iodine which reacts with the starch to give a blue color.

A BAFFLING COLOR CHANGE.

A decolorization experiment which appears to be magic pure and simple is accomplisht by pouring a wine-colored solution of potassium permanganate from one cylinder into another containing sulfur dioxid gas.

Place two or three small crystals of potassium permanganate in the bottom of a 500 c.c. cylinder and fill with water. Stir thoroly and a beautiful wine-colored solution will result. Now generate sulfur dioxid as in the previous experiment, and fill another cylinder of equal size with the gas by downward displacement, i. e., place the delivery tube downward into the cylinder. Cover this cylinder with a glass plate. See Fig. 2.

Make these preparations in advance of assembling your audience. Show them that the cylinder of sulfur dioxid is "empty," perfectly dry—contains nothing at all. Then pour the cylinder of potassium permanganate solution which you may call "wine" into the empty cylinder, and as you do so it instantly changes to "water." The chemical action taking place consists in the reduction of the potassium permanganate into a colorless compound by the sulfur dioxid.

A still further change can be effected by adding to the decolorized solution a little of a solution of farium chlorid and stirring. A white precipitate of barium sulfate forms and the solution seems to be changed to "milk."

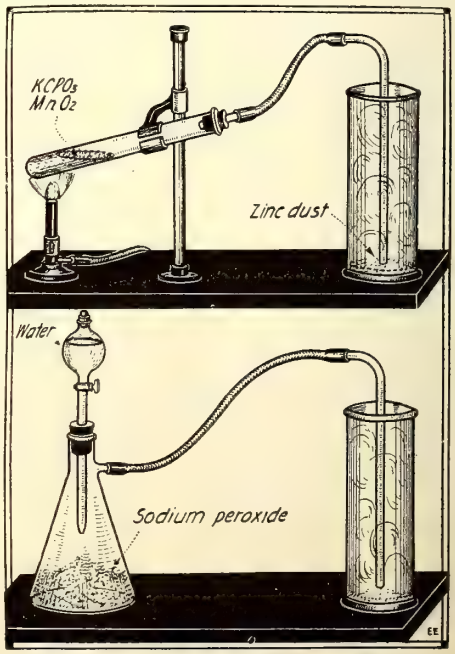


Fig. 3. Set-Up of Apparatus for Explosive Combustion of Powdered Iron or Zinc.

SPONTANEOUS COMBUSTION.

Make a solution of yellow phosphorus in carbon disulfid by dissolving a piece the size of a pea in 10 c.c. of the liquid.

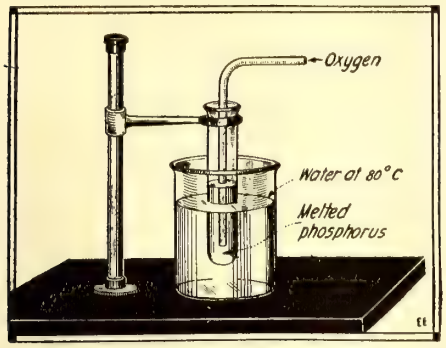


Fig. 4. Burning Phosphorus Under Water. An Interesting Experiment.

(*Do not handle phosphorus with the fingers. Use pincers.*)

Pour a little of this solution onto a filter paper or piece of a blotter. Then wave the paper back and forth thru the air for a few moments when it will burst into flame and burn to a crisp.

As the carbon disulfid evaporates, phosphorus is left in finely divided state over the surface of the paper and its rapid oxidation quickly brings it to the kindling point.

LIGHTING AN ALCOHOL LAMP WITH A GLASS ROD.

In the bottom of a small beaker place 1 gram of powdered potassium permanganate and moisten with a few drops of water. Add 2 c.c. of concentrated sulfuric acid. A vigorous action immediately takes place and a glass rod dipt in the mixture and touched to the wick of an alcohol lamp will at once ignite it.

The potassium permanganate and sulfuric acid generate ozone, a concentrated form of oxygen, and this will oxidize the alcohol, bringing it to its kindling temperature.

EXPLOSIVE COMBUSTION OF POWDERED IRON OR ZINC DUST IN OXYGEN.

In the bottom of a cylinder or bottle about 6 inches high and 1¼ inches in diameter place a ¼-inch layer of very fine iron filings or zinc dust. See Fig. 3.

Set up an oxygen generator in the usual way—ring stand, Bunsen burner, test tube, one-holed stopper, delivery tube, mixture of potassium chlorate and manganese dioxid. By means of rubber tubing connect the generator with a bent glass tube reaching to the bottom of the cylinder containing the metal filings. Upon directing a rapid stream of oxygen into the bottom of the cylinder the dust will mingle with the gas and be blown upward into the cylinder.

Remove the delivery tube and apply a match to the mouth of the cylinder, when an exceedingly brilliant combustion will occur, making necessary the use of colored glasses. The effect is much heightened by performing in a darkened room.

The oxygen may be generated more easily by the reaction of sodium peroxid and water. The apparatus for doing so is identical with that for preparing sulfur dioxid. Place sodium peroxid in the generator and water in the dropping funnel. See Fig. 3.

COMBUSTION OF STEEL WOOL.

Fill a bottle with oxygen by collection over water. Remove the bottle and cover with a glass plate. To the end of a stout iron wire fasten a tuft of fine steel wool such as is used for polishing hard wood. Now heat the steel wool in a Bunsen flame until combustion begins and then thrust it into the bottle of oxygen. A very brilliant combustion and a beautiful shower of sparks will result. A darkened room adds to the effect.

BURNING PHOSPHORUS UNDER WATER.

Melt two or three pieces of phosphorus each about the size of a pea under water in a large test tube by gently heating the tube. Half immerse the test tube in a beaker of water as shown in the diagram, Fig. 4. The water in the beaker should be at 80 degrees Centigrade. Insert a piece of clay pipe-stem in the test tube and conduct thru it a gentle stream of oxygen. As the oxygen comes in contact with the melted phosphorus, the phosphorus burns brilliantly, affording a very striking demonstration of fire under water. A clay pipe-stem must be used because a glass tube would break.

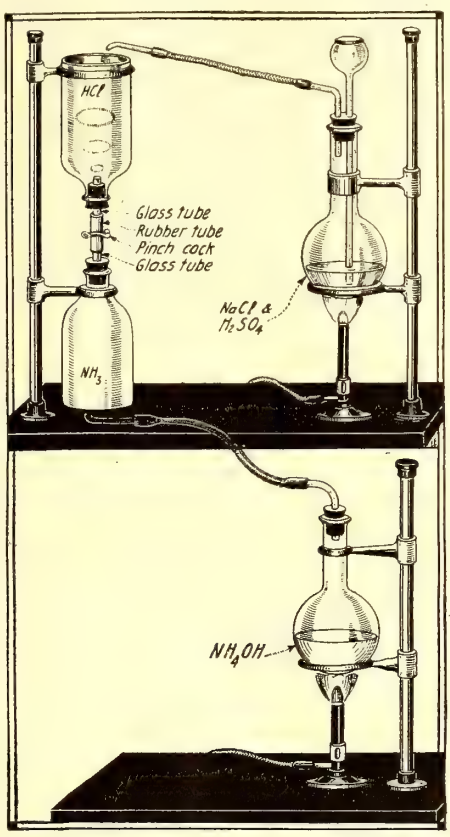


Fig. 9. The "Smoke Ring" Trick. The Rings Form in the Top Bottle.

FLOATING SOAP BUBBLES.

Half fill a large tall jar or bottle with carbon dioxid gas. To generate the carbon dioxid use marble chips and dilute hydrochloric acid in a hydrogen generator, collecting the gas by downward displacement. (See Fig. 5.) Determine when the jar is half full by lowering into it a lighted candle attached to a wire. When the candle reaches the level of the gas it will be extinguished.

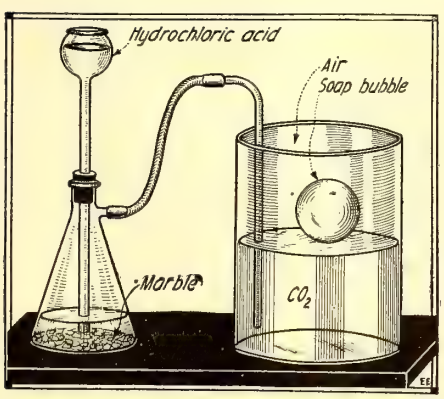


Fig. 5. An Unusual Experiment—Floating Soap Bubbles on Carbon Dioxid.

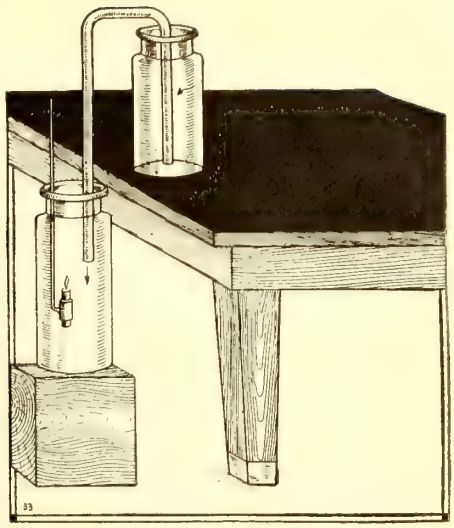


Fig. 6. Siphoning Carbon Dioxid From the Top Bottle to the Lower One. The Lighted Candle Test Proves the Success of the Transfer.

With a good soap solution and a clay pipe or thistle tube blow a bubble, and detaching it allow the bubble to fall into the jar. It will settle to the level of the carbon dioxid and there the bubble will float until it bursts.

SIPHONING CARBON DIOXID.

Fill a bottle holding about two liters (nearly two quarts) with carbon dioxid, generating the gas as in the previous experiment. Test the gas with a candle to show that the bottle is full. Bend a glass tube of large diameter into the form of a siphon and insert the short arm into the bottle of carbon dioxid. Move the bottle to the edge of the table and on a box beneath the long arm place an empty bottle of the same capacity as the other. Start the siphon in the usual way by gentle suction with the mouth and quickly raise the lower bottle so that the long arm of the siphon dips into it. With a lighted candle attached to a wire, test the gas first in one bottle and then in the other. As a result it will be shown that the heavy carbon dioxid is flowing from the upper bottle into the lower one. The candle will burn at constantly lower levels in the upper bottle and will be extinguished at successively higher levels in the lower one. See Fig. 6.

ROTATING A PAPER WHEEL WITH CARBON DIOXID.

Make and mount a paper wheel as shown in the diagram, Fig. 7. Use a stout circular cardboard and paste to it ten or twelve paper cups. Upon pouring carbon dioxid from a beaker into these cups the wheel will rotate.

Since carbon dioxid is colorless and odorless, an audience with no knowledge of the properties of this gas will be completely mystified by all these demonstrations.

(*Continued on page* 1199)

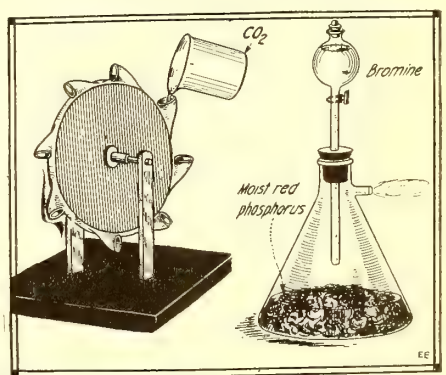
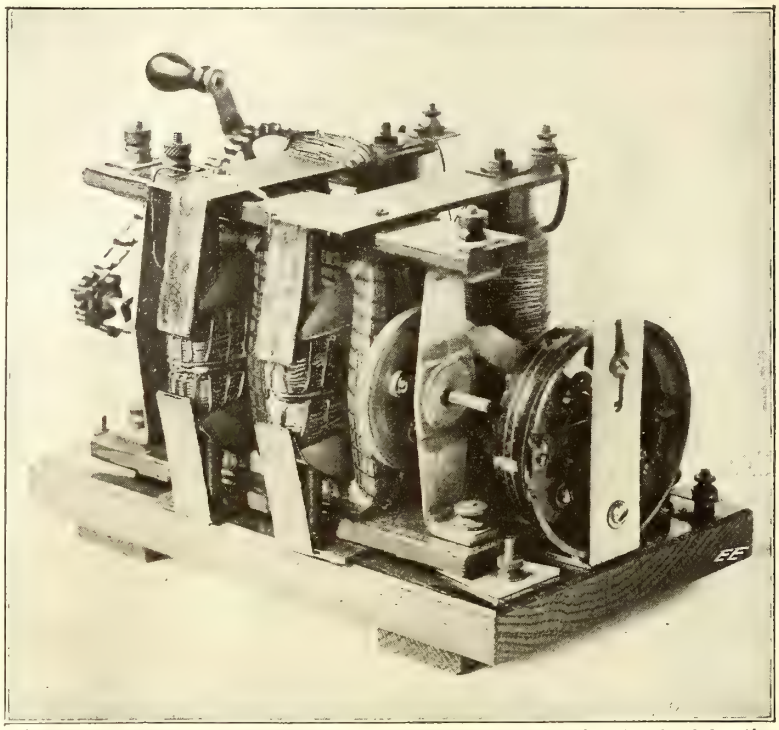


Fig. 7. Rotating Paper Wheel With Carbon Dioxid.
Fig. 8, at Right—The Bromide Gun.

New Commutator-Less A. C. and D. C. Machine

By RICHARD A. ENGLER

AN electromagnet for producing rotary, wave form magnetic fields by means of direct currents of any voltage or amperage without requiring consumption of driving power nor opening and closing contacts. All contacts are permanent, save two simple slip rings, and slip rings are all the non-permanent contacts that are necessary in any form or use of this electromagnet, and its forms and uses are many and varied. One element of the electromagnet rotates and this necessitates the slip rings. The rotation of this element causes an alternate succession of differential and non-differential dispositions of the two main elements constituting the electromagnet. This electromagnet may be called a "Homopolar" one because the same polarity travels in the same direction over a 180° arc of circle so long as the current flow in the electromagnet is not reversed or the direction of motion of one of the elements of the electromagnet is not reversed.



"Commutatorless" Alternating and Direct Current Machine Devised by the Author, Which Marks a Distinct Advance in the Development of Electro-Magnetic Machinery.—Fig. 4.

By means of this electromagnet it is possible by using direct currents, to produce rising and falling, constant value, simple alternating and polyphase alternating magnetic fields, which may all be employed as such fields usually are.

This form of electromagnet produces changes of magnetic flux in a direct current circuit without the use of any kind of troublesome and sparking interrupter or pole changers and produces true wave form magnetic fields.

Referring to Fig. 1, A, B, C and D represent four different positions obtained by the two co-operating elements as coils of the electromagnet thru one revolution of one of the coils. Noting position A in particular, magnetic poles marked N (north) will appear in each coil when the same are fed with direct current. Both coils should produce the same amount of magnetism. A resultant magnetic flux is caused thereby, which is marked N-S. This resultant rotates in the same direction as the rotating coil and its polarity remains the same over the same space, so long as the direction of current flow in the coils is not altered, but the strength of the flux varies from zero to a maximum and back to zero again in one rotation of the coil. At A the resultant flux is rising from zero, reaches a maximum at B, is falling again to zero at C and at D reaches zero from where it again begins to rise from zero. These four positions are one-quarter revolution apart.

Each succeeding revolution of the rotary coil causes a magnetic flux to rise and fall, rotate in the same direction over an arc of 180° and maintain the same polarity. This field of force having the same polarity rotating always in the same direction over the same space may be designated rightly a "Homopolar Rotating Magnetic Field."

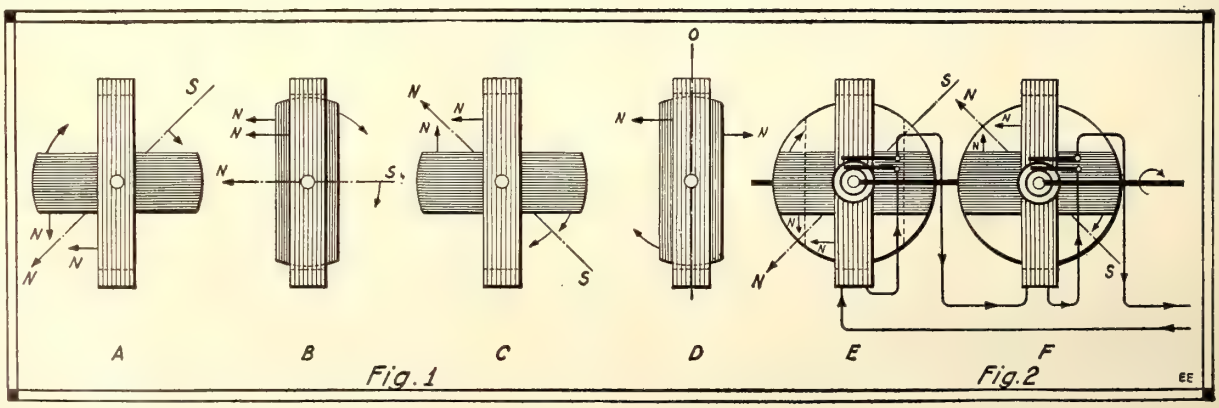
The movable coil may, however, in special cases merely oscillate over an arc of 180° to and fro, and in this case the same polarity would move up and down over the same space instead of always up or always down, hence still being within homopolar bounds. Both coils may rotate in other special cases, one in each direction, then the resultant rises and falls as before, but does not rotate, but the polarity remains fixt in space when the speed of rotation is the same for both coils. The polarity in this case is an alternating one. The rotatable coil may revolve continuously either way. One coil may rotate internally or externally of the other.

Reversing the current in the stationary coil in position A for instance reverses the polarity of the resultant and changes its position from that in A to that in C. Reversing the current in the rotary coil shifts the resultant from position shown at A to that shown in position C, but without reversal of polarity; this then is equivalent to a half revolution of the rotary coil. Reversing the current in both coils simultaneously merely reverses the polarity of the resultant without any shifting of the same.

The stationary coil requires a small per cent more wire to produce the same magnetomotive force as the rotary coil when the two coils are in series.

The two coils must be paired with a similar set in a manner to be explained presently and as shown by Fig. 2, so that no effort, other than that of overcoming friction, is required to rotate the rotary coils.

In position A, the poles produced by the two coils being at right angles to each other tend to force the coils apart to the parallel position shown at B. In position C there is the same tendency of the coils to set parallel. In position A this force would rotate the rotary coil clockwise and in position C counter-clockwise, therefore the



Figs. 1 and 2 Show Successive Positions of the Two Co-operative Elements or Coils of the New Engler "Commutatorless" A.C. and D.C. Machine.

two forces would neutralize each other. In position B, the coils and their magnetic lines of force being in open coil parallelism, no tendency to motion is produced; and in position D, the magnetic fields being in closed coil parallelism exactly neutralize each other, so again no tendency to move and also no opposition to motion in this case. Therefore, when the cooperating coils are paired as in Fig. 2, no effort, save to overcome friction, is necessary to cause the rotation of the coils and the powerful magnetic fields of force which they set up.

So it is in all intermediate positions of the two co-operating coils when paired as A-C and B-D there will be no motion produced by them, and not any opposition to motion applied to them.

Taking the two coils alone when not paired: one half revolution of the rotary coil aids any motion applied to it, while the other half revolution opposes such applied motion, hence the necessity of a pair of units such as A and C, shown by Fig. 2 as E and F, on the same shaft.

The rotary coils in Fig. 2 are each provided with an iron core, which serves also as core for the stationary coils. One way of connecting the co-operating coils is also shown in Fig. 2, but this is not the best connection because they can be so connected that one pair of slip rings *only* are needed for a pair of units.

In position A let the polarity of the resultant remain as indicated and in position C let the polarity of the resultant be reversed from that shown, then the actions and reactions between the coils of a pair of units such as A-C will still be the same as explained for the polarities when as shown, thus no power consumption.

Since the opening of the coils at A, Fig. 1, causes magnetism to appear and the rise of magnetism within a coil always induces an electromotive force counter to the electromotive force which causes the current to flow that produces the magnetism, we must look to the opening up of the two co-operating coils in all apparatus employing them as the seat of the counter-electromotive force. The faster the rotary coil revolves, the quicker will the magnetic changes take place and the higher will the counter electromotive force be.

The two units in Fig. 2 should be connected in series when used in such apparatus as herein described because then the co-operating coils in one or other of the pair of units are opening up at all times, and therefore the counter electromotive force is present at all times when it should be.

The number of turns of wire also determine the amount of counter electromotive force or self-induction in this electromagnet just the same as in an A.C. electromagnet.

The rotary coils may be driven by hand, by clockwork, by a small electric motor or any other convenient way. When an electric motor is used and with ordinary voltage and current in the co-operating coils, it may be in shunt of or series with the co-operating coils. When the voltage or current used in the co-operating coils is too great for the driving motor, it may be placed in series with a dead resistance and then both in shunt of the main line feeding the co-operating coils.

Now to illustrate one practical application of the above electromagnet, we will view Fig. 3. This figure is for the most part self-explanatory in view of what has been previously said and represents a transformer, transforming from D.C. to A.C. (and possibly vice versa). It must be imprest at the start that there is no generation of E.M.F. in Fig. 3 by the method such as in a dynamo, but such as in the ordinary static A.C. transformer. This is evident from the fact that a counter E.M.F. is generated in the co-operating coils of this apparatus when the secondaries are open just as a counter E.M.F. is generated in the primary of a static A.C. transformer when the secondary is open; or even in both cases with closed secondaries when the frequency gets too high. In a dynamo there is *no* counter E.M.F.

This figure is similar to Fig. 2, but with the polarity of one unit reversed and provided with a magnetic circuit and secondaries the several homopolar field co-operating coils being the primaries. There are shown four different positions as one revolution of the rotary coils of such a pair of units, each position a quarter revolution ahead of the other. The E.M.F.'s induced in the two secondaries cause true wave form alternating currents to flow. Fig. 3 has been demonstrated by the experimental model illustrated by the photograph. The photograph is designated as Fig. 4. The co-operating coils in the model photograph have the position shown in Fig. 2 and the rotary ones are driven by the hand gear as shown.

In Fig. 2 two pairs of slip rings are shown, but in the model Fig. 4 only one pair is used, because the rotary coils are connected in series direct, as are the stationary coils also and then stationary and rotary coils in series.

It was by means of this model that I have proven what was previously said herein.

I also used an automatic make and break, shown in the foreground in the photograph, in series with the co-operating or primary coils of the model whereby I was able to listen with a telephone receiver to all the values of induction in the secondaries from zero to maximum and back to zero during one-half wave or cycle or one-half revolution of the rotary coils.

The model is not laminated, but the results obtained with it were good nevertheless.

The secondaries were tried separately and with series, parallel and opposition connections. In the latter case one secondary E.M.F. just canceled that of the other, thereby proving the correctness of the theory of operation because different conditions exist in each of a pair of units at any given instant as explained under Figs. 2 and 3.

Any frequency can be had from Figs. 3 and 4.

In Fig. 3 the secondaries will react on the primaries, which in this kind of apparatus are the homopolar rotary field coils. When the primaries are magnetizing, the secondaries are demagnetizing, and since one set of primary coils in Fig. 3 unit two at G' magnetize by the opening up of the coils from position D to A, Fig. 1, while the other set unit one at G magnetize by a closing of the coils from position B to C, Fig. 1, it follows that the reaction of the secondaries on the primaries does not interfere with the rotating of the rotary

(*Continued on page* 1211)

In the Accompanying Figure Various Positions of the Moving Coils in the New A. C. and D. C. Commutatorless Machine Are Shown. In This Figure One Revolution of the Rotary Coils Causes One Complete Cycle or Alternation of Magnetism in the Pole Tips; That Is, a Certain Polarity Rises and Falls in One Pole Tip and the Reverse Polarity Also Rises and Falls in the Same Pole Tip, All in One Revolution of the Rotary Coils, as Becomes Evident by Carefully Studying the Successive Diagrams. As the Author Points Out, Any Number of Sets or Units, Such as Shown at Fig. 3, May Be Used and Thus Obtain Any Number of Phases by Giving Each Set a Proper Phase Displacement. "Tesla Uses a Continuous Magnetic Circuit," Says the Author, "I Use a Discontinuous Magnetic Circuit. The Lines of Force in the Magnetic Circuit Surrounded by the Coils in the Tesla System Reverse in Direction, Whereas the Lines of Force in the Magnetic Circuit Surrounded by the Coils in My System Do Not Reverse in Direction."

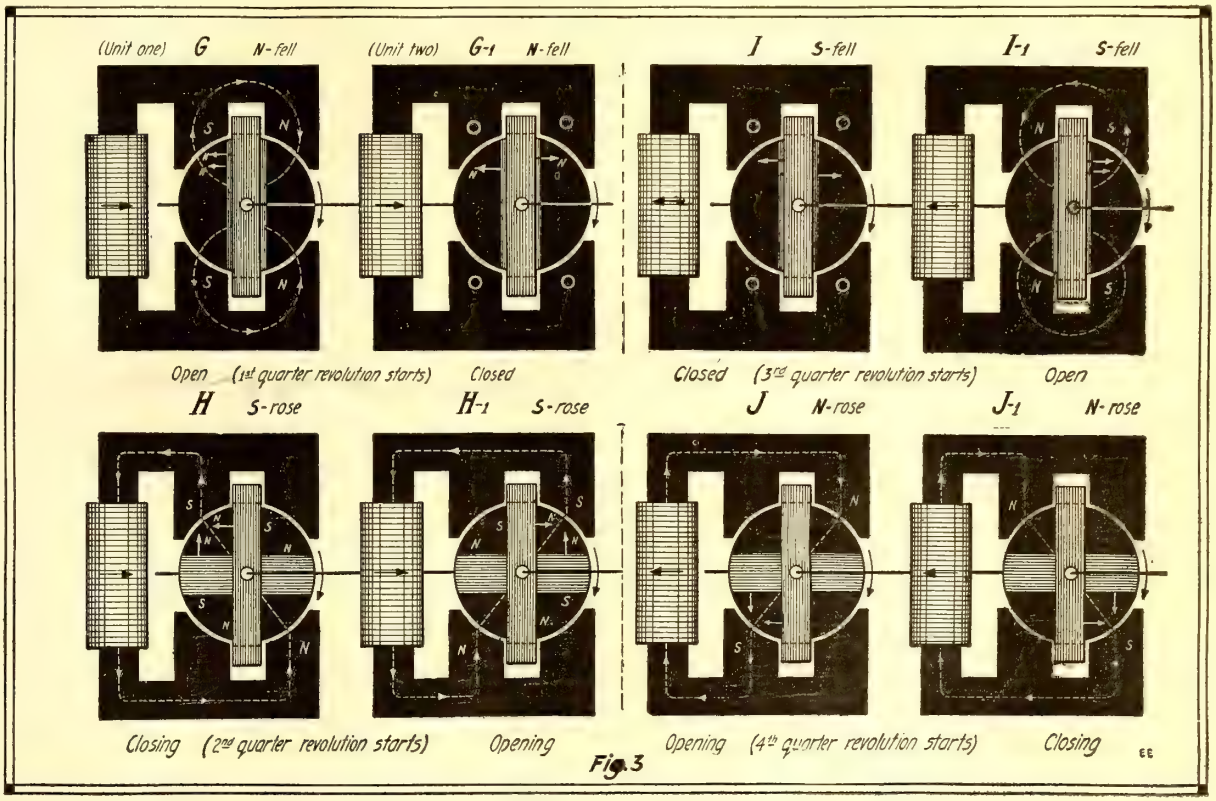
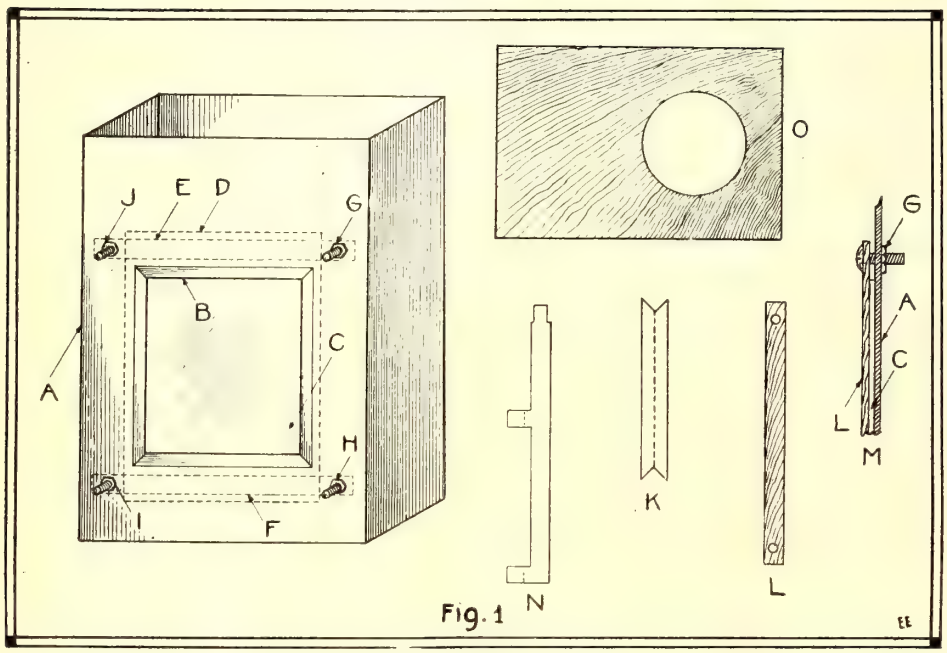


Fig. 3

THE CONSTRUCTOR

Electroscope for Radio-Activity

By FRANK M. GENTRY



Perspective View and Construction Details of Extra-Sensitive Electroscope, Useful for Tests of Radio-Activity and Ionization.

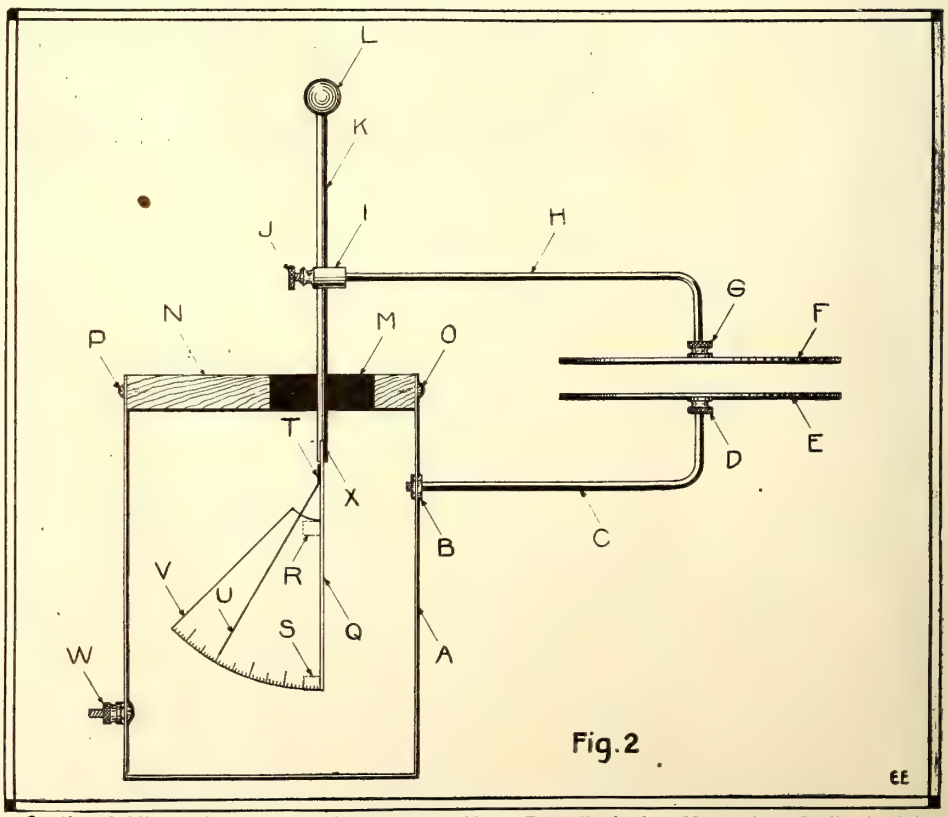
MANY articles, giving data for the construction of an *electroscope*, have appeared from time to time in the various magazines devoted to popular science. The writers, however, seem to have given their attention to the production of some supersensitive instrument, capable of detecting a more feeble charge than had previously been possible. Altho by far the most important modern application of the electroscope is in the study of radioactivity and ionization, no one seems to have made any attempt to produce a simple instrument adaptable to the new uses; if so, they have not publisht their ideas. Extreme delicacy, while of great value, is not such an important factor as proper design. The electroscope to be described was designed by the author in consequence of poor experimental results obtained with other types. The design is based upon the construction of Mme. Curie's electroscope with which she was able to detect a particle of radium weighing approximately one one-hundred-millionth the weight of a single human red-blood corpuscle! While the instrument to be described is not of such a pretentious character as the Curie electroscope, it will give excellent results in all but the most delicate of radioactive experiments.

Faraday showed that, due to electrostatic induction, the reading of any electroscope could not be considered as absolute unless it was inclosed in a grounded metallic container or unless the interior of its insulating walls was lined with a grounded coating of tinfoil or wire gauze. As structural difficulties preclude the use of wire gauze or tinfoil, the former method was adopted in this particular instrument.

A rectangular tin container, A, Fig. 1, measuring 2¾″ x 4⅛″ x 5¾″, was secured in place of the usual glass flask. The dimensions need not be precisely the same as those given, but they should be as near as is applicable to any peculiar situation. A hole, 2 7/16″ x 2⅛″, C, Fig. 1, was cut in the face of the container 1¼″ from its bottom. Four strips of tin ⅜″ wide were cut the general shape as shown in K, Fig. 1, two 2 9/16″ long and two 2¼″ long, and bent V-shape along the dotted line shown in the drawing. These strips were then soldered along the edges of the window, B, Fig. 1, as a reinforcement to prevent warping. A piece of glass, D, 2¾″ x 3⅞″, was clampt over the window by means of the strips, E and F, and the four battery bolts, ⅜″ long, G, H, I and J. The strips were made from ⅛″ poplar, 5/16″ wide and 3½″ long, L, Fig. 1. A sectional view is shown at M. A ⅛″ hole was drilled in the center of each side of the container ¼″ from the top to accommodate the screws, holding the cover in place, P and O, Fig. 2. A binding post, W, was provided on one side 1½″ from the bottom as a ground connection.

A piece of wood, O, Fig. 1 (N, Fig. 2), 4⅛″ x 2¾″, was cut from ½″ poplar to form a cover for the container. A 1½″ hole with its center located 1⅜″ from one end was bored in the cover to allow for the insulation, M, Fig. 2.

(*Continued on page* 1205)



Sectional View of Sensitive Electroscope Here Described, for Measuring Radio-Activity. The Gold Leaf Rises or Falls in Front of a Finely Graduated Scale, Visible Thru a Window.

Silvering Mirrors

By D. McCLANAHAN

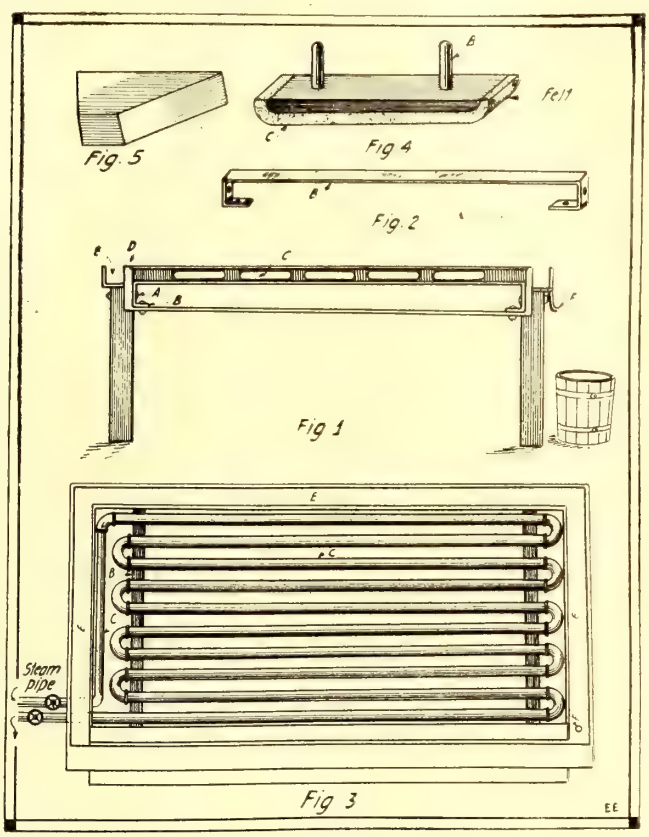
THE art of silvering mirrors has been held as a valuable trade secret for many years, but the formulas and instructions here given makes it possible for any one with ordinary care and a little patience to do the work successfully. I have endeavored to write these instructions in order that you may not become confused.

First you must have a clean room free from dust, in which place a steam table made as per instructions, tho this is not absolutely necessary, as you can warm the glass up to 80° to 100° F. by pouring warm distilled water on the same. But for those who anticipate silvering mirrors to any extent a steam table will be found necessary. The size of the table I will leave to you, tho would suggest to make the table small, say three by six feet, until you become more proficient in the art.

Make a box three by six feet, open at the top; for legs use two by four timber. Bolt the legs to the box frame at A, Fig. 1. Next take a piece of iron three feet long, two inches wide and one-quarter inch thick, placing it across each end so the steam pipes may rest upon it, B, Figs. 1, 2, 3. This is to prevent the boards on the bottom of the table from burning. Place one-inch pipes in the table as in illustration, Fig. 3-C; on top of the pipes is placed an iron top, three by six feet and one-quarter inch thick. (Note.—It is best to go to a foundry and secure your iron plate first and build your frame work to fit the plate, for sometimes it is hard to get iron plate the exact size you want it.) This iron top must rest flush with the side boards D, Fig. 1. This is done by making a quarter-inch groove on all four sides of the table. Now cover the iron top with unbleached muslin, stretch and tack to the side boards.

Make a wooden gutter all around the table, E, Figs. 1 and 3, about three inches wide, and at F, Figs. 1 and 3, make a hole and place a spout in it. The table is connected to a steam boiler or hot water heater, using suitable valves V, V, as shown, to control the steam inlet and outlet pipes.

Do not attempt to handle a very large glass at first. One a foot square will be large enough to start with. Obtain a good grade of plate glass free from scratches. Next get some polishing rouge, which comes in powdered form. Place in a bag made of two or three thicknesses of cotton flannel, sew bag up, place in water to soak, then take the rouge bag and rub over the glass while the rouge is still wet; then rub well with your polisher, Fig. 4. This is a block of wood measuring six by three inches, having two handles for holders, B, Fig. 4, with a thick felt rubber attached at the bottom, C, Fig. 4. Keep the felt wet and proceed to polish the glass all over the surface that is to be silvered, being careful to polish right to the edges. When the rouge has dried, wipe it off. When thru polishing avoid touching the polished side with your fingers, as this would leave a grease spot and the silver would not adhere to the glass where you touched it. Put your hands under the glass and place it on your washing table and clean as follows:



With the Materials Indicated Above Anyone Can Make Remarkably Good Mirrors Which Will Compare Favorably With Those Now Being Sold. The Steam-Heated Table Insures Absolute Evenness of Coating, Which Is Brilliant and Durable.

Washing Solution.

Take one-fourth ounce of muriate of tin crystals to ten ounces of water, and from this solution take one ounce and add it to one pint of water. This one pint of water should look a very light blue in color. Now pour on the glass and rub off with a felt block like Fig. 4, but minus the handles.

Be sure to rub only one way, then pour on a lot of hydrant water, rubbing it off with another felt block. Place your hands under the glass and put it on the steam table, which has been previously warmed up to 90° to 100° F. Keep the side to be silvered up. Now level the glass by placing wooden wedges, see Fig. 5, under the edges. Pour warm *distilled* water on the glass in the same manner as the silver solution will later be poured on.

By pouring distilled water on glass and placing wedges as may be needed you can level the glass until you have an even layer of water standing all over it. Should the distilled water be slow in covering the edges, take your glass rod and draw the water by scraping along the edges. When you get the glass level, raise one side slightly and let all the distilled water run off, laying the glass back in place gently, being very careful not to displace the wedges, thereby making the glass unlevel.

How to Silver.

Pour your silver solutions No. 1 and No. 2 into a glass or stone pitcher, using the exact proportions as given in the formula below, stirring the solutions with a glass rod or by pouring from one pitcher to another. Now pour into the center of the glass without stopping as the precipitation commences at once, or as soon as the solutions are mixed.

Let the solution flow out until the entire surface is covered, allowing it to stand thirty or forty minutes to precipitate, then tip the glass on one corner, allowing all the solution that will to run off.

Next clean by pouring on the luke-warm distilled water, place the glass back on the wooden wedges for a few minutes to dry. When dry coat the side that is silvered with a mixture of *orange shellac*—two ounces; wood alcohol, one pint; turpentine six ounces. Use a camel's hair brush to smooth it out—after this is dry, paint over with a camel's hair brush and some *asphaltum varnish.*

The Boiled or Cold Process

Solution No. 1—Take 150 grains of nitrate of silver. $AgNO_3$, crystallized salt C. P., dissolve in 1 pint of distilled water and to this add with a glass eye-dropper concentrated or 26% ammonia, one drop at a time, until it turns dark—keep on dropping the ammonia until it turns light again—then put in 130 grains more of silver, $AgNO_3$ and let it dissolve—now pour this into 3 pints of distilled water first measured out. Have a ribbed funnel and in the neck of same press a little absorbent cotton before you put in the filtering paper—now put in the ribbed funnel two sheets of filtering paper and filter the solution—it is then ready for use.

Solution No. 2—Take 96 grains of crystallized Rochelle salts, place in one-half gallon of warm distilled water, using a porcelain lined vessel. Let this come to a strong boil for about two minutes, then add 96 grains more of $AgNO_3$ and let it boil for six minutes longer. As soon as this solution is cool, it is best to pour it from the porcelain vessel in which it was boiled into some glass vessel, as the vessel that you boiled this solution in will be quite dirty. Filter this solution the same as you did solution No. 1—into a separate pitcher—when ready to silver mix the two and flow on the glass. Let stand for 15 or 20 minutes.

The Caustic Potash Process.

Solution No. 1—Take 3 pints of distilled water—measure from this amount 4 ounces and add to the four ounces of distilled water 240 grains of $AgNO_3$—let dissolve—then take concentrated or 26% ammonia, 3½ drachms and add it drop by drop until the sediment is nearly redissolved then add the balance of the water—let this stand 12 hours and filter.

Solution No. 2—Take 48 ounces of distilled water and divide into 3 parts and add to the first part 180 grains of $AgNO_3$—add to the second part 20 grains of caustic potash—add to the third part 1¾ ounces of crystal Rochelle salt C. P.

Mix all three—shake well and let stand for 12 hours and filter. To use, mix 4 parts of Solution No. 1 and 1 part of Solution No. 2—stir with a glass rod and pour on glass at once—allowing 35 to 40 minutes to precipitate.

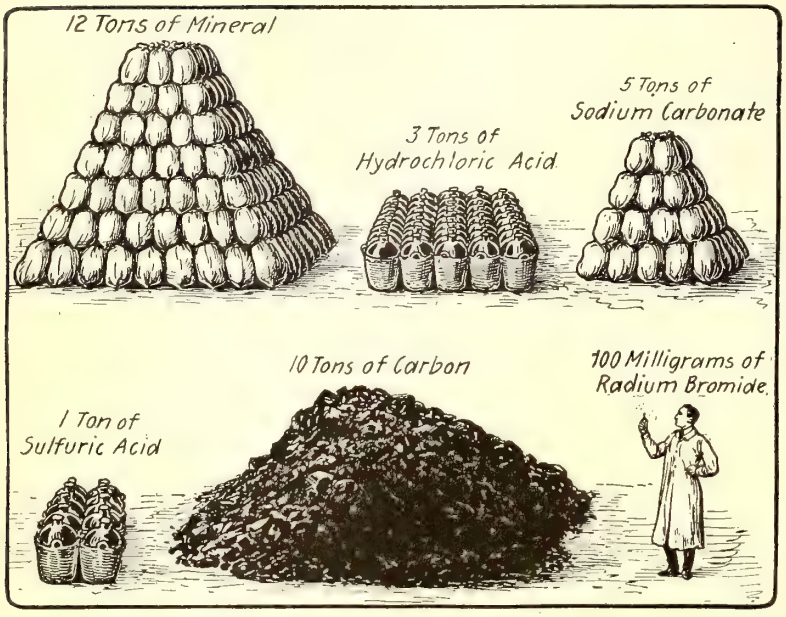
The French or Tartaric Acid Process.

Solution No. 1—Take 8 ounces of $AgNO_3$, dissolve in 8 ounces of concen-

(*Continued on page* 1219)

Radium--The Wonder-Substance

By HAROLD F. RICHARDS, A. M.



How Radium Is Made: The Illustration Herewith Shows Graphically the Enormous Amount of Material Required to Make One Hundred Milligrams of Radium Bromide, a Quantity So Small That It Will Not Cover More Than a Large Pin Head. It Will Be Noted That Twelve Tons of Mineral or About 280 Sacks Are Required. Further, We Need Three Tons of Hydrochloric Acid, Five Tons of Sodium Carbonate, One Ton of Sulfuric Acid and Ten Tons of Carbon for the Apparatus. In Addition to This It Takes over One Month and 500 Successive Crystallizations In Working the Material Itself, a Great Many Workmen Being Required To Do This.

THE RADIUM STOVE.

DO you want a small lump of fuel which will heat your home for thousands of years, *requiring absolutely no attention or replenishing?* Fires go out, hot water cools, ice melts, but a gram of radium keeps constantly from eight to ten degrees hotter than its surroundings. A small thimbleful of radium generates in twenty-six days enough heat to raise a pint of water from freezing to boiling. In winter the average six-room furnace-heated home requires two tons of coal per month. One cubic foot of radium would take the place of this amount of coal, and centuries would pass before the rate of heating diminished appreciably. In 1,000 years this fireless stove would give the heat-equivalent of 20,000 tons of coal.

Not only would the stove require no attention for centuries, but there are no known methods by which its activity could be altered or regulated. We can hammer the radium into powder, cover it with lead, dissolve it in acid, heat it, freeze it, melt it, but none of these operations interferes in the slightest degree with its activity. It is, in the present state of our knowledge, as far beyond our conrol as the planets revolving in the heavens.

There are several obstacles in the way of a general adoption of radium as fuel. The rays from such a quantity of radium would kill a man in short order, unless the stove were surrounded by a case of lead a foot thick. Furthermore, not enough of the precious substance has so far been extracted from the earth to provide even *one* such stove. And even if there were a sufficient quantity, it would cost, at the present rate, over seven billions of dollars. So the coal merchants need fear no sudden competition from these automatic, foolproof, fuelless stoves.

HOW RADIUM IS MADE

The illustration above from *La Nature*, Paris, shows graphically the enormous amount of material required to make one hundred milligrams of *Radium bromide*, a quantity so small that it will not cover more than a large pin head. It will be noted that twelve tons of mineral or about 280 sacks are required. Further, we need three tons of hydrochloric acid, 5 tons of sodium carbonate, 1 ton of sulfuric acid, and 10 tons of carbon for the apparatus. In addition to this, it takes over one month and 500 successive crystallizations in working the material itself, a great many workmen being required to do this delicate and tedious work.



Fig. 1 Shows a Radium Photograph, the Radium Rays Recording the Different Densities and Depths of Material Traversed. During the Five Hour Exposure, There Is Much Production of Secondary Rays Which Cause the Outlines to be Somewhat Blurred.

A MODERN PHILOSOPHER'S STONE.

The old alchemist didn't worry about the conservation of matter or the law of cause and effect. He thought he had the ultimate by the horns, and patiently boiled sulphur, mercury, perspiration and toads' legs, confident that sooner or later he would produce the "magic stone" which would transform lead into gold. But he never succeeded, and the scientists who followed indulged in many a laugh at the alchemist who thought it possible to turn lead into gold.

But in 1896 science suffered as thrilling a shock as if a descendant of old Petrus Peregrinus had announced the discovery of the proper bath for changing the basest of all metals into gleaming gold. Up to that time the scientists had been patting themselves on the back, supremely confident that they had diagnosed Mother Nature's case so completely that she could never again produce any startling innovations. Yet here was radium, an element thousands of times as precious as the golden goal of the alchemists, spontaneously *changing itself into lead.*

In performing this startling reversal of the alchemist's dream, radium revealed a whole world of complex actions going on within the atom itself, which had long been considered the simplest unit of matter. Scientists were thus forced to reconstruct most of their ideas regarding the constitution of matter. In the light of the new knowledge presented by radium it was apparent that, to a minute creature of a size comparable to that of an atom, every atom of matter would seem as complex a world as the whole universe appears to us.

Before we consider the astonishing actions of this wonder-substance, let us take just a glance at its production. Pure radium is a silvery metal, but it is usually extracted in the form of radium bromid or chlorid, which are white salts. Twenty tons of the richest pitchblende would yield a small thimbleful of radium. Radium costs approximately 300 times as much as a diamond.

ELECTROSCOPE MEASURES PENETRATING POWER OF RADIUM RAYS.

The characteristic and indeed the most wonderful property of radium is its ability to emit continuously a spontaneous radiation capable of penetrating solid bodies thru which light cannot pass. It was this phenomenon which led to the discovery of radium. These rays are of two kinds, one being waves in the ether, an invisible light similar to X-rays, while the other consists of minute particles of matter actually shot off by the radium. The atoms of radium are continually exploding, and every second a thimbleful of the substance shoots out more bullets than there were dollars in the Victory Loan, yet the particles are so small that the thimbleful can continue to do this for 2,000 years and there will still be half a thimbleful left.

Both the corpuscular and the etherial radiations affect a photographic plate, and pictures are produced similar to those

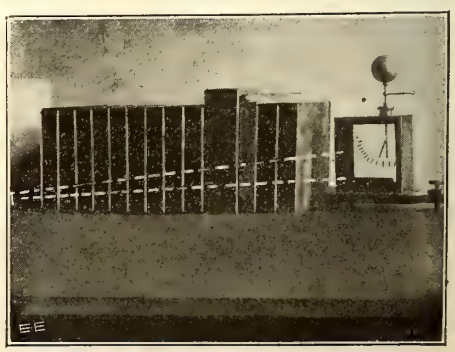


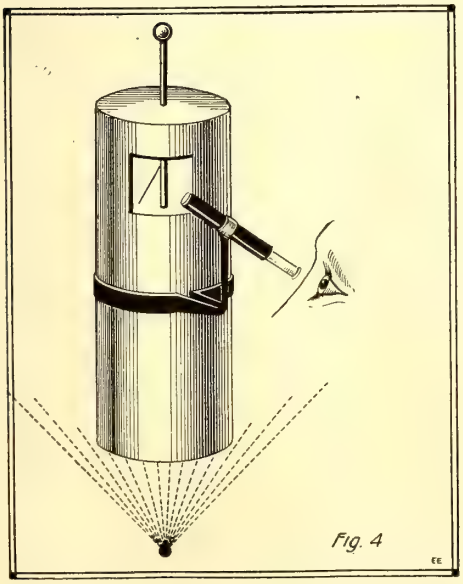
Fig. 1-A—A Remarkable Demonstration of the Penetrating Power of Radium Rays. In An Actual Experiment, a Charged Electroscope was Affected by Rays From a Radio-Active Substance After Penetrating Two Feet of Wooden Blocks, As Shown Here.

made with X-rays. See illustration, Fig. 1. The rays are directed thru the object, and the shadows on the plate are due to the different densities of matter traversed. But the most interesting experiments with radium are performed with an *electroscope*. This instrument operates by virtue of the *ionizing power* of the radiations. In passing thru air, the rays cause gas molecules to break up into negatively-charged electrons and atomic residues bearing positive charges. The electroscope consists of a metal rod to which one end of a gold leaf is attached. When rod and leaf are charged, electric repulsion causes the leaf to stand extended away from the rod. If the gas surrounding a positively-charged electroscope is ionized, the ions bearing negative charges are attracted to the rod, and there neutralize some of the electricity on leaf and rod. This causes the leaf to fall, and the *rate of collapse* is a measure of the intensity of the rays entering the vessel.

The penetrating power of the rays can readily be measured with such an instrument. The radiation passes thru the absorbing material before entering the electroscope, and the rate of fall of the gold leaf is measured by means of a telescope provided with a scale. The instrument can be made so sensitive that it will detect *gamma* rays after they have penetrated *three feet of hard maple wood* or *one foot of iron.* See Fig. 1A. This *gamma radiation* consists of ether vibrations. The electrons shot from radium are termed *beta* rays, and the atoms spontaneously expelled are called *alpha* rays. The latter can penetrate a few inches of air or a sheet of writing paper, while the electrons are able to go thru half an inch of wood.

MEASURING THE ELECTRICITY ON RADIUM PROJECTILES.

In an interesting experiment it is possible to measure the electric charge carried by the material bullets shot from radium. These have the property of causing a flash of light upon striking certain substances, such as diamond or zinc-sulfid. The radium is enclosed in a heavy lead box with a tiny hole, so that only as many rays emerge as can be counted. A plate of zinc-sulfid receives the rays, and by counting the sparks the number of particles can be estimated. See Fig. 2. The quantity of electricity received by the plate is measured, and from this data the charge carried by one particle can be determined. It is not a large quantity. The number of drops of water required to fill sixty railroad tank cars is the number of these particles that would be necessary to carry enough electricity to keep an ordinary sixteen-candle power electric lamp lighted for one minute.



Special Form of Sensitive Electroscope Used In Detecting Lost Radium, as for Instance Radium Which May Have Dropt on the Floor of a Laboratory or Room and Which Cannot Be Seen With the Unaided Eye. This Electroscope Has Lead Side-Walls and Top, But Is Open at the Bottom. When It Happens To Be Held Over the Radium, the Gold Leaf Will Fall Sharply as Soon as it Is Directly Above the Precious Substance.

SPEED OF THE RAYS.

The velocity with which the radium radiation travels is enormous. The *gamma* rays move at the same rate as light and the waves of wireless telegraphy, namely 186,000 miles per second. This is fast enough to encircle the earth 444 *times in one minute.* Even the material particles are shot from radium with unthinkable speed. The *alpha* rays, each one of which is a positively-charged atom of radium, minus one electron, have a speed 3,000 times as great as the muzzle-velocity of the shells thrown by the long-range guns in bombarding Paris. The fast-moving electrons, or *beta* rays, nearly approach the speed of light, or 30,000 times the velocity due to the giant guns. These electrons are exactly the same as those which produce X-rays by their collisions with the metal target in a Coolidge tube, and it is to their free motion in metals that the conduction of current in wires is attributed. In fact, the

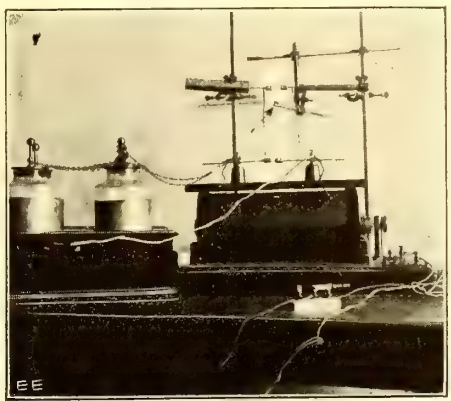


Fig. 3—The Spark Gap Experiment. The Ionization Caused by Radium Brought Near the Longer Spark Gap Just Above the Short One on the Spark Coil Causes the Spark to Jump Across It. The Spark From a Leyden Jar Battery Is Used. The Short Gap Is Protected From the Radium Rays By the Lead Disc on Which the Radium Rests.

more radical of present-day physicists assert that all matter is essentially *electronic*, and *that electricity is the foundation of the MATERIAL world.* The isolation of electrons from radium and the measurement of their mass, charge and velocity were largely responsible for the overthrow of 19th century ideas regarding electricity and the constitution of matter.

THE SPARK GAP EXPERIMENT.

One of the most spectacular experiments with radium is that of the *spark gap.* The high tension terminals of an induction coil are connected to two spark gaps. One gap is longer than the other, and the spark chooses the shorter one. Electricity, like many human beings, prefers the path of *least resistance.* But if the rays from radium are directed toward the silent gap, the spark will leave the other path and crash across the gap near the radium. In this way the silent gap can be made to respond instantly to the invisible power of the speck of wonder-substance. This is because the ions produced by the radium decrease the resistance of the air between the spark terminals. The smooth balls are used instead of spark points in order to stabilize the phenomenon. See Fig. 3.

The writer has also performed this experiment with a single gap to which is connected a battery of Leyden jars. The spark electrodes are drawn apart so that the coil is silent. The radium is brought near, and a tremendous crash is produced! The large quantity of high tension electricity stored in the Leyden jars is released by the radiumionized gap, with a noise like that of a high-powered radio transmitting station.

FINDING LOST RADIUM

Radium is commonly employed in the form of a tiny speck of its bromid salt,

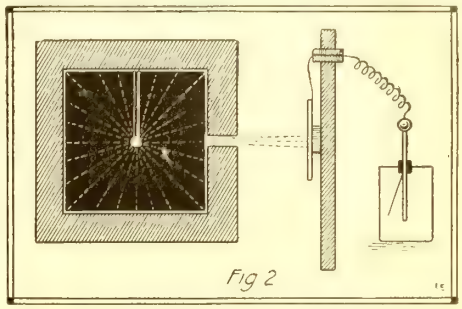


Fig. 2 Shows Apparatus Used In Determining the Electric Charge Carried by the Particles Shot Off From Radium. These Particles Have the Property of Causing a Flash Against a Zinc Sulfid Solution When They Strike. By Counting the Sparks the Number of Particles Shot Forth and the Charge Can Be Readily Estimated.

enclosed in a glass capsule. Inasmuch as even $500 worth, if dropt on the floor, can hardly be seen with the unaided eye, much trouble has been caused by such accidents. In some instances large sections of flooring have been removed and reduced to ashes, so that the lost radium could be recovered by electrical and chemical means. If the approximate locality in which the loss occurred is known, a specially constructed electroscope will indicate the spot where the radium lies. The electroscope is made with a long, cylindrical body, the sides of which are protected with heavy lead. Virtually all the ionization in such an instrument must be caused by rays coming directly thru the unprotected lower end. See Fig. 4. If this apparatus is carried about over the region where the radium is supposed to have been lost, the gold leaf will fall sharply when directly above the radium.

WHAT BECOMES OF RADIUM?

Since radium is constantly shooting itself away, one asks what becomes of it? The *alpha* rays eventually lose their electrical charge and become atoms of helium, which is one of the rare components of the atmosphere. Radium also gives off another gas, called *radium emanation.* This emanation has been condensed into a yellow fluid, and is itself radioactive, eventually turning into *helium.* But more remarkable still, radium itself, after radiating particles for thousands of years, *turns into lead!* Thus the most costly metal changes into one of the basest, and the golden dream of the alchemist is reversed. But it is the wonderful energy of radium which distinguishes it from common substances, and this energy has been largely expended before the radium becomes lead.

RADIUM REVEALS THE AGE OF THE EARTH.

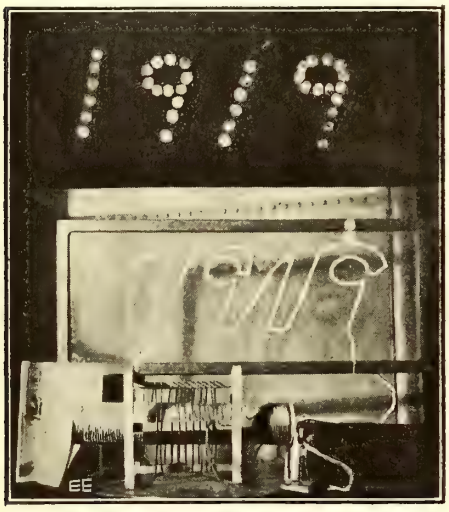
It is definitely known how much helium will be evolved in a given time by a quantity of radium. Some deposits of radioactive material have been found in rocky cavities, entirely enclosed in metal ore, so that the gas has no opportunity of escaping. In such cases it is comparatively easy to measure the amounts of radium and helium present, and the time for the radium to liberate that quantity of gas can be calculated. Undoubtedly the radium has been in the ground since the formation of the earth's crust, so that the age of the earth can be deduced. Various such measurements made in different parts of the world indicate that the earth is at least 230 million years old. This agrees very well with the figure given by Sir William Thomson, who, by calculations based upon the known cooling of the earth, estimates that it is 200 million years since the earth was a molten mass.

NOVEL ELECTRIC SPARK SIGN.

High-frequency experiments are always interesting and the one shown here and described below is one of the most entertaining that could be prepared for any audience. This experiment can be called "The Electric Spark Sign," and a study of the pictures will show how it is constructed. The apparatus needed is a transformer (or spark coil), a condenser and a Tesla coil. The operation of the sign is as follows:

The 110-V. current is stept up to a very high potential in the secondary of the Tesla coil. The discharge takes place across small air gaps which form the outline of the letters.

The sign is constructed as follows: A large sheet of glass 2 x 4 feet is secured. This can generally be found by a visit to the family bookcase. The letters, which are made of tinfoil, are placed on this glass. Strips of tinfoil ¼ inch wide and 10 inches long are cut. These strips are carefully glued to the glass in such a position as to form the letters required. These letters should be at least 8 inches high, and should be sufficiently separated from one another to prevent sparks jumping across instead of following the proper path. As is seen in the picture, a piece of tinfoil connects the end of one letter with the beginning of the next. Another strip of tinfoil is fastened to the beginning of the first letter; this leads to a binding post in the frame. A similar piece connects the end of the last letter to another binding post. Small



Upper Photo Shows Appearance of Mystical Electric Spark Sign Illuminated in the Dark. Lower Photo Shows Tesla Coil Connected to Tin-Foil Letters.

air gaps must now be made in the tinfoil strips that form the letters. With a safety razor blade gently part the tinfoil at these places and roll back one end of the tinfoil, about 1/32 inch. (If this space is found to be too small for the spark, it can be widened.) When a sufficient number of these gaps are made, the sign is complete.

The transformer and Tesla coil is connected as usual; two wires lead from the Tesla secondary to the two binding posts on the frame of the glass. When the transformer is started in a dark room and the primary of the Tesla tuned correctly a heavy discharge will flash across each air gap with a purplish-white flame.

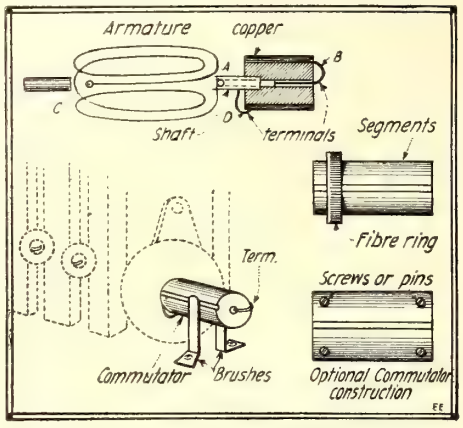
At a New Year's Eve party, a novel effect was secured by the use of this spark sign. The numerals 1919, in tinfoil, were glued to the glass and at midnight the sign was started. The numerals 20 were placed behind the 19 on a second glass sheet; by quickly changing the connections the year was mysteriously rearranged from 1919 to 1920.

The photographs show, first, a flashlight of the apparatus connected and operating; second, how the sign looked in the dark.

Contributed by E. C. FEWELL.

BATTERY MOTOR FROM METER.

Since I began experimenting I have owned a telephone ringing Magneto Generator. It delivered a strong *high voltage*



Here's How To Make a Battery Motor or D. C. Dynamo From a Telephone Magneto. A Commutator Is Required, But Its Construction, With But Two Segments, Is Very Simple.

alternating current which was of very little use to me. But I have devised a simple way of transforming it into a powerful battery motor, which will run at high speed with three cells and when used as a dynamo will supply sufficient direct current for lighting small electric lamps, motors, bells, etc. As seen in the illustration the apparatus consists of a *two-sector commutator* which was made as follows:

To the surface of a thread spool deprived of the flanges were glued two thin copper plates, equal in length and separated from each other about 1/16 of an inch.

To the end of the armature shaft were soldered two pieces of copper wire of about two inches, then the commutator was slipt thru the center one and glued to the end of the shaft, the connections being made as shown in the diagram, where AB and CD represent the two terminals of the armature windings.

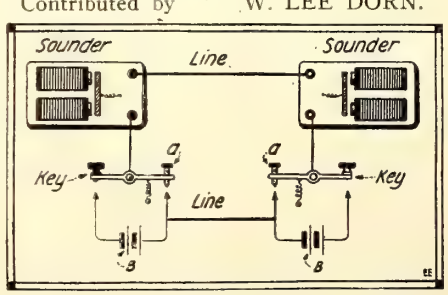
The motor was mounted on a wooden base and the two copper brushes fixt as shown. The armature winding was removed and the fine wire was changed for number 20 single cotton covered copper wire. As a dynamo the voltage will be reduced from 110 or 150 to 8 or 10 volts, with ⅛ to ⅙ ampere of current. About the same potential is required to operate it from batteries.

Contributed by JOSÉ VELARCO, JR.

A DRY CELL TELEGRAPH LINE.

One terminal of the sounder must be connected to the lever of the key and the key must have two points. The adjustment screw may make contact with the extra point, which may be fastened to base of the key. If the adjustment screw strikes metal the extra point may be made of a strip of brass fastened to the wood base and bent up over the metal base.

Contributed by W. LEE DORN.



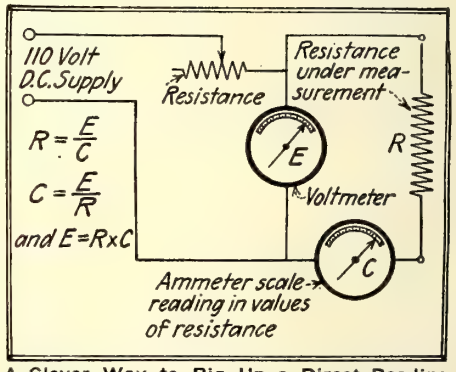
A Unique Form of Telegraph Circuit Employing Dry Cells Instead of a Gravity Battery at Either End of the Line.

A DIRECT READING RESISTANCE MAGNETO.

An ordinary voltmeter and ammeter are connected in series with the source of supply in order that a definite amount of voltage (110 volts in this case) may be maintained at all times.

The ammeter described is one with a scale of 0.3 ampere, the scale being calibrated to read in tenths. The following readings are herewith given for the convenience of those who wish to use the same size ammeter:

Amperes in tenths	Resistance in ohms
.1	1100.000
.2	550.000
.3	366.666
.4	275.000
.5	220.000
.6	183.333
.7	157.142
.8	137.500
.9	122.222
1.0	110.000
1.1	100.000
1.2	91.666
1.3	84.615
1.4	78,571
1.5	73.333
1.6	68.750
1.7	64.117
1.8	61.111
1.9	57.894
2.0	55.000
2.1	52.380
2.2	50.000
2.3	47.826



A Clever Way to Rig Up a Direct-Reading "Resistance Meter" By Means of a Voltmeter and an Ammeter, the Scales of the Latter Instrument Being Calibrated in Values of Resistance.

2.4	45.00
2.5	44.000
2.6	42.300
2.7	40.740
2.8	39.285
2.9	37.931
3.0	36.666

Should it be necessary to measure lower values of resistance more resistance can be inserted in the supply source, thereby lowering the voltage, but new values of resistance will have to be figured for a new scale. The main idea is to once plot the values of resistance and maintain the current supply at an exact value.

This method of measuring resistance is modeled after that followed in the electrical laboratory, employing two standard and accurately calibrated instruments such as a voltmeter and ammeter, which enable one to utilize the relations of Ohm's law to determine accurately the resistance of a certain coil. One very important factor, however, in such measurements at least where accuracy is demanded or required, is that the source of current shall be very constant. This is rarely so on ordinary 110-volt lighting or motor circuits, owing to the variations in potential on such systems, occasioned by variations in load, and the only really accurate and dependable source of current is a storage battery.

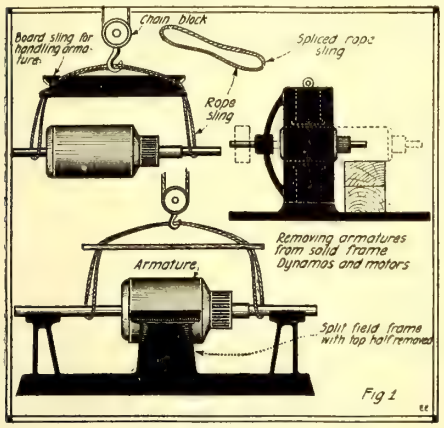
Contributed by E. T. JONES.

The Electrical Machinist

By H. WINFIELD SECOR

No. 5—PRACTICAL ARMATURE WORK, INCLUDING BANDING

IN the last paper we took up some of the machining operations on motor and dynamo field castings, and in the present paper we will take up some practical details of armature work, particularly that part of the work which usually



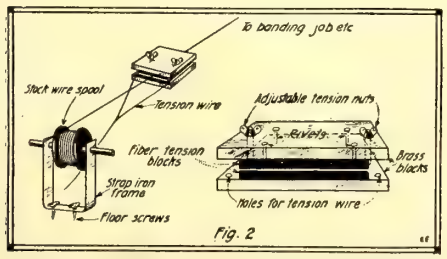
Lifting Armatures—Always Use a Board Cut to the Shape Shown So the Rope Can't Cut the Windings.

falls to the lot of the Electrical Machinist.

At Fig. 1, a few suggestions are shown for the handling of dynamo or motor armatures, as this is very important. An armature, no matter whether large or small, should never be set down on an ordinary floor, but should rest on a piece of cloth or burlap, and in many shops it is one of the ten commandments that an armature must not be laid down on its side or laminations, as, owing to the small width of the teeth, there is liable to be too much strain on them caused by the heavy weight of the armature and the teeth pushing into the winding, thus grounding or short-circuiting some of the turns composing them.

It is the best plan, therefore, to always place armatures on a rack suitably built for the purpose, or else on armature stands provided with roller or ball-bearings, such as that shown at Fig. 3.

In lifting the heavy armatures by means of a rope sling and chain block or other tackle, it is not sufficient that a substantial rope be used, but also it should be spread out on a wooden block or board having "V" notches cut in both ends as shown at Fig. 1. This is done to prevent the rope from bearing against the commutator or the armature coils, which would be liable to damage them both mechanically and electrically. It is easy to remove the armature from some machines, which have the top half of the field carcase or yoke split at the center, as in this case the top half of the circular field frame can be lifted off, also the top caps of the bearings, when the armature and shaft can be readily lifted out.



Detail of Tension Clamp for Armature Banding Wire. It Is Adjustable Yet Simple to Make.

Another detail shown at Fig. 1 is that of removing the armature from a solid frame machine, and this is always a difficult job to perform. Substantial wooden blocks or else a strong box is placed in front of the machine, after one of the end bearing frames has been removed, and the armature is generally lifted and moved out of the frame by two men, one stationed at either end of the armature shaft. Some burlap or padding should be placed on the blocking, so that the armature will not rest directly on the wood, and great care should be taken to see that no screws, metal cuttings or nails are on the surface where the armature is to rest, as this will be driven into the windings by the weight of the armature pressing upon them, and cause short-circuits, etc., in the windings.

DOLLARS FOR JOKES

A SCIENTIFIC magazine is supposedly notorious for its dry reading. Still we flatter ourselves that the ELECTRICAL EXPERIMENTER can hold your attention without your yawning too frequently.

Of course you like to laugh—we all do. Sometimes we make you smile while you peruse the EXPERIMENTER. Perhaps sometimes you laugh out loud—at some of our "preposterous ideas" which we print here. And then of course the joke's on us, because we were real serious!

Now it occurred to us that we would like to print a column of real, original jokes every month, but here's the hook: The joke must be a SCIENTIFIC JOKE. No, this is no joke, we mean it!

Anyone can print or re-print jokes, but we want them with a dose of science. So, till further notice we will pay $3.00 as a monthly 1st prize for the best joke, and $1.00 for each other one we print.

So you will know what we mean with a "Scientific Joke," we print one here, which we purloined from the "Baltimore American":

LOGICAL.—"I want some good current literature."
"Here are some books on electric lighting."

Now of course, our readers can do much better than this. So let's wait and see. One reader can submit as many jokes as he pleases. Even if it is old the joke is not necessarily barred or condemned. There is one rule however: The joke must not be too technical; in other words, it must be readily understood by anyone. Not more than 100 words can be used. Use only one side of the paper.

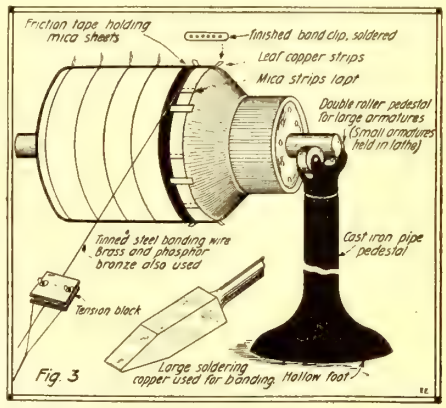
Address
SCIENTIFIC JOKE EDITOR,
Care of this publication.

BANDING WIRE TENSION CLAMP.

The winding of armatures hardly comes under the head of electrical machine work, so therefore this will not be touched upon except here and there in this series of papers.

One of the next important details which arrests our attention in the electrical machine shop routine is the *banding* of armatures. Before proceeding with the details of banding the windings, which work covers the winding around the exterior perifery of the core several bands of phosphor bronze or tinned steel wire, which serves to retain the armature coils within the slots, we will first take up the construction of a useful and substantial tension clamp for use in applying the banding wire.

As might be surmised, there is no use, and in fact great danger, in applying a loose wire band or bands on an armature, for it must be remembered at all times that the periferal speed of a spot on the surface of an armature to be used in an electric motor or dynamo is very high, and in no case is it less than several thousand feet per minute. The consequence of a loose band or one improperly soldered and fastened is



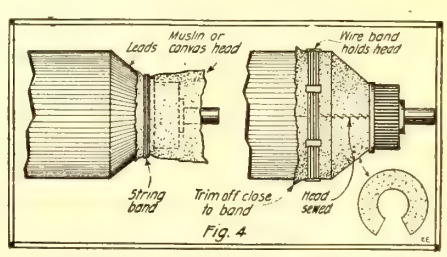
Banding Armatures—The Full Details Are Explained in This Paper. A Mean But Necessary Job.

likely to be a damaged armature, and the writer has seen accidents of this kind which have not only destroyed the electrical winding on the armature but have very badly damaged the core teeth, not to mention the "fireworks" displayed when the affair took place—all this trouble being caused by a loose band becoming displaced so as to be caught between the whirling armature and the field pole-pieces.

The tension block shown at figure 2 is therefore a very important piece of apparatus. It is usually made by the electrical machinist and electrician, with brass and fiber for the top and bottom clamping plates, or these can be made of iron, etc. Brass has the advantage that it will not rust, and is therefore the more desirable for the top and bottom members. Between the two metal plates there are placed two fiber compression blocks, between which the banding wire passes, and the tension on which blocks may be regulated to any pressure desired by simply screwing down on the two thumbnuts on the bolts passing thru the two sides of the tension block. Two holes are drilled in the rear corners of the tension block base, in the manner shown, to which a wire saddle is attached, and this leads down to a screw eye fastened to the floor. The banding wire, which may be of tinned steel, plain or tinned phosphor bronze, or sometimes hard brass wire, and which comes wound on a stock spool, is held on a metal rod or piece of pipe in some form of frame or saddle in the manner illustrated at Fig. 2.

A very good support for this spool of wire can be formed from a piece of flat

(*Continued on page* 1180)



Heading Up Armatures. It's Done With a Piece of Cloth Cut to the Shape Shown At the Right. the Bands Holding It in Place.

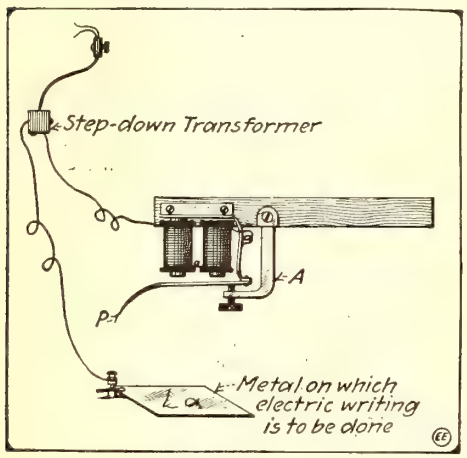
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00 **SECOND PRIZE, $2.00** **THIRD PRIZE, $1.00**

ELECTRIC PEN.

The diagram shows an electric pen which can be made in a few minutes. This instrument is very useful for marking tools, etc. It is run by a small step-down transformer, such as one used for operating toy trains. The coils and armature of an old bell are removed from the iron base and



Easily Made Electric Etching Pen.

mounted on a piece of board about ten inches long and three-quarter inches wide. The hammer is filed off and end of armature is bent as in sketch. The contact maker is also filed off and a regulator A is put on in its place.

To write, the pen is grasped by handle and point P is brought into contact with metal to be written upon. As soon as the contact is made an action similar to that of an electric bell is set up.

The writer's pen works best on eleven volts, but of course the current required is determined by the coils used.

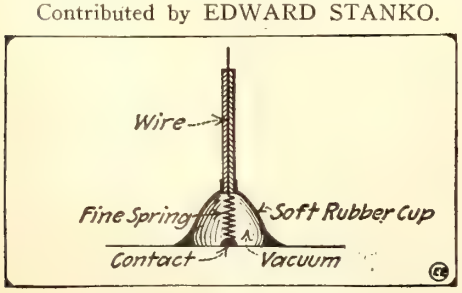
(*Editorial Note.*—The contributor submitted an excellent sample of this electric etching on a silver watch case.)

Contributed by G. BOUCHER.

VACUUM CUP CONTACT.

This device could be used instead of unsightly binding posts on wireless sets; also instead of cord tips on telephone receivers as well as on condenser surfaces, experimental circuits, etc. The rubber cup is wet, if necessary, before being pusht tightly against the metal surface.

Contributed by EDWARD STANKO.



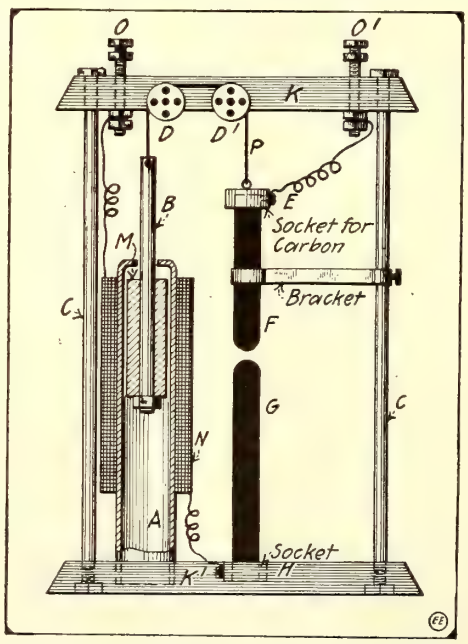
Quick-Acting Suction Cup Contact.

NEW TYPE EXPERIMENTAL ARC LAMP.

A very interesting arc lamp may be made in the following manner: First we must obtain an old bicycle pump. Then remove rubber hose and bottom, leaving piston and cylinder. When this is completed, cut cylinder (A) and piston (B) in half, drill small hole at end of piston (B) and then wind (A) with four layers of No. 18 annunciator wire as shown in diagram (N).

Fibre bushing (M) is placed between (A) and (B) in order to keep (B) in the center. A hole is drilled in wooden block (K') so that coil (A) shall stand firmly perpendicular to it. After this is completed, erect two pulleys as shown in diagram and prolong a soft wire from piston over pulleys to socket for carbon and then fasten. The socket (H) should be countersunk as shown, with its lower carbon placed as shown in diagram. The connections for wires are shown in the sketch and the binding posts are O and O¹. Lamp can be regulated by adding or decreasing weight at carbon end and can be operated on 40 to 50 volts, direct current.

Contributed by JACOB KEENER.



Home-Made Electric Arc Lamp Made Partly From an Old Bicycle Pump, and Other Odds and Ends Found About the Experimenter's "Lab."

"HAIR ELECTRICITY" LIGHTS GEISSLER TUBE.

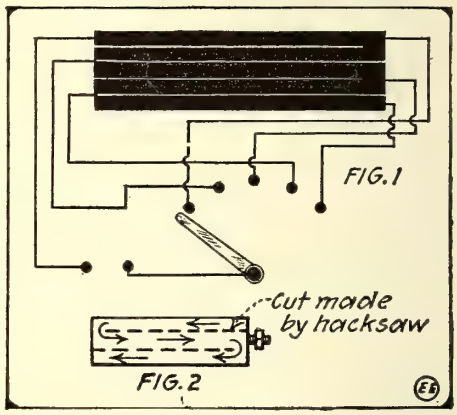
If a hard rubber comb, which has been electrified by running it thru the hair, is presented to the terminal of a Geissler tube, the effect of the discharge can plainly be seen. Needless to say, this experiment must be performed in the dark.

Contributed by FRED FLOYD, JR.

RHEOSTAT FROM BATTERY CARBONS.

Herewith is a diagram of a small rheostat. It can be made of one or more old battery carbons if desired. In Fig. 1 the white spaces are simply slits made in the carbon by a hack-saw. In Fig. 2 the arrows show the course taken by the current.

Contributed by WM. ATKINSON.



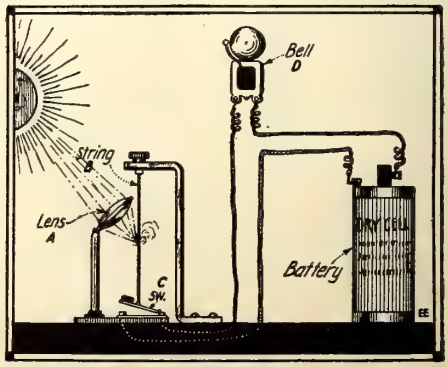
Rheostat Resistances Made From Battery Carbons.

FARMER'S ELECTRIC ALARM CLOCK.

Rising sun shines through sun glass (A), which is focused on thread (B), causing thread to burn. This released metal spring (C), closing circuit and ringing bell (D). Farmer gets up and goes to work. On rainy mornings the alarm will not ring, thus allowing the farmer to sleep as long as he pleases. The inclement weather would prevent his working if he did get up early.

Contributed by ALTON D. SPENCER.

[*Wal, I'll be horn-swoggled and be dinged, if thar ain't a purty fine idea. But, Gosh all hemlock, Alton, me boy, you furgit that thar "Daylight Savin'" statuty. When it's 5 o'clock now it's only 4 o'clock, and the sun hain't ris yet, dadgast their buttons! P. S. 2—Aside from the above, WHO will focus the lens exactly every morning, and, alas and alack—suppose it's cloudy or it's raining???—Editor.*]



The Ideal Sun-Rise Alarm for Farmers.



Improved Fireless Cooker

A cooking utensil designed to take the place of a fireless cooker is described herewith:

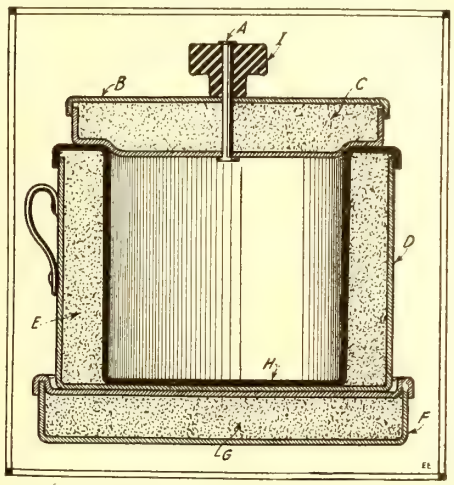
It is composed of a cover "B," body "E" and base "F." The ordinary fireless cooker" is bulky, taking up often valuable space in the kitchen whether in use or not. Second it is an expensive article to buy. Third—being difficult to keep clean, unless extraordinary care is taken it is liable to smell sour.

The device here submitted can be made at a fraction of the cost of the ordinary cooker.

It can be handled, washed and put away like any other cooking utensil.

It might be well to say a word concerning its construction and method of using it.

The cover "B" has a handle I and an air vent A. The walls are of aluminum and the packing, mineral wool. Mineral wool is a cheap non-inflammable non-conductor of heat. The body and base are of the same material and all three pieces should have packing of about one and one-half inches thickness. The wool should not be packed in tightly. No mineral wool is shown at bottom but rather a double aluminum bottom "H."



The Advantages of This Fireless Cooker Are Self-Evident. Very Practical and Cheap.

In using the body with cover in place is placed upon the heater and contents brought to a boil. This is accomplished with a minimum amount of heat as there is no loss of heat through radiation from walls and cover.

Then it is lifted from fire to base and there it will continue to cook for hours if necessary.

The advantage of the fireless cooker, well known to many, are the saving of fuel, and the impossibility of burning the food. Thus one can set food on at night and it will be ready in the morning or the evening meal may be set to cook in the morning before going to business and be ready when one returns from work.

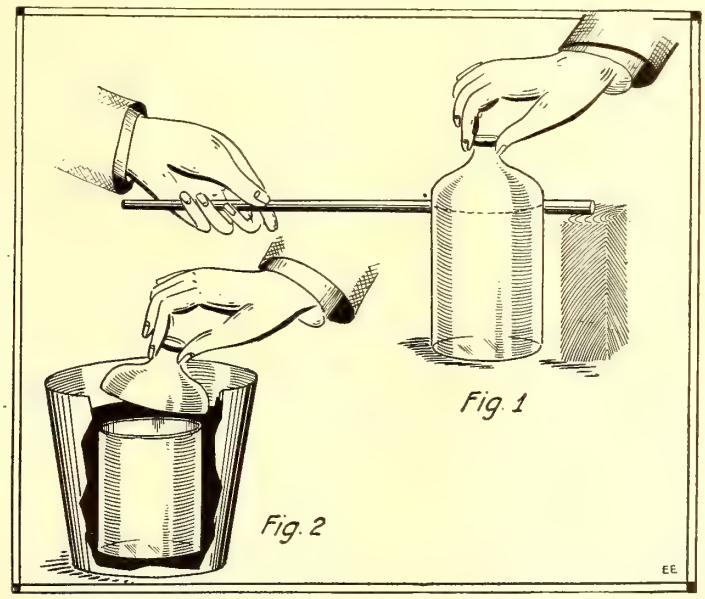
This would prove very handy for many who room in the large cities, working during the day and yet prefer doing some of their own cooking. Comparatively few people are awake to these advantages.

Contributed by JAMES MACINTYRE.

CUTTING GLASS BOTTLES.

It often happens that one desires to cut a glass bottle to make a battery jar or for whatever purpose, but there seems to be a common impression that it is difficult to do, while as a matter of fact it is exceedingly simple, and I have performed it many times and with good results.

All you need is to get a brick or some other non-inflammable substance of whatever height you wish to cut your jar. Next, place a heavy or preferably a short length of ½-inch iron rod, in the fire and heat about six inches of the end to a bright red heat. Then using the brick as a rest or guide, as in Fig. 1, turn the bottle slowly, keeping the red-hot bar well in contact with the bottle until the bar just ceases to be red. Then quickly plunge the bottle in a pail of cold water, and if carefully done a fine crack will be the result. The theory of this idea is that glass is a very poor conductor of heat, and as the bar touches the glass only a fine line all around the bottle, it will therefore only be heated in a fine ring around same and the rest remains comparatively cool. Upon plunging in the water a click will be heard and the neck and upper part of bottle will remain in your hand, Fig. 2, leaving an edge cut as clean as if cut with a glazier's diamond.



A New Bottle-Cutting Wrinkle! Iron Bar Should Be Provided With Handle.

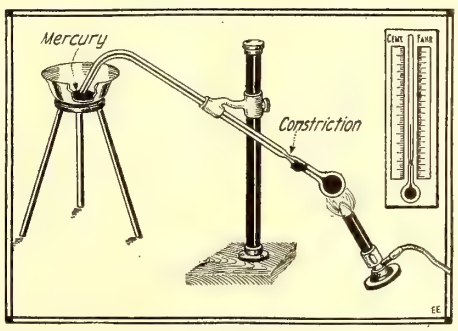
Another trick is to saturate a woolen string with turpentine and then set fire to it. The bottle is then plunged into cold water.

Contributed by
E. C. MEILLORET.

THERMOMETER FOR RECORDING MAXIMUM TEMPERATURE.

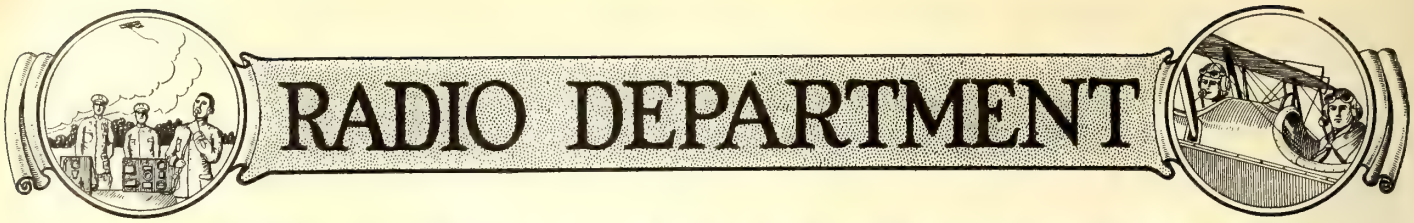
Secure an old thermometer and empty out the mercury. If you have not one on hand, a bulb can be blown on a piece of capillary tubing by heating the end in a Bunsen flame until it closes and then blowing gently into it, after removing it from the flame. Next heat the tube at a point about an inch from the bulb, revolving it slowly, and remove it from the flame when soft, still revolving it, draw it out carefully, so that the small inner bore of the tube is almost closed. (It must be less than half the original bore in order to function properly), and set it on an asbestos mat to cool. Now put about ten grams of mercury in a shallow evaporating dish and arrange the apparatus as shown in the figure.

When the tube has cooled it should be heated once more, near the top, and bent



at an angle of about 90 degrees, then clamp it in the position shown with the open end dipping under the surface of the mercury. Heat the bulb gently and then allow it to cool. Atmospheric pressure will force some of the mercury into the bulb. Repeat this operation several times until the bulb is almost full. Then heat it strongly, but do not allow the mercury to boil, until the mercury expands and fills the tube, expelling all the air and leave it in position until the mercury has cooled to 100° Centigrade, when it should be quickly lifted from the dish and the end closed in the Bunsen flame before the mercury column recedes and allows any air to enter. After cooling it should be wired to a base and a scale attached which is marked by comparison with a standard thermometer. To reset it simply hold vertically and shake.

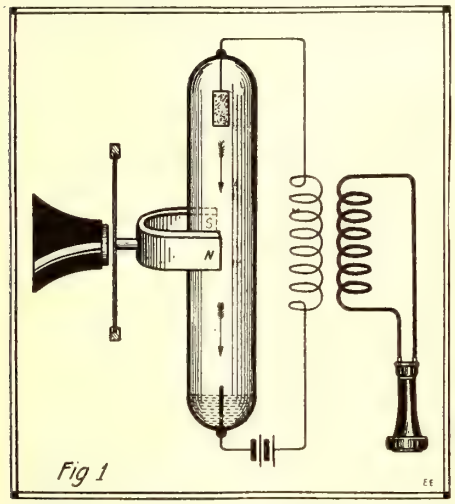
Contributed by A. K. LAING.



Gaseous Telephone Transmitters

By RICHARD A. ENGLER

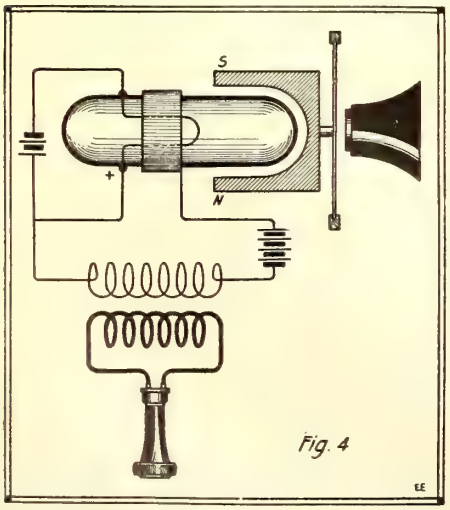
THE carbon or microphone transmitter, like all other good things, must give way to something better. History shall record the good deeds of the carbon transmitter, while the ones herein described have the stage.



Something Brand New in Telephone Transmitters—a Magnet Fastened to the Diafram Acts on an Ionic Stream and Causes Variations in It, as Well as the Current Traversing It.

Some of the reasons why the transmitters disclosed herein will supersede the old form are: A more subtle medium is employed in place of carbon granules, namely, a gas or vapor thru which the current to be varied flows; there can be no packing, frying or harshness, which is caused by carbon granules and too much current; both small and large currents are allowable for use; the articulation it reproduces is as perfect as it can humanly be reproduced.

These transmitters are available for both wire and wireless telephony; and in wire telephony as distortionless repeaters as well as transmitters. They are as simple in form and nature as the microphone. Since large currents can be used in this form of transmitter, it becomes possible to modulate the antenna current directly or thru several transmitters in concatenation, in wireless telephony.



The "Edison Effect" Is Here Employed and the Magnet on the Diafram Causes Variations in the Ionic Stream.

These transmitters employ any medium known in the art as a gas or vapor or ionic, thermionic or electronic discharge, as the medium to be varied by the sound waves.

This medium may be produced by the mercury arc, by carbon arcs, by cathode and X-rays, by radium rays, by the Edison Effect, by flames into which chemicals have been placed and thru which current is past, by vacuum tube discharges of all kinds, including Tesla bulbs, by hot bodies of all kinds thru which a current of electricity is passing, including those heated by light concentrated by a lens, by photo-electric cells and by ultra violet light falling on metals or otherwise, and all these ways of producing ions are spoken of synonymously herein.

Furthermore, a combination of one or more of the above media may be employed simultaneously, as, for instance, cathode and X-rays, one inside the tube, the other outside, or both within the tube. When cathode and X-rays in combination are

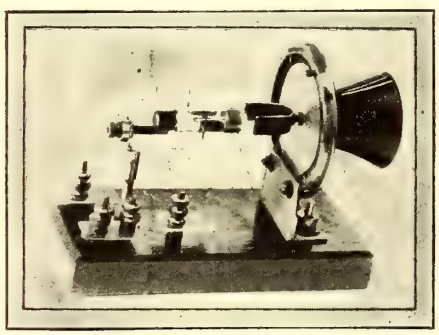


Fig. 6. Model of One Type of Gaseous Telephone Transmitter Built by the Author.

exployed, the current to be varied flows from a terminal or electrode in the X-ray tube, thru the cathode rays, thru the glass vessel, thru the air ionized by the X-rays generated by the cathode rays, to a terminal or electrode placed in the X-ray field. It is well known that the bombardment of the glass wall of the X-ray tube by the cathode rays heats it and makes a conductor of it.

The transmitters operate as a rule by throttling or obstructing means placed in the ion path, but may, of course, also operate by non-throttling means to vary the ions and consequently the current flow.

The throttling, obstructing or varying means caused to operate on any of the above media by means of sound waves can be of a material nature, including the sound waves themselves; or be of an intangible nature such as magnetism and electricity, both static or dynamic electricity; or a combination of one or more of the above means.

When magnetism or electricity is used as the throttling, obstructing or varying means perfect articulation is obtained due to the subtle means employed, namely, magnetism or electricity or both acting upon very mobile gases. The articulation will be equal to that of the Bell magneto-electric telephone transmitter, which is well known to be approximately perfect.

The magnetism for magnetic throttling

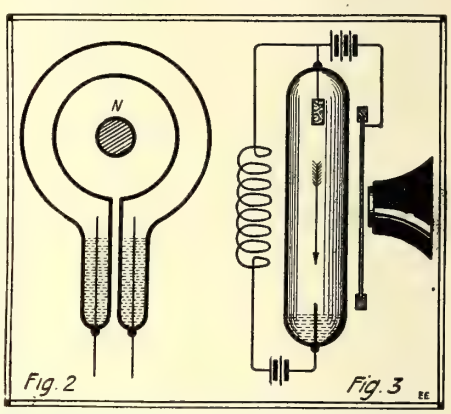


Fig. 3 Shows How Diafram May Alter Current Flow Thru Gas or Vapor Path by Electrostatic Changes.

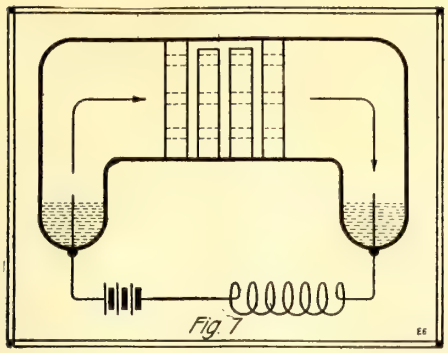
or varying can be had from permanent or electromagnets.

The magnet may act directly upon the gas or vapor path; or upon mechanical obstructions placed in the path; or upon mechanical means, which latter in turn control auxiliary electric currents, whereby the main transmitter current is affected; or a combination of the above means may be used.

The Bell magneto-electric telephone transmitter in combination with a conducting path of gas or vapor is also possible. This transmitter may be called an "Ionophone" or "Phonion," because each signifies "speaking ion," and ions are used in all forms of this transmitter; altho it may be possible to use a liquid or granular material conducting path and have the voice controlled magnet operate upon this path.



Fig. 5. Another Type of Gaseous Telephone Transmitter Devised and Built by the Author.



A Clever Form of "Valve" for Gaseous Transmitter Modulation. The Holes in the Valve Members May Be Moved Into or Out of Register.

PRACTICAL GASEOUS MICROPHONES.

I will attempt to describe in detail only the use of a few of the above media and a few ways of obstructing or varying the media in such transmitters, which will suffice to bring out the great advantages of these forms of transmitters.

Only two small current models were constructed, which, while somewhat crude, indicate the great possibilities of these transmitters. They both employ magnetism as the throttling or varying means, it being more easy to construct such models because, while simple in all forms, when one has not the necessary facilities and apparatus, other forms using internal throttling means are especially difficult to construct and it is no easy matter to find artisans who do such work. The delicate facilities and manipulations needed in the construction of first-class instruments cannot be had outside of a well-equipt laboratory or manufactory.

In Fig. 1 is illustrated a mercury arc tube, which can be provided with starting means and means to keep the arc quiet. Connected in series with the tube is a battery and an induction coil primary; the secondary of said induction coil being connected to a telephone receiver. In short, the circuit is the same as for a carbon transmitter. Adjacent the tube and partly surrounding it is a permanent magnet, N-S, which magnet is mounted upon a diafram. A mouthpiece is provided as shown. When the mouthpiece is spoken into, the diafram and magnet vibrate. The vibrating lines of force of the magnet affect the current in the mercury gas or vapor path, with the result that the vapor current is varied and this varying current reproduces in the telephone receiver what was spoken into the mouthpiece.

The diafram carrying the magnet may be vibrated by an electromagnet thru which voice currents are flowing. This, then, leads us to the telephone repeater or amplifier.*

Fig. 1 has the advantage, in wire telephony especially, over some of the other types, such as those using the Edison Effect for instance, in that only one battery is required for generating both the ions and furnishing the current which is to translate the sound waves into electrical undulations similar in form to the sound waves.

An electro-magnet may replace the permanent magnet. The core only of the electro-magnet need be attached to the diafram, the coil can be fixt in a stationary manner with the core working freely within the same. In this case we get a very strong magnet with very little material needed on the diafram; hence, the latter can respond freely and quickly to the sound waves impinging upon the same. The electro-magnet may be fed from a shunt circuit of the transmitter battery, but then reaction is quite possible and this must be guarded against by the use of an inductance coil.

When an electro-magnet is used, the Bell magneto-electric transmitter effect may come into play here, currents being induced in the stationary coil by the vibrating coil which may be added to the main effect produced by the magnet on the vapor path.

Auxiliary electrodes may be placed in the gas or vapor path and the magnet then cause the vapor to be deflected more or less from one auxiliary electrode to the other; or cause to immerse the auxiliary electrodes more or less; or cause them to approach and recede from one another more or less, in each case to get the desired variation of current in the main or auxiliary electrode circuits or both.

It is quite possible that closed iron rings placed around the vapor tube above and below the vibrating magnet may have an effect in making the vapor more susceptible to the magnet on account of the effect the rings may have on the magnetic properties of the vapor path.

Fig. 2 shows a form of mercury arc tube which makes starting of the arc easy. The anode and cathode of the tube are bent around to lie adjacent to each other; and furthermore have a large surface which makes them akin to a condenser. The

*However, since the transmitters are capable of handling large currents, corresponding large and powerful variations are possible, which can be sent over long loaded lines without repeating.

Such a device as Fig. 1 will be reversible. Since the vibrating magnet varies the current in the vapor path of a transmitter, this varying current flowing in a similar device used as a receiver will affect the magnet and cause it to vibrate together with the diafram and thus reproduce what was spoken into the transmitter.

In March "Radio Amateur News"

The Armstrong Super-Autodyne Amplifier—Part II.
By H. W. Houck

The Lyons Radio Station
By Henry de Gallaix

Short Wave Regenerative Set
By J. Stanley Brown

Two Hundred Meters and What It Means.
By Pierre Boucheron

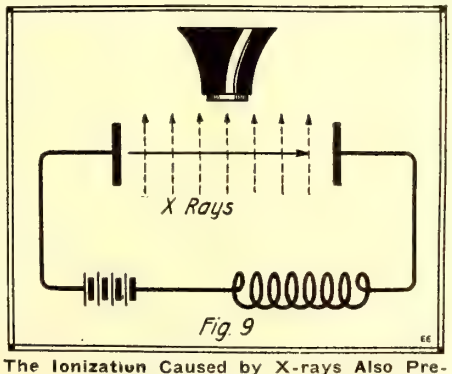
Variometers
By E. M. Sargent

Efficient Radio Club Management
By W. A. Heppner

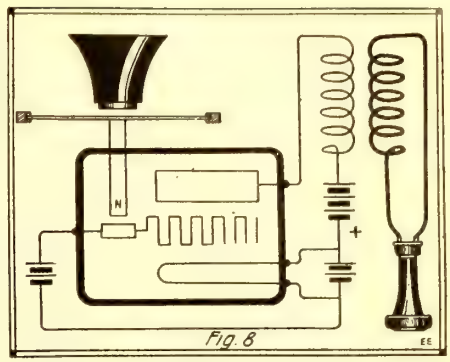
Radiophone Experiments
By Forest R. Kingman

Radiophone Section

Junior Radio Section



The Ionization Caused by X-rays Also Presents a Possible Field for Experimentation in Gaseous Telephone Transmitters.



In This Case the Diafram Magnet Member Is Caused to Act So as to Vary the Position of the Grid in a 3-Electrode Vacuum Valve.

vibrating, single pole magnet operates thru the center of the bent tube. If the anode and cathode are spoken to, they vibrate and thereby alter the electrostatic condition between them, thereby altering the current flowing in the vapor path.

In Fig. 1, a metal plate may be placed near the gas or vapor path, as shown in Fig. 3, a battery being in series with the plate. The vibration of the plate alters the electrostatic condition between the plate and vapor, and therefore altering the current flowing in the vapor path.

Fig. 4 shows how the "Edison Effect" is employed in such a transmitter. Here a small incandescent lamp (a four-volt one was used in the model, with a carbon filament) is shown connected to an "A" battery. Surrounding the lamp externally is the plate; this plate is in series with a "B" battery and primary of an induction coil, the secondary of said induction coil being connected with a telephone receiver. When the filament is heated, the glass also becomes heated from the filament heat and ion projection and becomes a conductor and consequently closes the circuit of the "B" battery thru the glass and ion stream within the lamp. The action of the filament heat and heat from ion projection on the glass of the lamp in this case is analogous to the heat from cathode ray or ionic bombardment of the glass tube in a Crookes or an X-ray tube; and in both cases the glass becomes conductive. In Fig. 4, when the magnet is made to vibrate, the ions in the lamp are wiped off more or less from the plate, thus causing a throttling or varying of the current from battery "B" and a resulting reproduction in the telephone receiver of the sounds uttered into the mouthpiece. The magnet will induce eddy currents in the plate, but it is evident that in this case they neutralize each other because they tend to flow in opposite directions around the plate. Anyway, the circular plate is slit in the model, so that eddy currents could not circulate in the plate, even if they did not flow in opposite directions in each half of the plate. In some cases the eddy currents can be allowed to circulate and then be utilized to affect the ion path.

The two figures, 1 and 4, are diagrammatically representative of the two models shown by the photographs and which latter are designated as Figs. 5 and 6 respectively. If very promising results can be had from such crude models, it is evident that well-constructed transmitters will perform in a manner equal to the best expectations.

When comparatively heavy currents flow in the vapor path of Fig. 1, and with a strong electro-magnet operated by the diafram, comparatively large and powerful variations will result.*

*The magnet can be located at one end of a lever and the diafram work at the other end, with the fulcrum near the diafram end, then greater amplitude of vibration of the magnet takes place.

(*Continued on page* 1200)

Radio Frequency Currents on Wires

By J. O. MAUBORGNE
Lieut. Col., Signal Corps, U. S. A.

ATTENTION was first directed, in 1911, to the practical utility of employing high frequency electric waves for transmission of energy along wires by Major (now Major General) George O. Squier. The discussion following the publication of his results indicated that, in the minds of many, the opinion prevailed that because of the excessive attenuation obtaining at the "ultra audio" frequencies, the system would be inoperative over great distances. This was thought to be particularly the case if frequencies greater than 100,000 cycles per second were employed.



The Above Photograph Shows the de Forest Audion and Oscillion Apparatus Employed In the first "Wired-Wireless" Tests in Canada, May 15-19, 1919. This Test Was Made Between Toronto and Hamilton, Over 40-45 Miles, Including in the Circuit Three Miles of Cable of the Hydro-Electric Power Commission Telephone Circuit. Wave Length, From 17,000 to 600 Meters (Iron Cable Also). Clear, Loud Speech Was Received Without Amplifier—Four Words Were Used Simultaneously Without Interference—Talking and Listening, No "Throw-Over" Having Been Required. The Current Used Was 100-150 Milli-amperes at the Transmitter End.

Recently this subject has assumed an important aspect from a military standpoint and it was decided to conduct further experiments with the object of examining the possibility of adapting certain existing types of radio-telephone and telegraph apparatus to multiplex operation. The results of the few preliminary tests which have been made recently by First Lieutenant R. D. Duncan, Jr., and Radio Engineer Samuel Isler of the Engineering and Research Division, Signal Corps, Washington, D. C., are of interest because they have shown that not only is it possible to transmit energy, at least in sufficient amounts to actuate standard "radio" receiving apparatus, over comparatively long lengths of wire circuits, but that frequencies considerably in excess of the value hitherto named as the upper limit could be employed.

The apparatus used in these tests is known as the SCR-67, which is the ground set of the standard ground-airplane radio-telephone equipment. It comprises two three-electrode vacuum tubes of the transmitting type (Type VT-2. One oscillator and one modulator) and connected circuit, a receiving tube (Type VT-1) and circuit, and a two-stage audio frequency amplifier. The method of modulation, that devised by Heising, is based on the fact that, to a very close approximation, the amplitude of the high frequency current is directly proportional to that of the E. M. F. applied between the plate and the common filament terminal of the oscillating tube; any variation of the E. M. F., for example, at an audio frequency, will modulate or mould the continuous flow or high frequency energy in a corresponding manner, which, when received by a tuned receiving circuit, and rectified, manifests itself as an audible sound in a telephone receiver. The means by which the modulation is accomplished is by a second tube, whose plate-filament path resistance is varied in accordance with the speech frequencies applied to its input terminals. By properly inter-connecting the plate or output circuits of the oscillating and modulating tubes, and by further converting the high voltage plate power supply to the two tubes from a constant potential to a constant current system, the variation in amplitude of the high frequency current may be made to follow out faithfully the variations imprest by the modulating source. This system is advantageous since the completeness and purity of modulation is practically independent of the frequency of the oscillating system.

The line may be connected to the source of oscillations in a number of ways, of which probably the most convenient is by inductive coupling.

To provide a practical means for carrying out of the tests, a wire, running from Washington, D. C., to New York City, was placed at the disposal of the Signal Corps by the Postal Telegraph Company. This line was duplexed and was in continuous operation by the Postal Company. In the first series of tests one multiplex station was established at the Signal Corps Radio Laboratory, Bureau of Standards, Washington, D. C., and a second at Dixon's Park, Curtis' Bay, Md., approximately three miles from the Postal office in Baltimore, the total wire distance between the two approximating 60 miles. The multiplex apparatus was connected to the line at these two points.

Satisfactory two-way communication was obtained; speech was received at both stations, loud and with exceptional clearness, the distortion common and inherent to long distance wire telephony being completely absent. The tuning at the receiving stations was quite definite, comparable in every respect to that when receiving signals of a "sharply" tuned radio station. This last fact permits of the operation of a number of multiplex units, each tuned to a different frequency and without the use of filter circuits on the same wire line. The carrier frequency employed in these tests was 600,000 cycles per second (wave length 500 meters); the effective line current, measured at each of the transmitting stations, averaged 60 mil-amperes. Throughout the tests the operation of the multiplex apparatus in no way interfered with that of the wire telegraph apparatus nor was interference experienced from the latter.

The satisfactory range of an SCR-67, when operating as a ground "radio-telephone" set, in communication with a corresponding SCR-67, is, under ordinary conditions, 10 miles. Thus, by confining and directing the flow of energy to a definite direction, the range is materially increased.

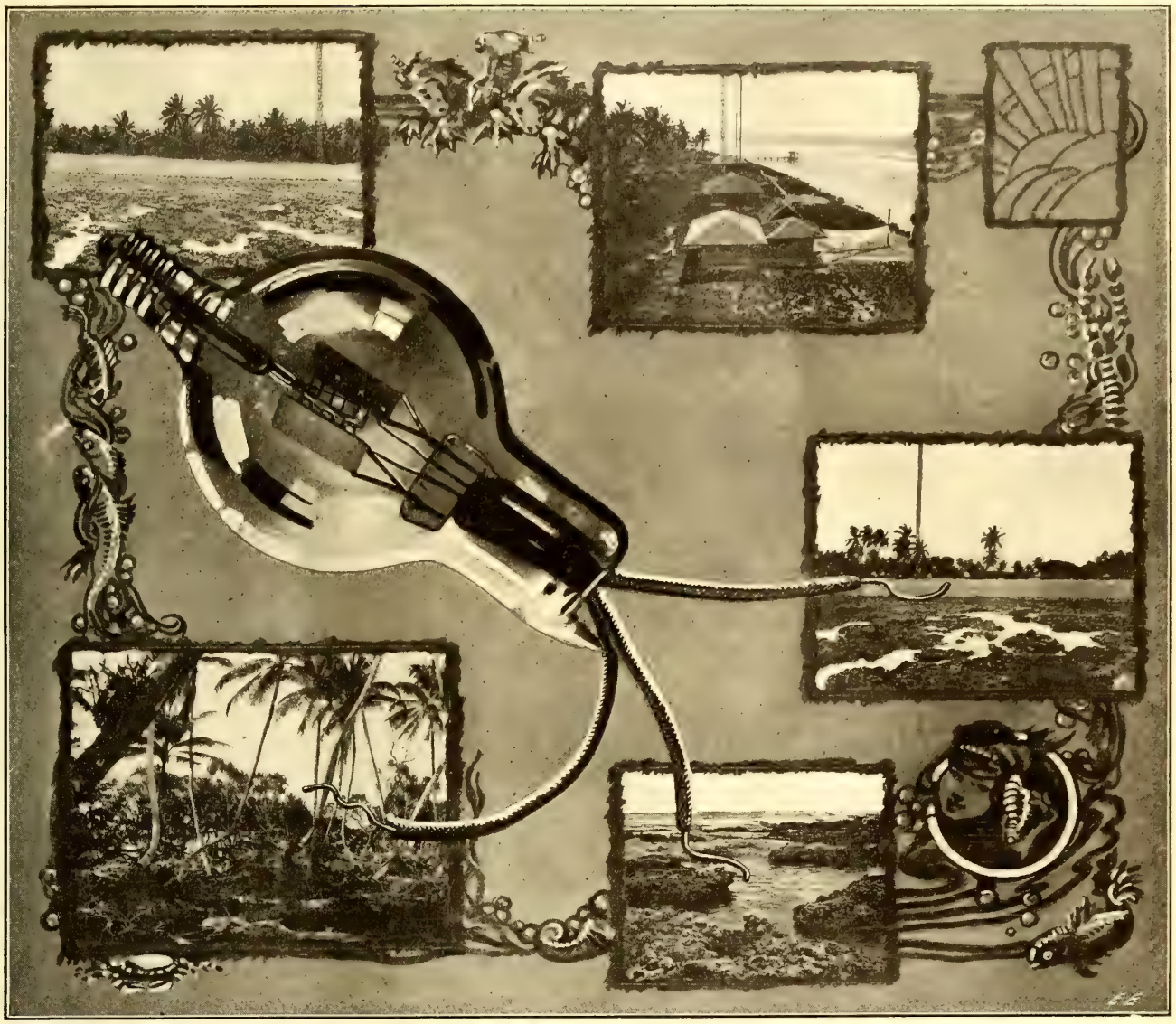
The advantages of multiplex telephony and telegraphy are many. From a military standpoint alone, it is obvious that in time of war any means of increasing the traffic handling capacity of already overburdened telephone and telegraph lines will be of inestimable value. There is a further advantage from an economical standpoint, in that certain of the existing types of Signal Corps radio-telephone and telegraph apparatus, large quantities of which were purchased during the war and which are now idle, with only slight changes in construction, may be adapted to either radio or multiplex operation. The increased range obtained makes possible the connection of outlying military posts and establishments with low power units, where ordinarily comparatively high power and consequently heavier apparatus would be required if strictly *Radio Communication* were solely relied upon.

About a year ago the American Telephone and Telegraph Company demonstrated over a circuit between New York and Pittsburgh, as well as on several other circuits, that it was successfully and accurately transmitting and receiving several telephone messages over a *single wire* at the same time, by utilizing audion generators of high-frequency currents, each frequency having a different value so as not to interfere with the others.

Major-General George O. Squier was the first to suggest the application of such currents to the multiplex telegraph and telephone system and took out patents on this system about ten years ago. The test conducted by the A. T. & T. Co. demonstrated conclusively that his "stunt" worked!

At the present time the first cost of the necessary apparatus for producing the essential high-frequency currents prohibits it from being adopted, except over certain circuits, and particularly under military conditions, where this scheme is of undeniable and invaluable advantage.

An abstract of this paper was presented at the Washington Meeting of the American Physical Society, April 25, 1919.



$25.00 For A Poem

January 6, 1920.

Mr. H. Gernsback, Editor,
Electrical Experimenter,
New York City.

My dear Mr. Gernsback:—

I have just received the enclosed very interesting communication with photographs from Washington Island.

The voyage of this little audion appeals to me as a thing fraught with romance and adventure, and a topic well worthy of a poem by some radio enthusiast.

If I could spend a couple of months away from all cares on an island of paradise in the South Seas, I could doubtless compose my soul sufficient to write a poem worthy of the theme, but our New York subway is not conducive to poetic rhapsodies. There has been altogether too little poetry on radio from its beginning. It is a subject which might well attract the pen of Kipling or Robert Service.

What do you think of the suggestion that this letter from Mr. Travers and some of his photographs be printed, together with a photograph of the wandering little bulb, and a prize offered for the best poem on the subject; award to be made by a competent board of literary men? If no poem was deemed worthy, the prize would not be awarded.

I believe there are enough broad-minded persons interested in radio matters, so that we can afford to widen the sphere of their activities and get a little bit away from the hard beaten track of everyday technics and hookups.

I shall be interested in getting your opinion on the subject.

Very truly yours,
(Signed) LEE DE FOREST.

HARDLY a month goes by that we do not read of some new wonder, some new accomplishment of that modern Aladdin's Lamp—The Audion. Its versatility was clearly chronicled in our February issue, but greater wonders are to come, much greater ones. We have but begun.

In the meanwhile the versatile audion once more accomplishes a wonder, not a scientific one, this time, to be sure, but nevertheless SOME accomplishment. The two letters printed here tell the story better than we can. It befits the occasion that Dr. De Forest, the inventor of the Audion, should suggest the idea.

Just think of a frail little vacuum glass tube traveling in the open sea—in the stormy Pacific—for thousands of miles, for months perhaps. Bobbing upon calm waves under a torrid sun, or in a typhoon, when waves run sky high. Sighting many steamers, many islands, but not "rescued" till a gentle wave lifts the little wanderer over a perilous coral reef undamaged. Thence another kind wave assisted by a zephyr, gently deposits our little be-glassed vacuum onto the velvet beach on a lonesome island in the dead of the Pacific. *And it arrives undamaged.* Forsooth what will the Audion do next!

(*Continued on page* 1186)

Washington Island,
Via Honolulu and Fanning Island,
December 1, 1919.

Dr. Lee De Forest,
New York City.

My Dear Sir:

I am sending you by parcel post an interesting valve I believe to be one of your pre-war types.

This valve traveled for many miles thru the Pacific Ocean, bobbed over a coral reef, and came to rest upon the sands of this island. Washington Island is a wee spot in the wide Pacific, having less than a dozen miles of coast. It is situated 1,000 miles southwest of Honolulu. The nearest steamship lanes are the Australian, and they are 500 miles to the westward. To the eastward there are no regular routes, with the exception of the Tahiti from San Francisco until the coast is reached. The coast is from 3,000 miles, vicinity of San Francisco, to 5,000 miles, directly east, vicinity of Panama. From which of these locations the valve has come is difficult to guess. Not far from here is the Equatorial Current, but the Counter Equatorial is between, somewhat upsetting calculations.

From wreckage picked up on the island from time to time, it appears drifting objects come from the eastward. A lifeboat came ashore here which had been washed overboard off the lower end of Lower California; a direct line of 3,300 miles.

I am enclosing a few photographs. The one of the reef will give you some idea of the hazardous end of the voyage.

I am sending this valve to you because I believe it will be of interest in your collection.

Yours fraternally,
(Signed) R. A. TRAVERS.
In charge Washington Island Radio.

Vacuum Tube Amplification

By PIERRE H. BOUCHERON

Some Timely Remarks Concerning Various Cascade Methods of Rectifying and Amplifying Either Radio or Audio Frequency Oscillations

THE amplification of received signals in radio communication was practically unknown before the advent of the Vacuum Tube, except possibly by mechanical or microfonic arrangements capable only of amplifying the sound waves produced by the diafram of the telephone receiver. This was due to the fact that crystal and similar forms of detectors are capable of rectifying properties only, and if the received signals happen to be exceedingly feeble as those transmitted from long distances, the rectified energy will not have sufficient volume to affect the diaframs of the usual telephone receivers.

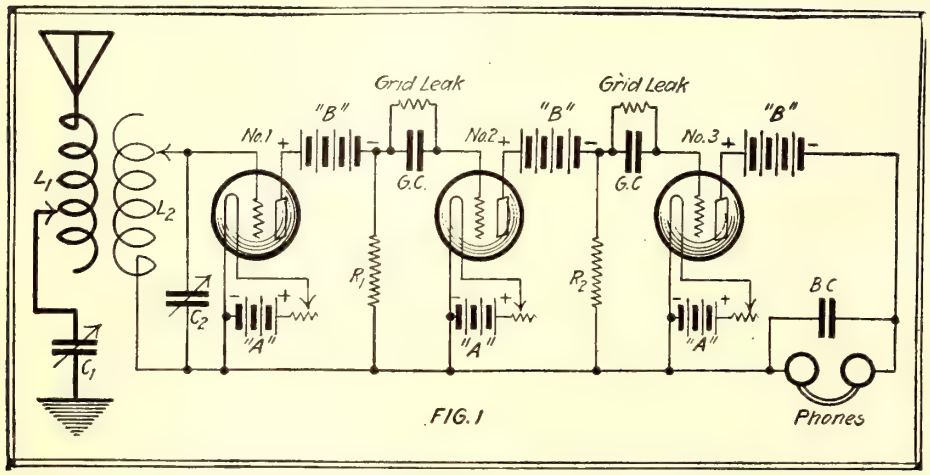


Fig. 1—This Is a Possible Method of Connection Employing High Resistance Grafite Rods and Suitable for High or Radio Frequencies.

The VT, on the other hand, has proved itself most successful and valuable when applied to either or both rectification and amplification. In general, the work of the VT as an amplifier consists of repeating the grid circuit variations caused by the received antenna oscillations in the plate or output circuit, on a much greater scale than would otherwise obtain, and while it is quite true that a VT amplifier returns more energy at its output than it receives at its input terminals, yet it does not actually give something for nothing. As a matter of fact, the additional power secured from a VT amplifier or oscillator *is really at the cost of the plate circuit "B" battery.*

Amplification may be accomplisht at either radio or audio frequencies, depending on the conditions at hand, and the use to which the amplifier is to be employed. In this connection, some experimenters often wonder which is the better method and why. There are divers opinions as to the advantages of both methods, but speaking from a practical point of view, radio frequency amplification has been found more satisfactory when employed in long cascades of 4, 6 or even more stages; while audio frequency amplification is preferable when used to amplify a *rectified* current from one to two stages such as the Army and Navy two-stage amplifiers. These two methods may be modified and combined as in the case of special Navy and Signal Corps 6 and 7 stage amplifiers, by first amplifying the initial *radio frequency* oscillations up to 3 steps, then rectifying the resultant current by means of a detector VT, and finally further amplifying the rectified *audio frequency* energy up to 2 or 3 more steps; the complete operation necessitating the employment of six or seven tubes.

Before making further remarks, let us well understand the difference between so-called radio and audio frequencies as applied to amplification. Radio frequencies are those received in a tuned oscillating antenna circuit, *prior to being rectified* by a detector. These are quite high, in frequency per second, and therefore are *not audible* to the human ear which is only capable of responding to frequencies up to possibly 12,000 cycles per second. Audio frequencies, on the other hand, are those which result in a receiving system after having been rectified by a detector, and since these are usually well below 12,000 cycles, they are quite audible to the ear thru the agency of the telephone receivers. In speaking of radio frequency amplification, therefore, we mean the *magnifying* of the original antenna oscillations thru one or more stages *before actual rectification takes place;* while audio frequency amplification refers to the magnifying of the signals after they have past thru a detector and have therefore been *reduced* to a comparatively low or audible frequency.

Another important point to remember is that amplification as explained here is applicable to *either damped or undamped* wave reception; except that in the case of undamped or continuous signals, the preliminary VT circuit involves two functions, namely: the generation of a local source of high frequency oscillations and the detection of the "beats"; that is, the *resultant difference* between the locally produced oscillations and the incoming oscillations or signals. The Armstrong Regenerative Circuit is capable of doing this.

CASCADE AMPLIFICATION.

We are concerned in this article with the so-called "cascade" or multi-stage method of amplification as distinguisht from Regenerative or other means of amplification. Since VT amplification consists of greatly increasing the grid circuit variations imprest on the plate circuit to an external or output circuit, this condition when once obtained may be repeated several times in cascade fashion so that the final variations of the last tube will be many times that of the original or first tube. This final amplification, therefore, is said to have a ratio equal to the product of the amplification ratio of each individual amplifying step or stage of the cascade, and it may be several thousand times greater than the initial plate circuit variations of the first step.

GRAFITE RESISTANCE COUPLING.

In Fig. 1 we have a possible circuit diagram of a cascade amplifier employing high resistance grafite rods as a means of coupling between each step of amplification, and altho this method has several minor disadvantages, it has been found quite satisfactory for amplifying very high or radio frequency oscillations. L1, C1 and L2, C2 represent the regular oscillating tuned circuit system, where the received energy is first amplified by tube No. 1 actuated by the "A" filament and the "B" plate batteries. R1 and R2 are non-inductive grafite rod resistances of 25,000 to 100,000 ohms. Owing to the amplifying action of the VT, the original antenna oscillations are accurately reproduced across R1 and R2, but greatly increased in *amplitude* each step. The amplified energy is thus past thru the amplifying process of tubes No. 2 and No. 3, or more if desired, altho, of course, a practical limit must be reached, for the results secured with more than

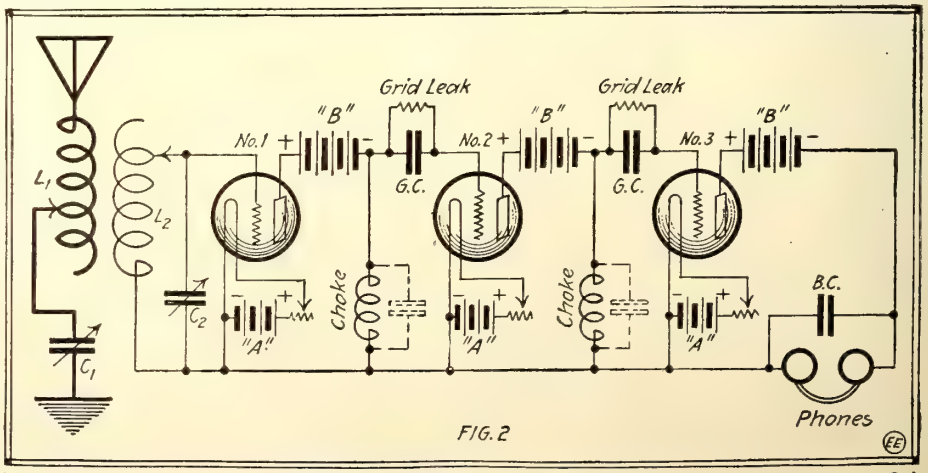


Fig. 2—Another Circuit Suitable for Radio Frequency Amplification, But Using Choke Coil Coupling Instead of Grafite Rods.

six stages of VT amplification do not warrant the use of additional and complicated appliances, unless special precautions are taken, as will be mentioned later.

The plate circuit of the last tube in cascade, therefore, is connected with the telephone receivers in series and the greatly amplified signals of radio frequency rectified and properly intercepted. In this circuit, grid condensers GC of approximately .0005 mfd. each are useful in preventing the "B" battery potentials of adjacent tubes from interfering with the proper action of the grids; while the "grid leak" resistances, which may consist of the lead-pencil-line type of about 2 or 3 megohms, (2 or 3 million ohms), are for the purpose of providing a leakage path for the negative grid charges. L1 and L2 may be a loose-coupler or two honeycomb inductances of suitable wavelength valves, depending, of course, on the length in meters of the wave to be intercepted; C1 and C2 are variable condensers of the .001 mfd. maximum capacity type. The "A" and "B" voltages depend, respectively, upon the individual requirements of the tubes employed; i.e., "A" is usually a 4 or 6 volt 40 to 60 ampere-hour storage battery (dry cells may, of course, be used temporarily); while "B" is usually a series of small dry cells of the pocket-flashlight variety, varying from 20 to 80 volts. Most VT's on the market today are furnished with operating instructions. The telephone receivers should preferably be from 2,000 to 3,000 ohms in series, and, as is usual with other receiving systems, their effectiveness may be increased by shunting them with the small bridging condenser BC, either of the variable or the fixt type and having from .001 to .0025 mfd. capacity.

In general, ideal radio frequency amplification is secured with this system when the external plate circuit has a large impedance, yet not so large as to necessitate too high a "B" plate battery potential, which latter is expensive and cumbersome.

CHOKE COIL COUPLING.

Fig. 2 shows an amplifying circuit also suitable for *radio* frequencies rather than audio frequencies, but this one employs a high inductance or choke coil coupling between each stage of amplification instead of a non-inductive resistance as with the grafite rods. These choke coil couplers, however, must each have an inductance sufficiently great so that the natural period or frequency of the *total plate circuit* is the same as that of the incoming oscillation; i. e., that of L1, C1 and L2, C2. This method of amplification is considered better than the grafite resistance coupling because, on account of the comparatively *low ohmic resistance* of the choke coils, it is possible to use much lower plate or "B" battery voltages. Also by introducing a variable condenser of the .001 mfd., maximum capacity type, shunted across each inductance as shown by the dotted lines, a high and variable plate circuit reactance is secured, a fact which makes the resulting conditions ideal for efficient radio frequency amplification. Not only that, but by careful adjusting of this LC circuit, unusual *selectivity* may be obtained—a desirable factor in preventing interference when the operator attempts to "weed out" unwanted signals of similar wavelengths.

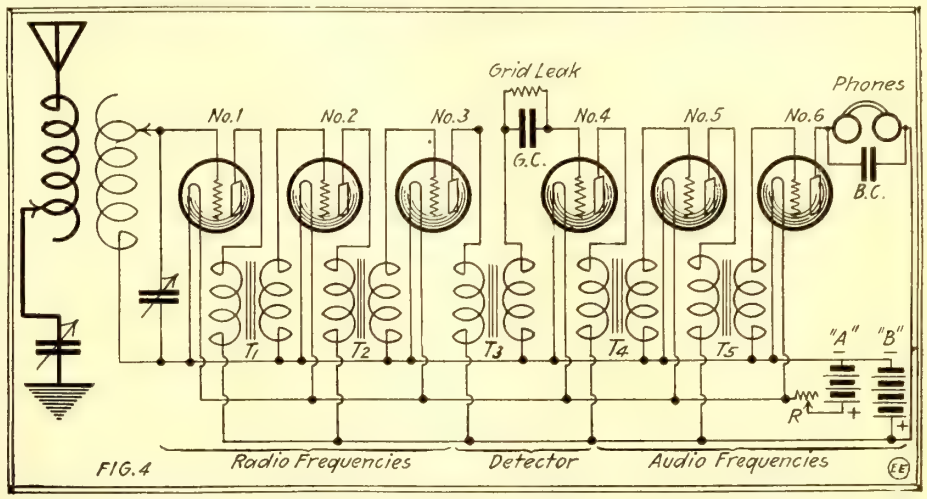


Fig. 4—This Circuit Is a Combination Radio and Audio Frequency Amplifier. The First Three Tubes Amplify at Radio Frequencies and the Other Three Tubes Detect and Amplify at Audio Frequencies.

An objection to this circuit—if it may so be called—is that it is not always convenient for the average experimenter to obtain these additional choke coils and condensers; and also that their use necessitates very careful adjustments and balancing of the two plate circuits of No. 1 and No. 2 tubes in respect to the grid circuits of their respective oscillatory systems. For the latter reason, therefore, and if selectivity is not an essential factor, preference should be given to the use of fixt choke coils of large inductance and without the aid of the variable condensers mentioned.

Other parts of this amplifier system are essentially the same as those employed in Fig. 1, except that in this case, and for the reason previously mentioned, it is not necessary to employ as high a plate voltage, from 20 to 40 volts being usually sufficient in most cases. Since most VT's on the market today are *highly evacuated,* thereby possessing no internal gases thru the medium of which excess negative charges may leak off, it is again necessary to employ the so-called "grid leak" of 2 or 3 megohms resistance across the grid condensers of tubes No. 2 and No. 3, respectively.

TRANSFORMER COUPLING.

In Fig. 3 is shown an amplifier circuit employing either *air core* or *iron core* transformers as a means of coupling between each step of amplification. This method of coupling may be used for either *radio or audio* frequencies, providing, of course, that specially designed transformers are chosen for one or the other purpose. In this particular circuit, VT No. 1 functions as a *detector* or *rectifier of the high frequency oscillations* by the use of the grid condenser GC and the grid leak GL, and the resulting *audio* or comparatively low frequency pulsations of the plate current are transferred to VT No. 2 thru the agency of audio amplifying transformer T1. VT No. 2 further amplifies the audio frequency energy and passes it on to VT No. 3 thru transformer T2 for still further amplification, where finally the total amplified energy is intercepted in the telephone receivers. One or even two more stages of amplification may be used in this or similar circuits, but special precautions must be taken in order to prevent undesirable operating conditions such as "howling" and other parasite noises caused by the local production of separate oscillations, or by the temporary stoppage of plate current flow of individual tubes. Briefly, some of these precautions may be carried out by grounding the positive side of the "B" battery; by shunting the primaries and secondaries of all amplifying transformers with suitable condensers; and by placing non-inductive resistances of high resistance in various parts of the circuit, to be determined by experiment.

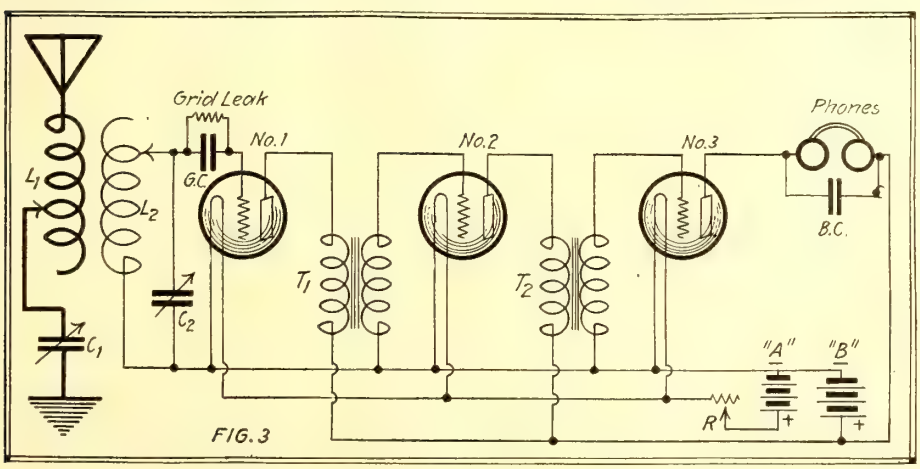


Fig. 3—In This Case We Have a Circuit Employing Amplifying Transformers Specially Designed Either for Audio or Radio Frequencies.

RADIO-AUDIO AMPLIFIER.

As a general rule, and as has been inferred before, it is quite difficult to build an efficient amplifier having more than three steps of amplification at either radio or audio frequencies without encountering undesirable noises or oscillating. It is, however, quite possible to build an amplifier which will first amplify the received signal at its *radio* frequency up to let us say three steps, then rectify the signal by means of a *detector circuit,* after which the resultant *audio* frequency is amplified up to three more steps. This method is probably the most efficient and modern one and is said to be the latest word in practical amplification. The U. S. Signal Corps have an amplifier of this type which employs seven tubes, while the Navy, not to be outdone, has just launched a similar six-step amplifier to be used in connection with the reception of very weak *Radio Compass* signals.

Fig. 4 shows a circuit diagram of an amplifier similar to the latter type. It is claimed for this amplifier that it will give

(Continued on page 1204)

Construction Of Honeycomb Inductances

By HILBERT R. MOORE

THE purpose of this article is to set forth the construction of the new honeycomb inductance in such a way that any amateur may make his own with little trouble or expense.

The first consideration is the construction of a machine which will wind the coils in a cellular fashion, spacing the turns properly. The materials needed are some pieces of ½" and ¾" pine, some dowel stick, a few old spools, a drawer knob, a little sheet tin, and about two dozen wood screws. A base 12" by 5" of ¾" pine is smoothed off and the two uprights CC are screwed to it. (See drawings for dimensions.) Fix uprights D to uprights C, placing shaft E, spool F and crank disk G in place. Spool F should be small in diameter or the coils will be wound too closely. Place a washer between crank disk G and support D. Brads are used to hold the spool and disk on the shaft, which is made of dowel pin.

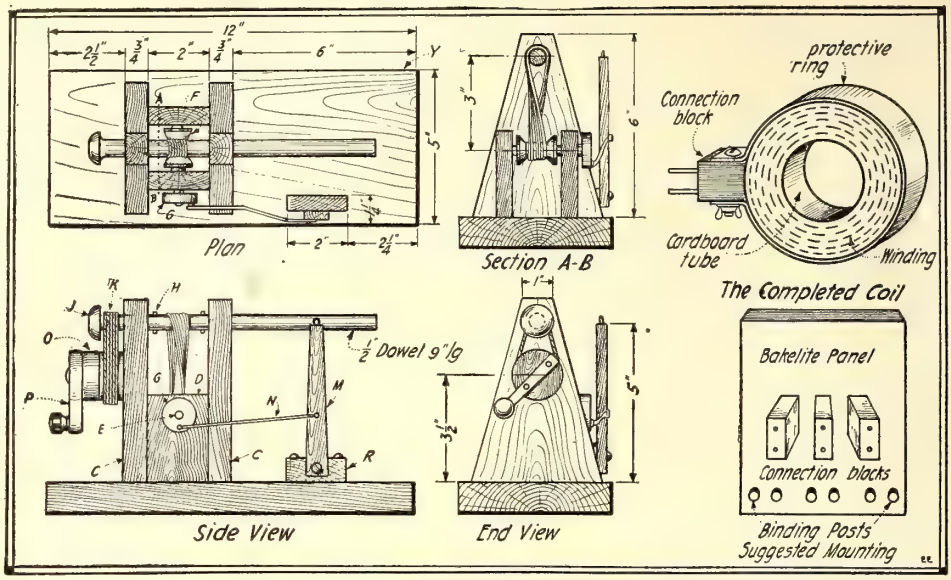
Next place spindle J of ½" dowel in holes bored for it in C C. Two pins H hold it in position. A piece of spool at J is fastened to the end of the shaft to keep the belt from slipping off. The belts may be made by passing stout cord between the pulleys seven or eight times and tying. Sandpaper glued on the spindle and spools will keep the belt from slipping. The lever M is next fastened by a screw to block R in such a way that it may turn easily. A screw eye in the top serves as a guide for the wire. The connecting rod N is made of wire. The purpose of this lever is to guide the wire backward and forward according to the speed of the spindle, and thus produce the criss-crost or cellular windings. A crank P with a drawer knob for a handle is screwed on to pulley O and the machine is complete. This winder can be used for winding string, yarn or other such materials in addition to its designed use.

The second consideration is the construction of the honeycomb coils by means of the machine described above. They may be wound on 1" sections of cardboard tubing with an outside diameter of 2". A wooden cylinder should be made which will fit on the spindle of the winder and firmly hold the sections of tubing on which the coils are wound. Cardboard or fibre disks fastened on either side of the cylinder will keep the wire from slipping off the form during the winding process. Thread the wire thru the eye at the top of the guide lever, fasten it to the spindle, and turn the crank. The winding is automatic. Number 24 S.S.C. or S.C.C. wire is best and the amount depends on the size of the coil which it is wished to wind. A winding of six layers will suffice for a short wavelength coil, while one of sixty provides a very long wavelength. Any inductance may be wound by using more or less wire When the coil is wound, remove it from the winder and pass a thin metal band around it as shown in the figure. Secure the ends to one of the sections of a connection block such as those used with receivers.

The other section of the block may be mounted on a panel or table. Usually two or three are mounted together. By plugging in coils of various inductances, different wavelengths may be received. These coils are most effective in connection with a .001 m.f., variable condenser.

Honeycomb coils have made a big hit owing to their great saving in space.

It must be remembered that these coils are patented by the DeForest Radio Telephone and Telegraph Co., and must not be made for sale.

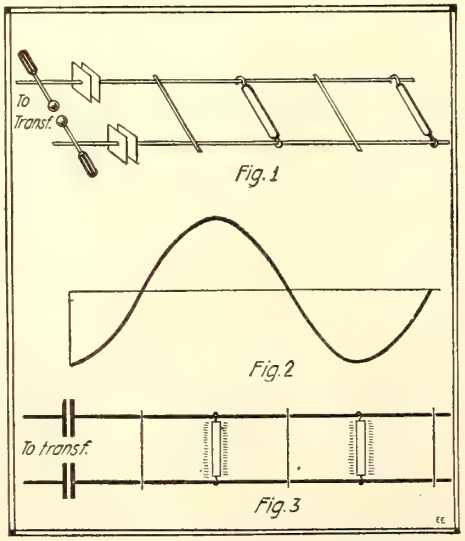


The Above Home-Made Machine Will Enable the Radio Experimenter to Construct Honeycomb Inductances Without Any Extra Expense, Except for the Wire Employed in Building Up the Coil. It Is Well to Wind a Number of Them Having Different Inductance Values.

An Experiment With Wave Motion

A striking experiment to show the pulsating character of alternating current waves can be performed in the laboratory with the aid of a small transformer or induction coil and several Geissler tubes, utilizing "standing" waves along a wire. Two lengths of bare copper wire about fifteen feet long are stretched horizontally across the room on insulating supports, separated about twelve inches. At one end a metal plate about six inches square is attached to each wire, while the other ends are left free. Two similar metal plates are supported a short distance from the first two, thus forming a series air condenser of small capacity in each wire. The last two plates are connected to a spark gap and transformer, the complete arrangement being shown in Figure 1.

When the transformer is operated, a stationary alternating current will be produced in each wire, that is, the maximum nodes of the sine wave will always remain at one point, as in Figure 2. The current values in the two wires at any given point will be of equal intensities but opposite in sign, and the maximum difference of potential will exist at the maximum nodes of the sine wave. If the Geissler tubes are connected across the wires at these points, they will light up brilliantly, while the zero nodes can be completely short-circuited by pieces of copper wire without affecting the passage of the current in the least.



Extremely Interesting Experiments With Stationary Waves on Electric Conductors. The Two Wires Along Which the Waves Are Set Up Are Connected Thru Two Air Condensers Formed of Metal Plates and Thence to a Transformer. Stationary Waves Are Set Up Along the Conductors, and If Geissler Tubes Are Connected Across the Wires at Points of Maximum Potential, They Will Light Up Brilliantly.

The maximum and zero points are found by moving the tubes and wires along the system until best results are obtained, adjusting the distance between the condenser plates at the same time. It is evident that a zero point must occur exactly half way between two maximum points, and the distance between two maximum or two zero points is equal to one-half wave-length. Such an apparatus is called a Lecher wave system, and is useful for demonstrating short electric waves, but it is not likely that the amateur will use this device for measuring the wavelength of his wireless transmitter.

Contributed by

L. A. BARTHOLOMEW.

POTENTIOMETER ARTICLE CORRECTION.

In the article entitled "The Potentiometer, How to Use It", by E. T. Jones, page 429 of the September, 1919, issue, an error occurred in the second diagram showing the potentiometer connected to two distinct batteries. One of these batteries should have its polarity reversed, as will be evident upon a little study of the circuit there shown. In other words the two batteries should oppose each other.



Above There Is Shown a Group of Most Interesting Laboratory Photos. These Show the Excellent and Complete Details of the Apparatus, Even to a Gasoline Engine and Lighting Dynamo, as Constructed by Its Owner—Mr. Joseph Noden, of England. Mr. Noden Has Dabbled Extensively in Electricity and Chemistry, as These Photographs Demonstrate.

An English Experimenter's "Lab"

SPECIAL PRIZE $10.00

By JOSEPH NODEN

I WAS attracted greatly by your *"With the Amateur's"* page, and I thought I would take a few photos of my experimental laboratory and workshop, which may be of interest to American amateurs, knowing they have come from their country's cousin from the other side of the Atlantic. I may add that nothing in the photos comes under my daily work, for I am a clerk in the L. & N. W. Railway Shops at Crewe.

All of the electrical apparatus are of my own manufacture, also engine and generator made from the castings (½ H. P. gasoline engine and 100 watt generator) which I use to charge my accumulators and light my laboratory and shop. The microscope is also home-made with the exception of lenses (800 times). I have a number of models, including *Curtis Tractor*, which can be seen in photos. The lathes I have are four-inch swing Drummond, also wood lathe, as well as polishing machine and grindstone (home-made). My "Lab" contains about 250 chemicals, solids, liquids and reagents, and practically all appliances for experiments under my heading. The condenser, separators, etc., were made myself from various glass tubes—also Bunsen burner, tripod and stands. I have a small room which contains bench, vises and cupboards containing mechanical and wood-working tools, shellacs, varnishes and paints; also scrap boxes which are good ones, and I might impress this on every "Amateur Scientist" never to pass an odd end, but pick it up and throw it in, for it may come in handy some day. I also have a collection of all the most important minerals found in the British Isles; the stand camera I have taken these photos with, which is my own make.

Now this one is a very important point. I am nearly thirty years of age and married, and I must say my wife is just as interested in my experiments as myself and is as anxious to see results as I am and so is in sympathy with all my work which you will agree is a great asset to any Amateur and Experimenter, but it is like this—the more time I get in my room the more I want.

SPECIAL LABORATORY PRIZE CONTEST.

As announced some months ago, we stated that for special experimental laboratory photos and descriptions an extra inducement or special prize would be offered. This month, we have pleasure in presenting an exceptionally fine experimental laboratory group, that of Mr. Joseph Noden, of England. We hope to receive more of these complete laboratory write-ups every month, and shall offer a cash prize of $10.00 for the best description, accompanied by photos, submitted.

Send photos and descriptions to Editor of "Special Laboratory Prize Contest."

As you are aware, the restrictions on wireless are still on here, and I am waiting patiently for their release (they are very slow here).

I vouch for everything I have put in this letter as being correct and true, and I have neither had any training or tuition, only text-books. In this work I have had no personal tuition whatever.

My password is "perseverance."

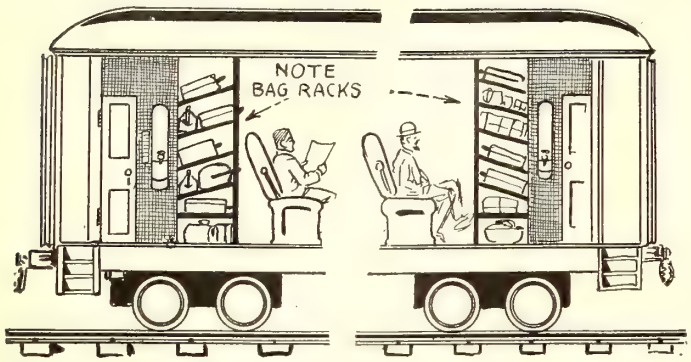
Wish your magazine every success. Joseph Noden, Fern Villa, Coppice Road, Willaston, Nantwich, Cheshire, England.

[*Editor's Note:* We shall be pleased indeed to hear from other International Experimenters with photos of their laboratories as well as of themselves. There are some excellent experimental laboratories in foreign countries, as we well know from personal experience. Many of these experimenters probably feel that New York is too far away, and that American workers in the field of science are not interested in foreign developments. But such is not the case at all. So we shall expect to hear from some of our readers in England, France, Italy, Russia, Sweden, Africa, China, Australia, and, in fact from any Experimenter anywhere. Science recognizes no nationality or creed. The ELECTRICAL EXPERIMENTER is rapidly increasing its foreign circulation, a special edition being printed for English readers now and a little later we expect to have to print French and other editions. We don't want to blow our own horn, but men from at least five European countries and Australia have told us the same thing—"You do it well! We have nothing at home that compares with the EXPERIMENTER." Dr. Alexis Carrel's assistant, a doctor of philosophy and an international scholar, was one of those who thus complimented us. Compatriots in science—we welcome you!]

What To Invent

By JAY G. HOBSON

TRAVELERS on trains these days will readily see the advantage and importance of the following improvement on the present system of accommodating passenger's personal luggage, which they ever insist upon carrying with them instead of checking same in the baggage car as provided with every ticket. But human nature persists in such peculiar characteristics, which fully accounts for the regular day coaches being jammed with all kinds of parcels, making them look very much like a "Check Room" instead of the comfortable, roomy public conveyance as originally intended.



Ever Travel Much? What's the Matter With This Idea? Bags Are Placed in Slanting Racks at Each End of Car.

This annoying condition suggests an idea for a parcel and bag rack in each end of the car, as illustrated. A compact rack made of metal tubing, so provided with individual compartments that it will hold as many parcels as there are passengers; a rack so constructed that it would be as attractive as the furnishings in the car. An efficient system as described for carrying passenger's personal parcels at either end of the car would not only be appreciated by the traveling public, but would greatly expedite loading and unloading of the coaches at stopping points. Then the item of safety is very important. Quite frequently careless passengers place their heavy suitcases, bags and belongings overhead on the parcel racks. The swaying motion of the train often throws them down upon the heads of people, causing painful injuries.

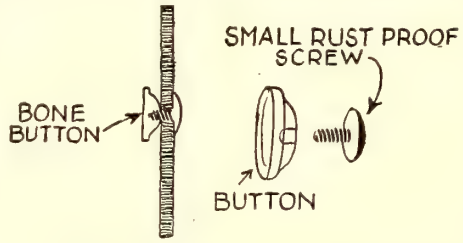
All these things would be overcome and great comfort for travelers would ensue from the application of this much needed improvement. A patented parcel rack for this purpose could be reasonably made and sold in large quantities, it seems.

A new article that would be worth while has often suggested itself to me by my personal experience with this trying and costly trouble. Just a few days ago it was again forcibly imprest upon me as being more in need than ever. A friend and I were talking about various things of interest, when suddenly he exclaimed: "By Jove, Hobson! Do you know it is the worry of my life trying to keep my coat collar from soiling my linen collar! I have tried everything, even to having my coat collar cleaned, but it seems to do no good. A few minutes after I put on a clean collar it is soiled by rubbing against my coat collar. How the deuce can a fellow eliminate this annoyance?"

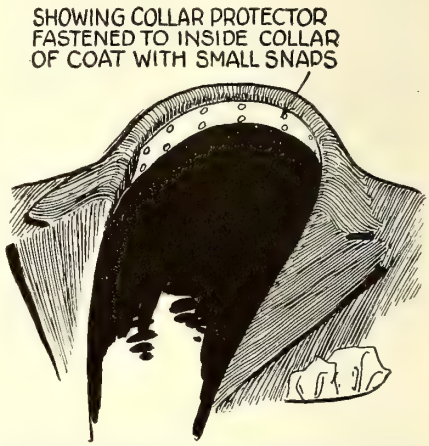
I replied that my experience had been similar and we both agreed it was a pesky nuisance. Since then the idea of the following improvement has appeared. A narrow collar-protector made of white cloth, cut to the shape of the coat collar and neck and fastened to the inside of coat collar, by very small snaps, as illustrated.

This small, invisible protector could be easily and quickly attached or detached as desired. When one had become soiled or worn, another could be attached, thereby saving excessive laundry expense and the nuisance of forever wearing soiled collars. This little device is practical in every way and would sell to most every man learning of its advantages.

Of all the disgusting difficulties to be encountered when traveling away from needle, thread and home is to lose buttons off one's undergarments, such as union suits, night gowns, pajamas, shirts, etc. Bachelor buttons of many kinds have appeared on the market from time to time, but these have all been made to replace buttons on coats, pants, overcoats and the like. Nothing in the threadless buttons for undergarments has ever been produced, to the best of my knowledge. My experience with this, "Everyman's Bother," brings to mind an improvement in bachelor buttons and especially one for men's undergarments. I see one as illustrated comprising a bone button without the usual four holes in the center, but solid instead, being somewhat thicker in the center at the back to allow for a small screw to be made of some non-rustable metal. The back center of said button would be provided with a small hole threaded to accommodate the threads on the small screw. The head or larger end of the small screw would be somewhat cup shaped and highly polisht on the surface worn against the body. This peculiar saucer-shaped screw head would grip the clothing securely when the screw was inserted thru the goods and screwed tightly into the button proper.

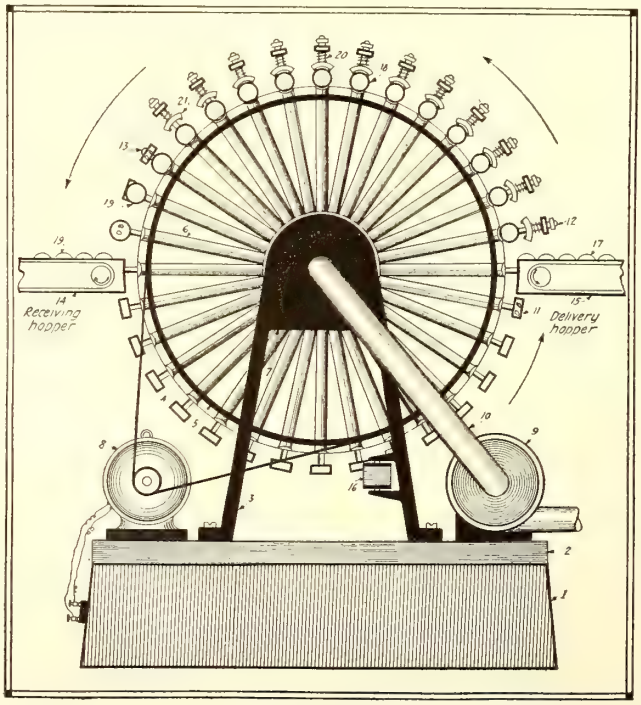


Another Idea. Why Not Make an Improvement in Bachelor Buttons?



Why Not Devise a Collar Protector to Snap Inside Your Coat, to Prevent Soiling Linen Collars?

Being screwed into the button assures a permanent fastening, and the large end of the screw prevents tearing of the garment. A button of the design would last as long as the garment and be dependable under all circumstances of wear. They could be manufactured cheaply in large quantities and sold thru dealers by the million. I am sure the masculine public would gladly buy this improvement, and it is safe to say the women folks would not object.

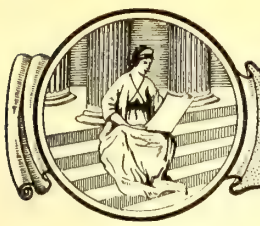


Here's a "Starter" on That $10,000 Prize Contest for a Successful Walnut Brander. Finish It, and the $10,000 Is Yours!

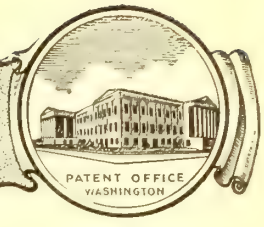
A $10,000 INVENTION WANTED!

Last summer a large California Walnut Growers' Association offered $10,000 to the first person succeeding in perfecting a practical machine that would automatically stamp their trade-mark on each individual English walnut so that their customers could depend upon getting their particular brand when asked for. As far as I am able to learn, this same association is still willing to pay a very good price to the inventor who submits a working model of a machine that will actually put their trade-mark on each walnut, at a small cost of operation, so that it will be permanent.

(*Continued on page* 1184)



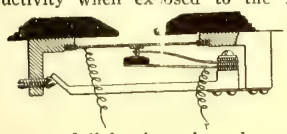
LATEST PATENTS



Selenium Transmitter.

(No. 1,328,996, issued to William G. Houskeeper.)

This invention relates to the use of selenium in telephone transmitters, together with improved form of transmitter. Selenium in the metallic crystalline state not only has the property of varying in conductivity when exposed to the in-

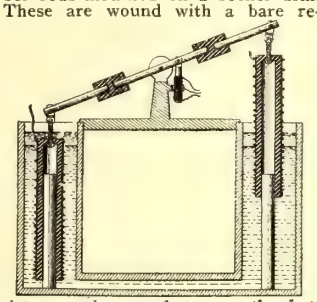


fluence of light, but also when exposed to various pressures. Herein the inventor adjusted a piece of carbon to the diafram of the transmitter, another piece to a flat spring with the pointed selenium crystal between. Either carbon or other material which will not go into chemical action with the selenium being suitable for holding it in place. Adjustment is made by the screw at the bottom of the transmitter.

Novel Rheostat.

(No. 1,329,167, issued to Robert W. Ebeling.)

An improvement in rheostats which promises to be quite revolutionizing. Very often at the movies and other places it is desirous to effect illumination of signs or produce colors or variations of colors, changing from one to the other, this, of course, being effected by two lanterns. In order, therefore, to decrease the intensity of illumination in one and increase that in the other of the two lanterns the inventor has utilized two hard rubber rods mounted on a rocker arm. These are wound with a bare re-

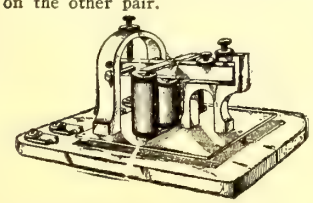


sistance wire so that near the bottom their turns are closely approximated, whereas at the top they are further apart. A solenoid actuates the rocker arm. These rubber rods being forced in this manner into two containers of mercury, which has a thin layer of oil on top of it, preventing evaporation. A two-way switch actuates the mechanism and absolute gradation of current to the lamps is made possible by the extremely simple yet unique method exemplified. There is no light flicker resulting in its use and no contacts to burn out.

Alternating Current Sounder.

(No. 1,324,536, issued to Harry K. Beasley.)

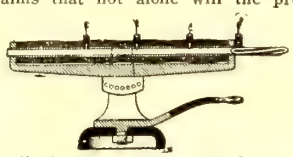
Essentially it consists of three electro-magnets, whilst the rest of the apparatus is more or less like the standard sounder, alternating currents are used of a definite phase, preferably of 90° phase difference. Non-inductive resistances are connected into the circuit on the central magnet and a condenser connected in on the other pair.



Magnetic Guns.

(No. 1,324,204, issued to Charles E. Morris.)

Magnetic guns have at all times caused considerable comment and one of the cleverest and unique devices along this line appears in this patent just issued. It consists of a barrel of polygonal cross-section so that when this barrel is mounted on its support it presents, not a perfectly straight front, but it is twisted in a spiral form. Encircling this barrel is a series of helices, the winding of these helices tightly embracing the barrel to conform with its spiral shape, altho its bore is perfectly true. By reason of this construction the inventor claims that a spiral magnetic field is provided which serves to rotate the projectile on its axis. The projectile itself has a series of spirally arranged non-magnetic inserts (copper or brass), so that the pins which make contact with the projectile will be assured of causing a positive circuit with the brass strips. The inventor claims that not alone will the pro-

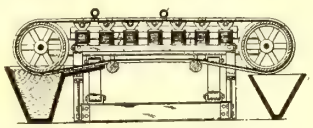


jectile be sent out at a good speed, but also a rotating motion is imparted to the projectile, the successive helices being electrified by the projectile closing contact with the pins.

Magnetic Separator.

(No. 1,324,149, issued to John E. Greenawalt.)

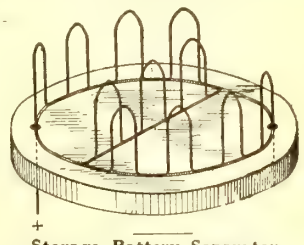
This invention is for apparatus and processes for utilizing magnetic fields for separating magnetic from non-magnetic particles and seems to be an extremely clever device. The modus operandi is as follows: Crushed ore in the form of pulp is placed upon an endless moving belt, said belt having small uprisings on both sides. A series of electro-magnets attract the particles of magnetic ore, whilst the other non-magnetic particles are washed down into a hopper, shown empty in the accompanying diagram, by streams of water emanating from supply pipes indicated by the small round circle on top of table. These pipes run transverse to the direction of the belt. Simultaneously with this is imparted an oscillating motion to the belt, which agitates the particles sufficiently to cause thoro separation. The table being slightly inclined, the poor ore is washed away, whereas the magnetic material falls over the edge now not under magnetic attraction into a hopper full of water. Here it is collected and past on to subsequent stages.



Thermic Telephone Manufacture.

(No. 321,989, issued to Pieter de Lang and R. Aernout Baron Van Lynden.)

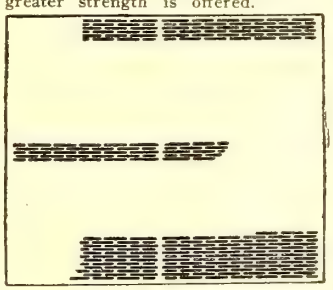
Thermic telephones coming into greater use, the inventor has realized a method of manufacturing supports for the heating conductors of the same so that this work may be carried on in a large scale. The ends of the heating conductor wires, which are bent at an angle to the branches of the wire, are forced into grooves in an insulating base and hence are connected to the support without any special means. The heating conductors connected to their support, in this manner, can be etched without difficulty to the desired sound producer length by dipping them to the required depth in an etching bath. The grooved support holding this series of wire loops in electrical contact with each other prevents the displacement of the loops by the walls of the grooves.



Storage Battery Separator.

(No. 1,329,180, issued to Walter E. Holland and James M. Skinner.)

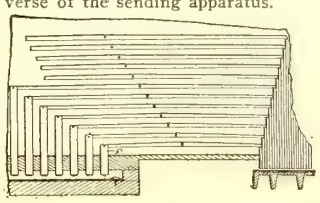
Heretofore it has been found to be practically impossible to utilize a perforated rubber separator for insulating the positive and negative plates of storage batteries, particularly those used for starting and cranking of automobiles, assuming the rôle at the same time of furnishing the voltage necessary for this purpose together with the current for the internal combustion (viz. spark coil) and lights. The battery thus not only failed to perform its primary function of cranking the engine, but failed as a reliable source of ignition. The inventors have therefore invented a separator which overcomes the drawbacks of other separators in so far as it allows for a perforation of at least 40 per cent and thus more fully exposes the positive plate surface to the action of the electrolyte. Not only is higher porosity possible, but also a method of making the separators without breaking them has been found. The main idea being to place the slots in the separator out of alignment so that greater strength is offered.



Picture Transmitter.

(No. 1,322,340, issued to Bernard Proser.)

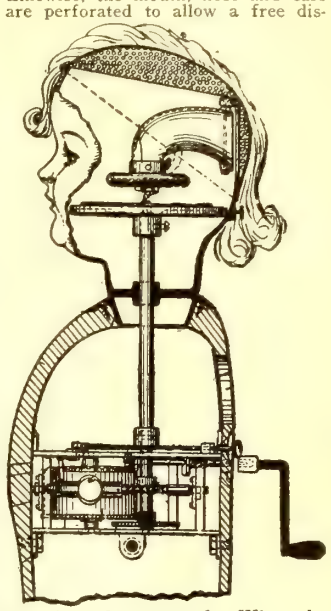
This invention relates to a method of transmitting pictures or other designs by mechanical means and was designed primarily for the purpose of enabling a newspaper office to transmit to a distant office certain important pictures, all in such a manner that the distant office can speedily reproduce the picture. It consists of a plurality of vertically positioned plungers bearing at the other end a printing character, just like the keys on a typewriter, except that they are minute in character and close together. When an embossed design is placed upon these pins it actuates all the type characters and they are printed at one stroke by the printing plungers. The characters are then transmitted by telegraph to the receiving end, where they are deciphered by an apparatus working just the reverse of the sending apparatus.



Talking Doll.

(No. 1,325,013, issued to Christoph Adolph Giebeler-Wanke.)

A doll's head is made of prest aluminum and a body of wood, the head mounted so as to be easily moved relative to the body. A phonograph motor is situated in the wooden body with a shaft extending up to the head, where the reproducer is located. A cam-like device also allows the mouth of the doll to open and close very naturally. Hair is placed on the aluminum head, covering many perforations, which allows the sound to escape from the doll. Likewise, the mouth, nose and ears are perforated to allow a free dis-

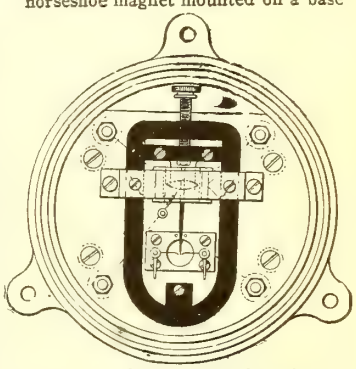


tribution of the sound. When desirous of changing a record it is only necessary to "pull the scalp back" and the head opens like a door.

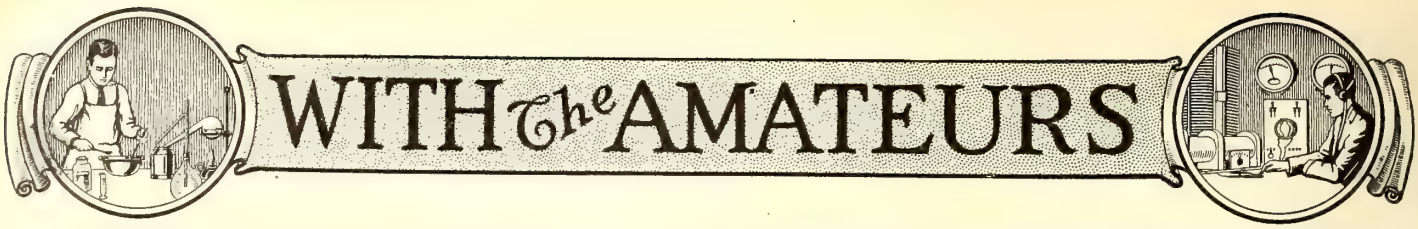
Alternating Current Relay.

(No. 1,328,825, issued to Charles Vickery Drysdale.)

This is one of the cleverest alternating current relay patents which has appeared in recent years. It works on the principle of tuning or resonance. Various models utilizing the inherent principles are submitted. Essentially, it consists of a horseshoe magnet mounted on a base



which has fixt between it poles, a coil to which alternating current passes. Within this coil is pivoted a soft iron or steel needle having a platinum contact at its end. The poles of the magnet are arranged to give an intense field in the neighborhood of the needle. Adjacent to these poles is a soft iron shunt mounted on a screw so that by causing it to move a greater or less proportion of magnetic flux is shunted. In this way the control and frequency of vibration can be varied.



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNERS— MESSRS. FRIDGEN and FROMMELT

HEREWITH we present photographs of our wireless set. The receiving room consists of the following: Four Edison primary batteries, which we use for audion filament current. We also use a 6-volt, 60-amp. storage battery, one standard station clock, one twelve thousand meter loading inductance, small loose coupler, Murdock variable condenser, E. I. Co. variable condenser, De Forest audion panel complete with De Forest bulb, two audio-tron panels complete with bulbs, one navy type loose coupler 4,000 meters, one "NAA" type loose coupler 3,000 meters, Marconi type receiving set, 5,000 meter range, one pair Murdock 2,000 ohm phones, one pair Brandes 2,000 ohm phones and a 500-meter loading inductance. One of our main assets in the ELECTRICAL EXPERIMENTER MAGAZINE for the last three years, and also a complete set of reference library on electrical engineering from the "I. C. S." We use 35 red seal dry cells for our "B" batteries, as we find in them the longest life. We use 2 E. I. Co. radiotone buzzers—one we use for testing our crystal detectors and the other we use on a practise set.

The transmitting set consists of the following: One one-thousand watt Thordarson transformer, type R; one five-hundred watt Packard transformer, two rotary spark gaps, two oscillation transformers, one Leyden jar condenser, one glass plate condenser, one hot wire meter, two kick-back preventers. We have two keys, one of which was built from directions found in the ELECTRICAL EXPERIMENTER. A commercial type aerial switch is used.

We are both middle-aged men, Mr. Fridgen having had seven years' experience in radio work, two years in the U. S. Navy. Mr. Frommelt has had four years of radio work at home. We can copy on an average of 28 to 30 per minute. We are both members of the Radio League of America, which we advise every amateur and professional to enter. We have had very successful results with our sets. We have been able to copy quite a large number of high powered stations, such as Arlington, Key West, Fla., Sayville, Jupiter, Fla., South San Francisco, San Diego, Cal., and practically all good sized naval stations. We expect soon to be able to hear (P. O. Z.) and other foreign stations. With our set we are able to copy two different stations at once. One man can be working on 2,500 meters and the other on 600 meters wave length.—E. N. Fridgen and F. J. Frommelt, 1645 Avon St., La Crosse, Wis.

HONORABLE MENTION, O. W. JACKSON $2.00 PRIZE PAID EACH "HONORABLE MENTION"

MY laboratory apparatus, among other things, includes a small motor-generator set, a 6-volt storage battery and a Thordarson 1-kilowatt transformer, which are seen on the table. My receiving set is a loose coupler of my own make and an E. I. Co. detector stand; also a 3,000 ohm head set and a variable-fixt condenser. With a 60-foot aerial, 52 feet high, I can hear some of the distant stations.

I can boast of some interesting experiments in this corner. I have also made an Oudin high-frequency coil to go with my 1 k. w. transformer, and I have three 7-inch Geissler tubes and two different makes of spark gaps, four 1-quart Leyden jars, 30-ampere key, D. C. and A. C. motors, a telegraph set, a gravity battery, 4-volt D. C. motor, a carbon grain transmitter, a small rheostat and a set of Hawkins' Electrical Guides.—Oliver W. Jackson, 712 Yale Ave., Yakima, Wash.



Science in Slang

By EMERSON EASTERLING

"WHAT in the dickens is this Einstein racket we are hearing about?" Bender queried, as he scanned the pages of an automobile monthly.

"It don't have much to do with carburetors or ignition," returned Jazz, glancing down the sheet, "but *ignorance* plays a great part in it.

"It goes this way:

"Once upon a time a gent with a pencil, a well organized set of brain cells, a scratch pad, and a hunch sat before a table. He——"

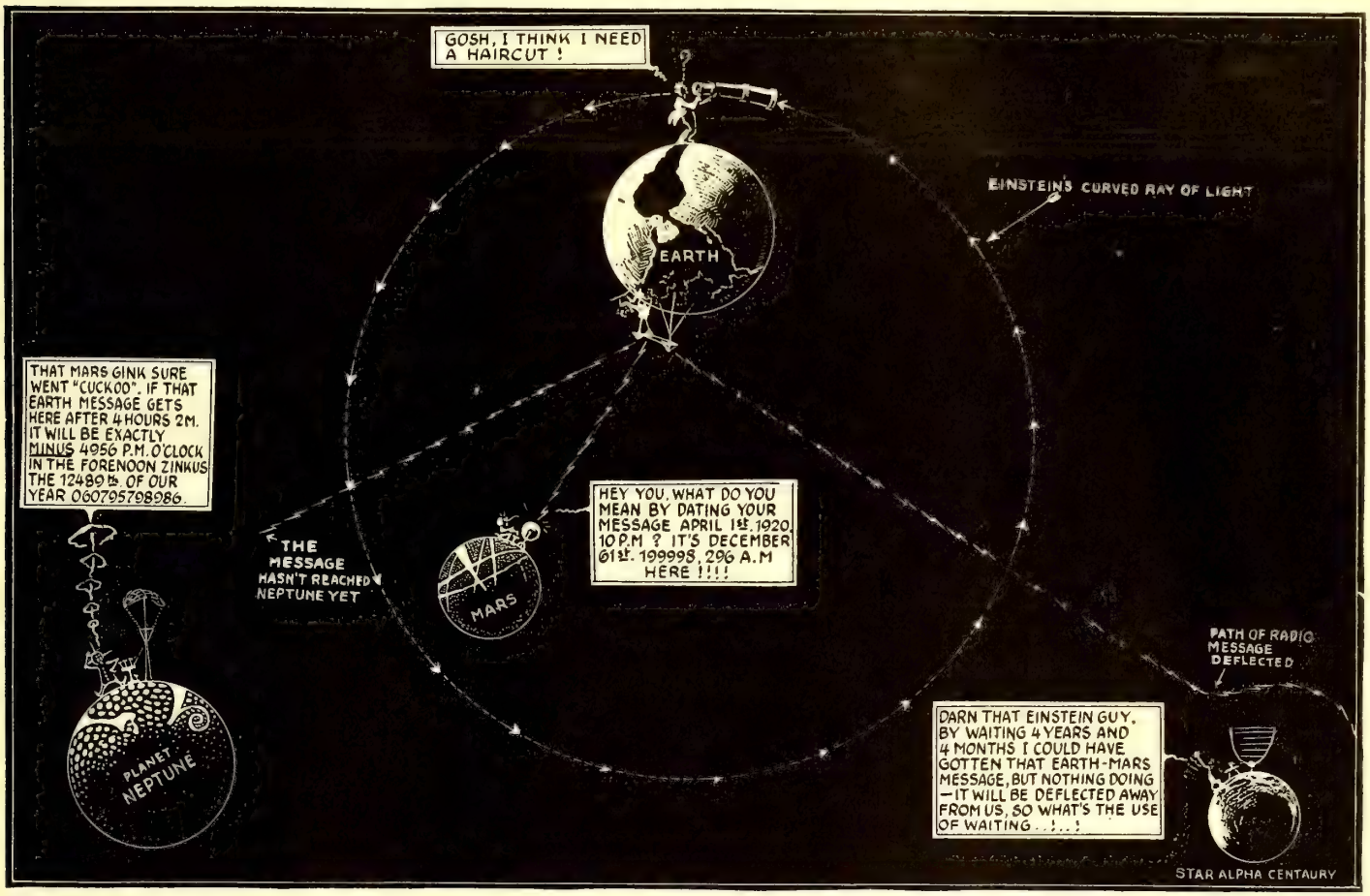
"What's Einstein got to do with that magazine?" Stew rapt out.

Relative that Einstein Theory

Isabel Lewis avers a couple of times in the January issue of this magazine (Jazz jerked from his pocket a copy of the magazine you, dear reader—if a girl, *dearest* reader, are holding in your hand—if you are) that the Newtonian laws of motion are but first approximations of the Einstein ditto.

"Like Christopher, the guy that bet on Dempsey, Wellington, Elijah—Einstein had to prove his point before the contemporary wiseacres would nod their ivories in a vertical direction and look foolish; but unlike cles and drawl tried to be at home while they played Robinson Crusoe on the island of Principe which still lies off the coast of the country that touches on the Gulf of Guinea. They, too, stayed at their location and took pictures of the star-bespattered welkin for a couple of moons, took their daily *mawnin' bahwth*, exclaimed, 'Such a blooming, bawly country!' etc.

"Packing their telescopes together, kissing the natives farewell, and exclaiming, 'Aht lawst!' they paddled their canoes back to the land where Oscar Wilde once wrote of days gone by, Shakespeare did what David Belasco and George Cohan do today; and when the guy who does the de



An Actual Photograph Of All the Facts of the Einstein Theory Relatively Speaking. It Will Be Noted That the Relative Light Ray Is Quite Relative to Space to Which It Bears Some Relativity and Vice Versa. So Far for the Relativity of the Theory. This Photograph Also Shows An Important Boner of Doc. Einstein. He Has Been Telling Newspaper Co-respondents That Only Light Rays Were Curved. He Forgot To Tell Them Probably Because It Never Occurred To Him That Radio Waves Consequently Must Curve As Well. We Take All the Credit for This Important Discovery. Some Gink Will Now Please Prove To Our Electric Lighting Companies That Inasmuch As the Light Rays Received from Lamps Are Mostly Crooked, the Warped Bills Should Now Be Straightened Out Accordingly.

"Nothin'," replied the solemn Bender.

"Let Jazz string us along," I bawled out. "We haven't got over twenty-five thousand words space in this publication."

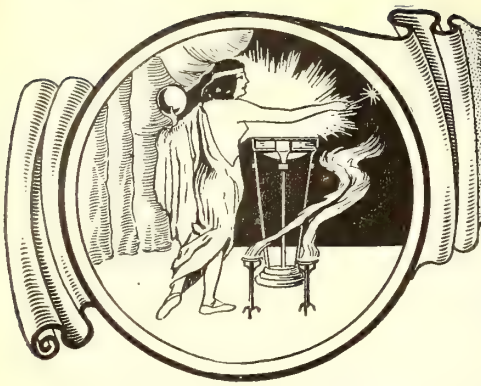
"As I was saying," Jazz continued, "the guy was *Einstein—Onestone,* I believe, translated into our language — the hunch was that the old star gawkers were barking up the wrong tree in their conception of the universe. In simple lingo, the stars were not on the spots as printed on the maps of the observatory.

"Primarily the old bird was a two-plus-two-equals-four guy, but as we often find, great mathematicians are great something-elses. This gink goes Izzy Newton one better on his propounding — Newton was right, but Einstein was *righter*—or as friend Christopher, the Dempsey fan, Wellington, and Elijah, he never had a *Santa Maria,* a Fourth of July decision, an army tired out some after a victory over the weinie eaters and a bum scribe for a general, or a bunch of Baal priests with fake gods that failed to respond and a *real* one that *did;* but on a certain May 29, 1919, two expeditions of Great Britain Englishers from John Bull's Anglo-Saxon country set out for the two corners of this round ball of dirt, otherwise called earth. One gang set up their long distance opera glasses at Sobral, Brazil, took a *bawth,* then exclaimed, 'Such a blawsted, bawly country!' and showed the natives how much superior they were to the average humanus for four fortnights. The other collection of monoveloping races out with the prints dripping with water, they scramble over each other and snatch the *proof*—photographic and scientific—with mingled belief and *dis*-ditto, but exclaimed in unison, 'Bah Jove! Ripping, old top, I say.'

"Old Bert had the right dope!

"Then the scientific world raised their voice in proclaiming what Switzerland could produce besides cheese, winter sports and territory that served so nicely as Everyman's Land during the 'gunic' struggle now past, 'gunically' speaking. Albert Einstein had had his cognomen carved in the Pillars of Distinction that uphold the Hall of Fame. We now squat down at class in astronomy and listen to the proff

(*Continued on page* 1217)



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

CHOKE COIL CALCULATION.

(1038) W. F. G., Ontario, Can., writes the Oracle Dept. in reference to choke coil design:

Q. 1. A choker (choke coil) having straight open core of 15 cm. length, and 19 sq. cm. area or 1½ x 2 inches is intended to work on 110 volt A.C. circuit, 60 cycles, B=10,000; μ=2,000, coil to pass 5 amperes when tapt at a point that gives 20 volts. I desire to know beforehand the exact magnetizing current comprising the energy and wattless components when there is no load. Please show exactly the process for working out this quantity, step by step. If I have not made the question sufficiently clear, you may assume 220 total turns of wire on the core, and that when it is merely balancing itself against 110 volts, what will be the energy losses and the idle component? Weight of core, laminated, 5 lbs. best silicon steel; resistance negligible.

Q. 2. It is desired to build an induction coil (or any kind of coil) to work on 110 volts A.C. 60 cycles, and the primary passes 2 amperes, or 220 watts (energy watts). Please show how to figure a condenser to exactly suit this particular case, assuming any other quantities if necessary.

Q. 3. Please state why the inductance in henries (L) is always converted into centimeters for wireless work, and how the "constant" if any, is obtained. It is not easy to understand how a quantity like L or self-inductance composed of $\frac{\text{Flux-turns}}{\text{C } 10^{8}}$ stretches out entirely into centimeters. The whole reason and process seems to me very interesting. Please explain these three questions completely.

A. 1. Since the choke coil as described is being used merely as a step-down auto-transformer, we can then obtain the magnetization current or the wattless component of the exciting current of the primary of the coil arrangement, from the following algebraic expression:

$$\text{(a).}\quad \text{I mag.} = \frac{10 \times 1 \times \Phi}{4\pi\sqrt{2}A\mu n_p}$$

where I mag. = magnetizing current
l = length of core in cms.
ϕ = flux density
A = area of core in sq. cms.
μ = permeability of the core material.
n_p = primary number of turns

Total flux equals:

(b). ϕ = BA Maxwells
hence: ϕ = 10,000 × 19
= 190,000 Maxwells.

Substituting the values of the problem in equation 1, we have

$$\text{I mag.} = \frac{10 \times 15 \times 19 \times 10^{4}}{4\pi\sqrt{2} \times 19 \times 2{,}000 \times 220} = .19 \text{ ampere}$$

This being one of the components comprising the main exciting current, which produces the magnetizing flux and which is 90° behind the primary imprest voltage and in phase with the flux. The second component of the exciting current is the one that takes care of the iron losses (hysteresis and eddy current losses) and this is in phase with the imprest voltage and at quadrature with the magnetizing current or wattless component. Thus the exciting current can be exprest as:

$$I_{exc} = \sqrt{I^2_{mag} + I^2_{eth}}$$

where
I_{exc} = exciting current
I_{mag} = magnetizing current or wattless component
I_{eth} = current taking care of core losses, eddy and hysteresis losses; this is called the *power component.*

Having computed the magnetizing current, the other component I_{eth} is determined from the following algebraic expression:

$$I_{eth} = \frac{Vf(K + t^2B^2_m + nB^{1.6}_m\ 10^{-7})}{E_p}$$

where
V = volume of iron in cms.^{3} (cubic centimeters)
f = frequency in cycles per second
K = resistivity constant = 1.6×10^{-11}
t = thickness of a single wire of iron core
B_m = maximum flux density ($\phi_m \times$ cm.$_2$)
n = hysteresis constant
E_p = primary potential

Substituting the values in the above expression and assuming from practise, standards such as $K = 1.6 \times 10^{-11}$ and n .0021, we have:

$$I_{eth} = \frac{15 \times 19 \times 60\ (1.6 \times 10^{-11} \times 60 \times .0635 \times 10{,}000^2 + .0021 \times 10{,}000^{1.6} 10^{-7})}{110}$$

I_{eth} = .02 ampere.

Therefore the exciting current equals:
I_{exc} = .162 ampere.

The other components of the choke coil (auto-transformer arrangement) are the copper losses both in the primary and secondary (I^2R), which cannot be determined as the size of the wire used, was not given in the problem. However, it is found by squaring the current in each circuit, and multiplying this value by its respective coil resistance.

A. 2. The electrostatic condenser capacity necessary for the secondary of a certain coil may be computed from the following expression:

$$C = \frac{2P\ 10^{6}}{NE^2}$$

where
C = capacity in microfarads
P = secondary power in watts
N = number of times condenser charges
E = voltage of secondary coil.

In the example given it is necessary to know the secondary potential, and we will assume it to be 10,000 volts. Then substituting the proper values in the foregoing expression, we have:

$$C = \frac{2 \times 220 \times 10^{6}}{60 \times 2 \times 10{,}000^2} = .0366 \text{ mfd.}$$

A. 3. The reason why the value of inductance in henries in radio work is converted into centimeter units, is because the henry unit is too large; the value of the inductance of the coils used is very small in value, hence the use of the microhenry and the centimeter. However, you can use the henry if you so desire, providing the proper constant before the radical is employed.

(*Continued on page 1168*)

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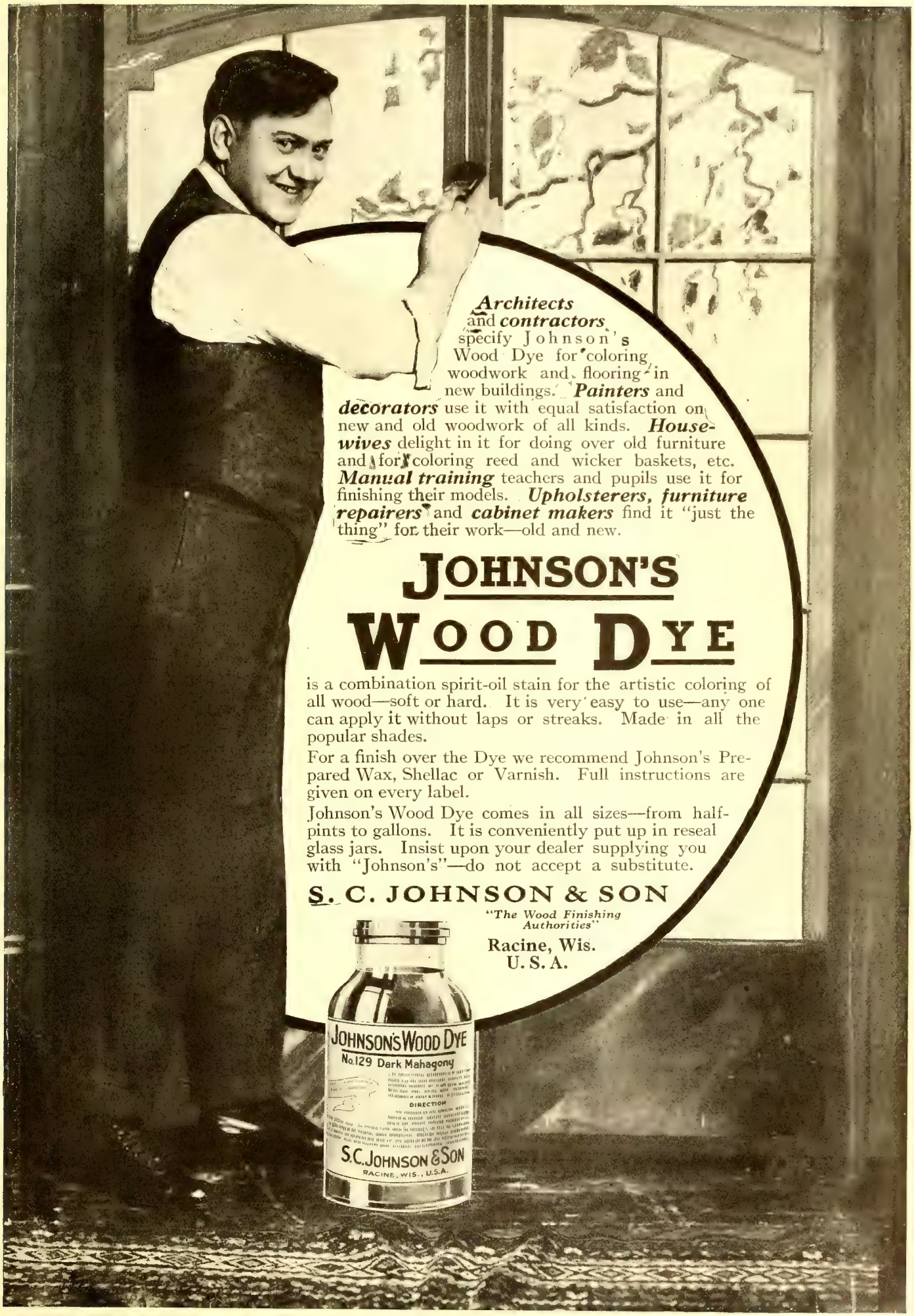
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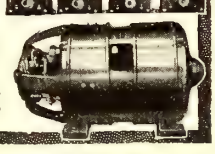
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The Oracle

(*Continued from page* 1166)

The wave length of an oscillation is exprest generally as follows:

(a). $\lambda = K\sqrt{CL}$

where
λ = wave length in meters
K = constant, depending upon what units C and L are used
C = capacity
L = inductance

Let us assume in one particular case that C will be in microfarads and L in centimeters, then the time period of the oscillation is

(b). $T = 2\pi\sqrt{CL}$
C = in farads = 10^{-9} milli-microfarads
L = in henries = 10^{-9} centimeters

Since the speed of electricity is the same as that of light, namely 186,000 miles per second, then the wavelength of an electric oscillation as compared with that of light will therefore be the same, thus:

(c). $\lambda = TV$
T = time
V = velocity of light (3×10^{10} cms. per second)

Substituting the value of T and V in expression (c) we get:

$$\lambda = 3 \times 10^{10} \times 2\pi\sqrt{C_f L_h}$$
$$= 6\pi \times 10^{10}\sqrt{C \times 10^{-9} \times L \times 10^{9}}$$
$$= 6\pi \times 10^{10}\sqrt{CL10^{-18}}$$
$$= 6\pi \times 10^{10} \times 10^{-9}\sqrt{CL}$$
$$\lambda = 1.884\sqrt{CL}$$

where: λ = wave length in meters,
C = capacity in milli-microfarads (microfarad $\times 10^{-3}$)
L = inductance in centimeters
1.884 = derived constant

The Airship of To-morrow

By GEORGE WALL

(*Continued from page* 1113)

partments of which the one shown is a single unit, with an electric elevator to carry the passengers from one floor or deck to another.

All the comforts of home will be had on these latest airships which will soon be poking their noses over the horizon of such large cities as New York, London, Paris, Constantinople and even the far eastern cities of Japan, China, India and Australia.

There will be found among other necessary luxuries, if so we may call them, shower baths, music and smoking rooms, an electric kitchen for preparing meals for the passengers, electric lights, and electric fans for the warm weather, electric razors and massage apparatus in the barber shop and private baths, besides an electric heating system for cold weather and telephone service between the guest rooms—and speaking of the telephone it brings to mind some of the joys and pleasures of being an aerial bell-hop!

In the evening there will be motion picture shows operated by electricity, by means of a small and especially compact motion picture projector, and by the use of a powerful audion amplifier, wireless music from ship or shore stations can be picked up on the aerial of the giant aircraft as she swims along thru the clouds, and this music then reproduced thru telephonic "loud-talkers" for the benefit of the audience.

This may sound somewhat fastidious, but by these means a great deal of weight is saved in not having to carry an extra load of pipe organs or band paraphernalia for the amusement of the 1,000 passengers or so aboard!

AIRSHIP ROOMS ARRANGED IN CIRCLE.

As will be seen, the guest rooms are arranged in a circular formation on each deck, and this has many advantages as soon becomes evident. For one thing a single elevator gives impartial service to all of the rooms, in view of its central location, and there are a number of other advantages in the serving of meals to guest rooms, etc., which is more difficult to carry out on an airship such as this where a smaller number of servants would be available, than in a hotel on land.

War Inventions Disclosed

(*Continued from page* 1120)

made of copper wires forming an uninterrupted circuit by being stretched back and forth vertically. In order that the blast of the gun itself does not break the wires it is necessary to place the frames some 300 calibers away from the gun. The distance between the two frames of the Le Boulangé apparatus is variable, but in general, it is between 20 to 50 meters.

This distance between the frames is of course measured with great precisions when it is considered that the time limit down to the hundredths of a second is calculated, using as a base the distance between the two frames.

The insert, Fig. 4-A, shows how two electro-magnets in connection with the chronograph recording trigger mark the exact time elapsed when the bullet or shell strikes the first frame and when it reaches the second frame. At the moment of firing the projectile first cuts the circuit of the first frame. Instantly the long black chronometer bar begins to fall, but the instant the projectile cuts thru the second frame the second circuit is also disturbed.

The second electro-magnet instantly acts and its armature hits the chronometer recording trigger. A small pin with a knife then strikes the falling bar armature of the first electro-magnet and makes a mark easily distinguishable. Noting the time of falling of the long bar and figuring this time against the point on which the mark was made from the knife, actuated by the second electro-magnet, the time interval is readily calculated—it is in fact, almost automatic.

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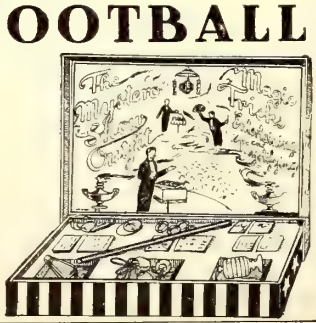


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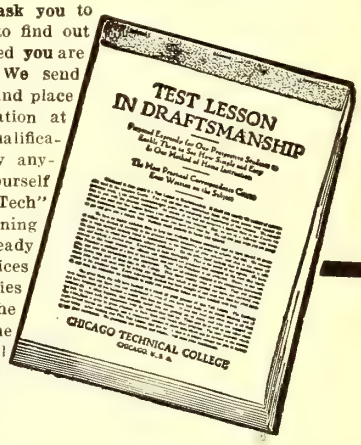
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Popular Astronomy

By ISABEL M. LEWIS, M.A.

(*Continued from page* 1137)

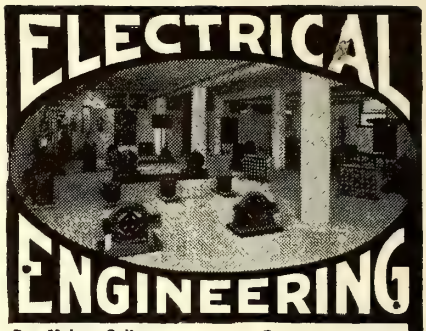
serving the transits of stars across the meridian, and which is erected with its central axis exactly in this plane, and a chronograph record in circuit with the sidereal clock for recording the instant registered by this clock when the star is on the meridian.

It is one of the duties of the U. S. Naval Observatory at Washington, D. C., to send out daily telegraphic time signals to all points in the United States east of the Rocky Mountains. Points on the Pacific Coast and in Alaska receive time signals from the Mare Island Navy Yard in Calif.

On every night when the weather permits a set of six stars, known as a "time" set, is observed at the time of their transit over the meridian of Washington.

As soon as the star drifts into the field of view of the telescope, which has been pointed approximately on the star by setting the circle readings so as to show the star's "declination" (or distance north of the equator), the observer is ready to begin his set of observations. By means of a self-registering micrometer which is designed so as to close an electric circuit automatically five times in one revolution (with an extra contact provided to mark the beginning of each revolution) two closely parallel vertical threads are made to move across the field of view of the telescope keeping the star always exactly between them. As soon as the micrometer screw has been turned a certain definite amount and the star has advanced a certain distance across the field, the first electric contact is closed and connection is instantaneously made with a chronograph record which is connected electrically with a sidereal clock and which records by a "make and break" circuit the even seconds of this clock on a sheet of paper wrapt on a cylindrical roll in the form of little jogs in a straight line occurring at regular intervals. When the observer makes electric contact with this choronograph record by means of his micrometer screw an irregular jog appears on the chronograph sheet between the positions marking even seconds and by measuring these records the exact time shown by the sidereal clock at the time when the star was a known distance from the meridian can be read to hundredths of a second of time. From the five different contacts for each star its sidereal time of meridian passage is computed.

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The Breakers

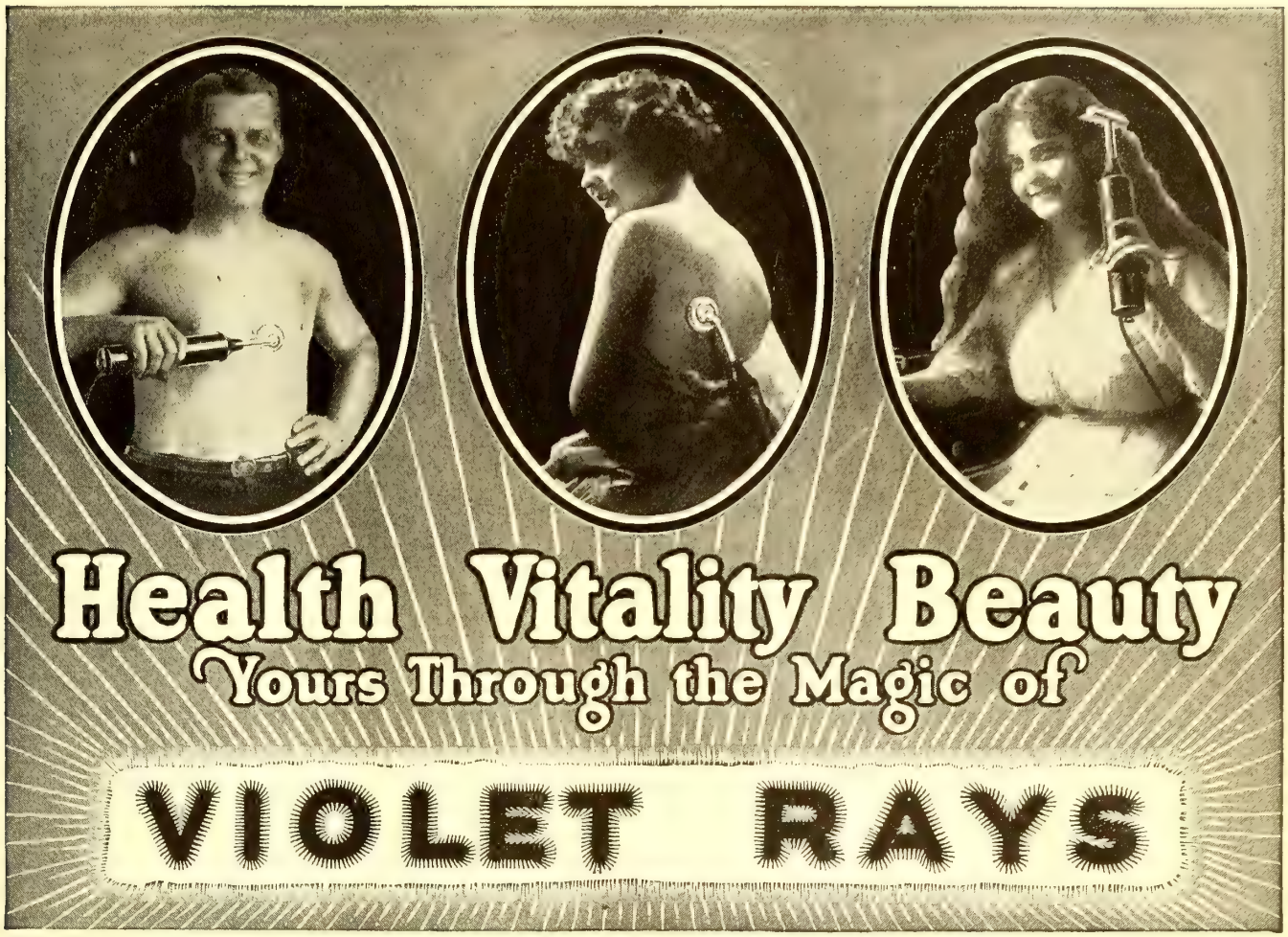
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Vi-Rex Violet Rays are effective for a host of disorders and ailments. Doctors in all parts of the country are adding this scientific outfit to their office equipment and recommending its use to patients. Beauty specialists have long realized its efficiency for inducing a clear and healthful skin. Until recently expense prohibited the use of this remarkable health-building force in private homes. Now the practical, inexpensive Vi-Rex Violet Ray Machine enables everyone to enjoy all the benefits of this marvellous treatment at home

What Satisfied Users and Physicians Say

Trixie Friganza, well known actress, says: "Cheerfully do I add my praise for Vi-Rex. It is *wonderful.* It cured my brother of neuritis. As for myself, I use it for facial treatments and general massage. I cannot say too much for it."

K. L. Allen, D. C., 205 Boone Building, Boone, Iowa, writes: "I have had some very good results with the application of high frequency current in cases of Paralysis, Rheumatism and Neuritis, and think it a great help in drugless healing."

Dr. Daniels, Lisbon, North Dakota, says: "Have used the Vi-Rex in such cases as Goitre, Bronchitis, Pleurisy, Neuritis, Neuralgia and Lumbago, and find it very beneficial. In fact, I would not be without it in my office."

Dr. Bert H. Rice, of Vinton, Iowa, says: "I have good results with the Vi-Rex high frequency instrument in all cases of Neuralgia. Almost instant relief in facial neuralgia."

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All About Diamonds

By JOSEPH KRAUS

(*Continued from page* 1115)

for. It is always best when purchasing stones to obtain a good one.

DEFECTS IN DIAMONDS.

One of the greatest defects in diamonds is *carbon spots.* These when found in large masses make the stone practically worthless, whence it is called *carbonado,* and is used in rock drills, etc., but in stones coming from Africa and other places (except in the Mexican variety), carbon spots are seldomly found, as the cutter has used his utmost skill to clear these. The reason they are objectionable is that the spot is reflected and exaggerated many times, altho in reality it may be quite small in itself. Ofttimes a carbon spot is left in the stock but generally in such a position that when a stone is placed in a setting, it is covered by either the gold or platinum mounting. It is then more valuable to leave the spot in the stone rather than cut the stone away, making it smaller in size, as stones are sold by the carat, namely, a unit of weight. A stone is more valuable, even with small carbon spots invisible to the unaided eye, than a stone of poorer color, and it is found that in the course of examining differences in stones, nearly all of them if *pure white* have traces of carbon in them. Very often a stone has cracks or breaks across the grain or with the grain, irregular when across the grain and straight when with the grain. These breaks cause a reflection which is a very bad feature and is second to large carbon spots in regard to frequency of occurrence. They are called *cracks* when large and *feathers* or *flaws* when small. Minute feathers are not very noticeable.

DIAMOND CRAFT.

In the diamond there is a "grain" in the rough stone which grain is parallel to any of the triangular faces of the octahedral crystal. The stones in the rough are examined for perfection and assorted for sizes. The largest stones are given very close inspection for flaws and carbon spots. When these are found it may be desirable to split the stone into several smaller pieces, to eliminate the flaws and to secure stones of more marketable size. It behooves an individual known as a "cleaver" to know thoroly the grain of the diamond in the rough. Sometimes days are taken to decide on its cleavage in order to get the largest and best results—a mark is placed upon the diamond with pen and ink, a tiny groove is ground into it and the stone mounted on the end of a holder with the sharp edge of another diamond. A knife about 6" long by 1" high is now inserted into the groove or on top of the line, and with a quick blow the diamond separates easily along its grain.

There are two sets of cutters that work on this line, one called the *lopper* and the other the *brilianteerer.* The lopper makes the stone into octagonal shape. The brilianteerer cuts the facets and smaller parts, finishing the stone. When the stone is placed upon the rapidly revolving iron

(*Continued on page* 1174)

Something New

on a subject that is not understood by many people. This is the question of the relationship between SEX and the PHYSICAL and MENTAL HEALTH.

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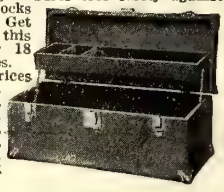
written by an experienced physician, who has investigated this subject and has found it to be the origin of most chronic diseases. This is also the cause of so many unhappy marriages. This is a very valuable book for those who are married or intend to get married; it will avoid considerable unhappiness and heart-aches. This book will be sent you prepaid upon receipt of

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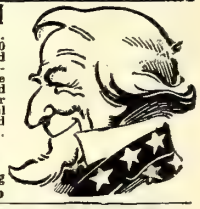
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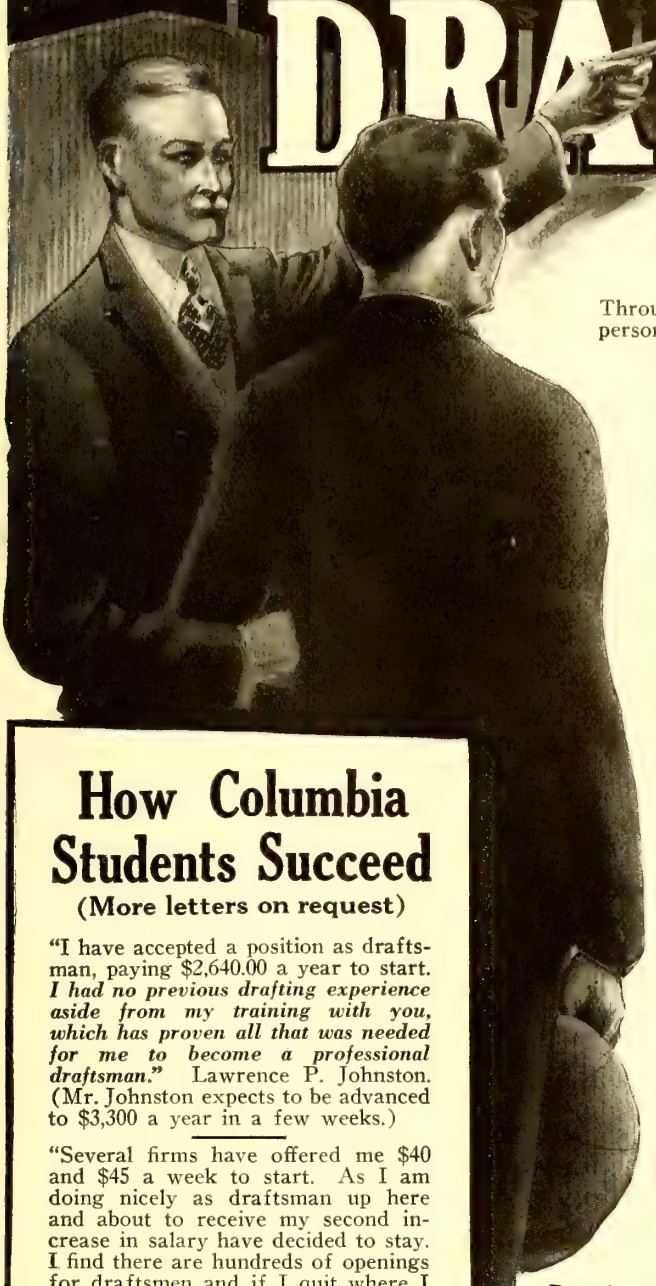
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All About Diamonds

(*Continued from page* 1172)

plate, one very strange fact noticeable is that large sparks may be drawn from the plate and are seen to fly to other metal parts. These are at least about one inch long. This typical static electric discharge comes from nothing apparently, the only explanation perhaps being that it is due to friction of the diamond against the rapidly revolving iron plate. Care must be taken that the iron plate does not have any irregularity in it, as this would result in a poorly cut diamond. The disc if necessary is scored with sand stone to make it smooth on another lathe.

Strange to say, altho many companies have put small diamonds on the market, very few have continued to follow the same line of "cut" thruout. At the firm where these photos were obtained the smallest diamond up to the largest is absolutely perfect and has 58 facets; and hence a stone of this nature would naturally be more expensive, but the slight expense for the cutting of the facets is shown markedly, if any attempt is made to resell the stone.

There are several methods of cutting stones. The *brilliant* being the finest example of the diamond cutter's art. This cut is specialized in by this concern. First is the *cabochon* or *baldpate* cut. This is a very simple cut and can be round, oval, square, cushion, or heart-shaped. The thickness is about one-half the spread in transparent stones. This cut is generally used in opals. It has a very quiet beauty of color and saves considerable weight of the stone. Sometimes in the transparent stones the bottom is slightly concave. In the *rose cut* the thickness is about one-half the spread. It is circular on the bottom and nearly pointed at the top (see illustration). It presents 24 triangular facets on its surface.

One strange fact, however, is that altho fairly brilliant, its brilliancy is dispersed and scattered. We next come to the *step cut* of which so many stones are examples. It needs practically no explanation, a glance at the diagram making this clear. We now come to the *brilliant* to which a great deal of science and skill has contributed an immense quantity of knowledge. It has been found that a back slope of a brilliant must be of a definite inclination, so that no considerable amount of light can strike more steeply than 24 degrees in order to obtain complete reflection. Likewise the angle formed between the girdle (which is the thin knife-like edge used to fasten the stone into a setting) and the sloping side for the top should be about 35 to 37 degrees and 41 degrees for the back angle. These two measurements have been found to be best. In regard to *lumpy stones,* it has been found that attempts to sell these are increasing over stones of good qualities. The reason is that the stone thus formed gives greater carat weight, but a stone of this nature is not to be desired. Sometime the thickness will cause it to leak light in the center and hence a *well* or a *dark spot* is formed. On the other hand there is not sufficient reflection if the stone is too thin and it lacks brilliancy.

The *briolette* is a pear-shaped gem drilled at the narrow end and worn as a pendant.

A FEW FACTS WORTH REMEMBERING.

We have already spoken of *paste jewelry,* but not the various forms. In glass, the edges are not very sharp, which is one of the essential differences between that and

(*Continued on page* 1176)



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"Well, I did my best at my routine work, but I soon realized that if ever I was going to get ahead I must not only do my work well, but prepare for something better. So I wrote to Scranton and found I could get exactly the course I needed to learn our business. I took it up and began studying an hour or two each evening.

"Why, in just a little while my work took on a whole new meaning. Wright began giving me the most particular jobs—and asking *my* advice. And there came, also, an increase in pay. Next thing I knew I was made assistant foreman of a new department. I kept right on studying because I could see results and each day I was applying what I learned. Then there was a change and I was promoted to foreman—at good money, too.

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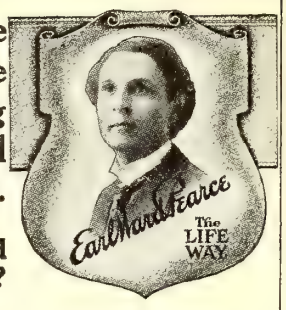
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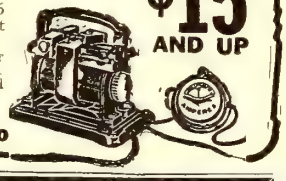
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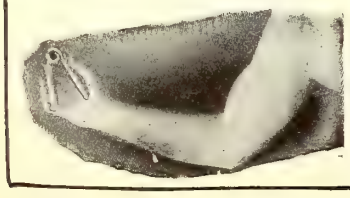
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Prof. A. BARKER, D. C., Studio 6100, 127 W. 42nd St., N. Y.

All About Diamonds

(*Continued from page* 1174)

the diamond. However, advantage of the *doublet* and *triplet* formation of stone is taken and very often the stone may be genuine in its top table or in the entire top,—the bottom, nevertheless, being of some spurious, worthless imitation. If a stone of this nature is placed into oil, the oil prevents reflection and refraction, and two distinct colors may readily be seen which of course, verifies the suspicion that the stone was not genuine. Some African stones likewise have been found to fluoresce in the dark, due perhaps to some radioactive material contained therein. This is particularly evident if the stone after having been exposed to an arc light, is rubbed on a piece of wood and then is placed in a dark room. It has been asserted and proven that color in the diamond is changed by allowing radium to act upon it.

SPECIFIC GRAVITY TESTS OF DIAMONDS.

One of the finest tests and practically invaluable is the *specific gravity* method of determining the value of stones. For this purpose a delicate chemical balance will be necessary capable of weighing in carats and fractions of carats. The method of procedure is as follows: A fine wire is suspended from one side of the balance, it having a small pan attached to one end. This is weighed in air and then in water. Now the diamond is placed upon this pan and it is again weighed in air and water; the respective weights of the wires being subtracted in both cases in order to obtain the actual weight of the diamond.

Now by subtracting the weight in water from the weight in air, we obtained the loss of weight in water and then determined the specific gravity.

$$\text{Sp. Gr.} = \frac{\text{Weight in air}}{\text{Loss of weight in water}}$$

Let us take an example:

Suppose the wire and pan weighs ..... 2 in air
And weighs ..... 1 in water
Diamond, pan, etc., weighs....12 in air
Diamond, pan, etc., weighs.... 9 in water
Subtracting weight of wire and pan in each case we get:
(a) Weight of diamond in air..... 10
(b) Weight of diamond in water..... 8

Loss of weight in water (subtracting b from a) =..... 2

$$\text{Sp. Gr.} = \frac{10}{2} \text{ or}$$

Sp. Gr. 5

By referring our results to the table herewith we can readily determine the specific gravity for each stone, and in this way determine precisely, to a great extent, the type of stone under test.

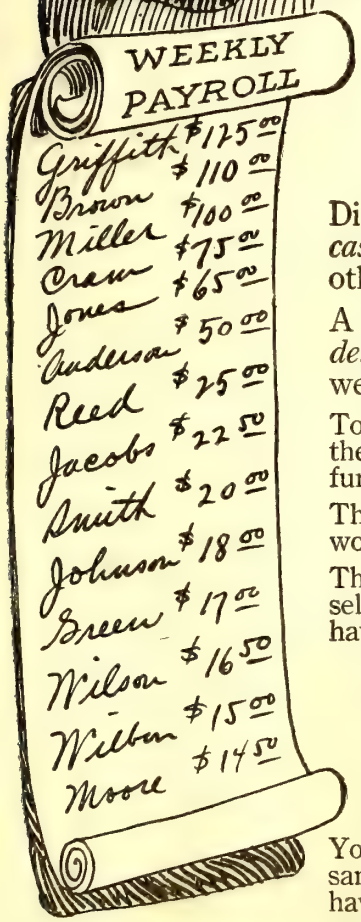
Beryl (Emerald)	2.74
Chrysoberyl (Alexandrite)	3.73
Corundum (Ruby, Saffire, Oriental Topaz)	4.03
Diamond	3.52
Garnet (Pyrope)	3.78
Hessonite	3.61
Dematoid or Olivine	3.84
Almandite	4.05
Opal	2.15
Peridot	3.40
Quartz (Amethyst Common Topaz)	2.66
Topaz (Precious)	3.53
Kunzite	3.18
Turquoise	2.82
Zircon	4.20–4.69

In addition the specific gravity of a stone

(*Continued on page* 1178)



C. O. D.



Did it ever occur to you that all salaries are paid on a C. O. D. basis—*cash on delivery?* It is the only plan on which salaries can be figured, otherwise business would be very uncertain.

A man who is only worth $25 a week cannot expect more until he can *deliver more.* The man who can deliver service worth $75 or $100 a week to the boss expects it—*and gets it.*

To the fellow who has never stopped to think the matter over it must seem that the men who draw big pay are either "lucky" or have a "pull." Nothing is further from the truth, for "luck" and "pull" cut no ice on any payroll.

The amount on your pay check represents in cold figures just how much you are worth on the market—how much you know and *how much you can deliver.*

The men who are at the top of the payroll are there because they fitted themselves to deliver the service they are drawing big pay for. This is all you have to do to increase your pay.

RAISE YOUR OWN PAY

You can raise your own pay by increasing your delivery of service. You can easily do it—just as thousands of American School students have done—by devoting a part of your spare time to practical training. One hour after supper each night will do.

Employers won't show workers how to deliver more—but they are willing to and do pay real money to those who know how to deliver a maximum of service.

We know we can increase your delivery and are willing to guarantee ***our service*** to ***satisfy you*** or we will ***refund your money in full.*** Take ten lessons before deciding whether you wish to continue. You risk nothing, so let us know in the Coupon in which line you want to deliver more—and earn more.

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Dept. G-263, Chicago

TRAINING—THE KEY TO SUCCESS

Please tell me how I can qualify for the position marked X.

.....High School Graduate	.....Business Manager
.....Automobile Engineer	.....Cert. Public Accountant
.....Automobile Repairman	.....Accountant and Auditor
.....Airplane Mechanic	.....Bookkeeper
.....Electrical Engineer	.....Stenographer
.....Electric Light and Power Superintendent	.....Fire Insurance Expert
.....Hydroelectric Engineer	.....Sanitary Engineer
.....Architect	.....Master Plumber
.....Building Contractor	.....Heating and Ventilating Engineer
.....Civil Engineer	.....Gen'l Education Courses
.....Structural Engineer	.....Com. School Branches
.....Mechanical Engineer	.....Lawyer
.....Shop Superintendent	.....Telephone Engineer
.....Steam Engineer	.....Western Union Courses
.....Draftsman and Designer	.....Wireless Operator
.....Photoplay Writer	.....Employment Manager
.....Foreman's Training Course	

.....

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Finish This Picture

Fill in the missing lines. See how close you come to the original drawing. The above picture was drawn by Student Wynn Holcomb. We have a great number of students and graduates whose work appears in magazines and newspapers all over the country.

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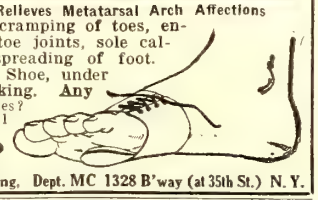
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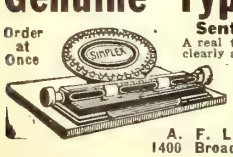
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All About Diamonds

(*Continued from page* 1176)

may be obtained roughly by testing with the following solutions. If the stone floats in the first and sinks in the second, its specific gravity is somewhere between the specific gravity of one and the specific gravity of the other.

(1) Methylene iodid, saturated with iodin and iodoform, sp. gr. equal to 3.6.

(2) Methylene, iodid sp. gr. 3.3.

(3) Methylene, iodid and benzene sp. gr. 3.

(4) Methylene, iodid and benzene sp. gr. 2.65.

MISCELLANEOUS FACTS ABOUT DIAMONDS.

Stones which resemble a diamond to a great extent are colorless topaz; zircon, rendered colorless by heating; white saffire; spinel; beryl, tourmaline and even rock crystal and other minerals. All of these are double refracting except the topaz and zircon, the diamond, likewise, being only singly refracting. Strass glass resembles diamonds most, but when tested with a file will soon show its "metal." It has been found that a yellow tint in diamonds frequently is concealed by the presence of a thin coat of some blue substance sometimes used in the mounting of a stone.

Concluding we can say that the diamond is composed of carbon entirely; it is cubic in crystallography, and its cleavage parallel to faces of the *octahedron being highly perfect.* It is the hardest stone known, its index being 10. It has a special gravity of 3.52 and it appears in colorless yellow, red, blue, brown, pink, green, and black variety; when pure it is perfectly transparent. Its refractive index is 2.439. It is singly refracting and found in material known as quartzose and conglomerate in India, Brazil, South Africa, and Australia.—*Exclusive photos taken by courtesy of Fera & Kadison Company.*

Huge Siphon Tidal Power Plant

(*Continued from page* 1121)

power development schemes, but in another short span of years, when coal has become so scant that its cost will be prohibitive, at least for power house generating apparatus, and when the natural oil and gas resources of the country have become greatly diminisht, then you will see hundreds of these plants being installed on every sea coast, or wherever there is a useful rise and fall of the tide.

ELECTRICITY FROM TIDAL POWER.

The turbines operated by the water flowing under a fairly high velocity thru the siphons in one direction or other, may be connected directly with dynamos generating electric current, which can be transmitted and distributed over hundreds of miles at a potential of 200,000 volts or more, or a series of turbines may be connected to common jack shafts, by a gearing or otherwise, and these shafts in turn coupled to a single large dynamo or two, mounted on the rising and falling turbine platform or pontoon.

In the illustration herewith, one method of conducting electric current from the rising and falling turbine-dynamo pontoon is shown. Here the pontoon carries a steel mast to which wires are brought from the dynamos located in the water-proof chambers of the pontoon and from this tower or mast, the wires lead over to another mast on the stationary wall, and thence they lead to step-up transformers in a distributing station where the current is raised to a very high voltage suitable for transmission purposes over long distances.



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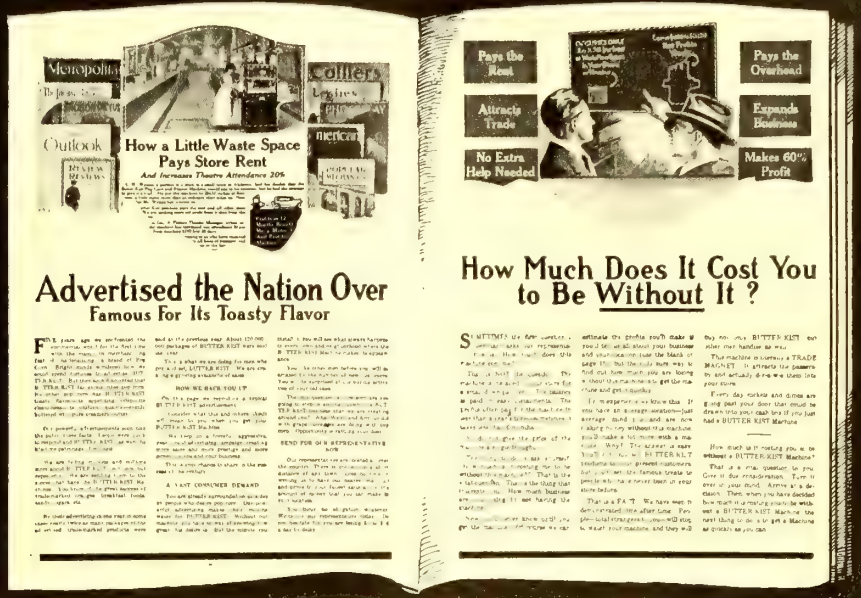
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"Not only made 49,015 sales of Butter-Kist Pop Corn the first year," writes W. O. Hopkins, a storekeeper in Evansville, Ind., "but my magazine sales increased 97 per cent through additional patrons brought in."

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"Have averaged over $90 a week," writes theatre owner in West Virginia.



Shows How to Make $600 to $3,120 from a Little Waste Space



Here is a book that will open the eyes of every retail merchant and theatre owner. It is called "America's New Industry." It is a startling revelation of the big money that storekeepers are making with the Butter-Kist Pop Corn and Peanut Machine. It shows letters written by the merchants themselves telling of the new profits and new trade the Butter-Kist Machine makes. It shows photographs of the machines in different kinds of stores. It proves to you in actual figures that the Butter-Kist Machine *does* pay $600 to $3,120 a year in extra net profits. Write for this book today. It is sent free and post-paid to every merchant who requests it.

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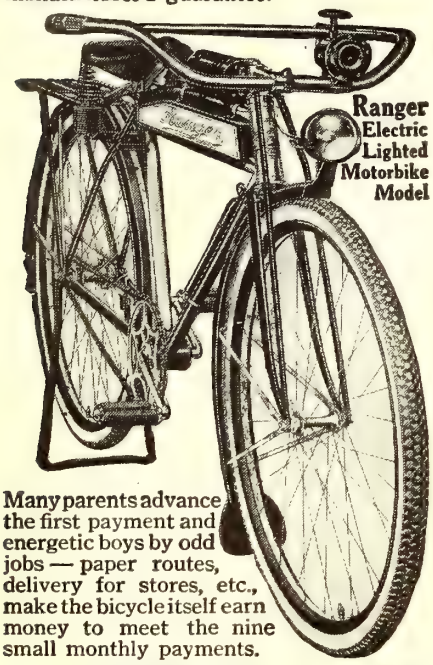
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The Electrical Machinist

By H. WINFIELD SECOR

(*Continued from page* 1151)

iron strip bent to a "U" shape and having two holes drilled thru the bottom of the "U" thru which screw eyes can be secured to the floor to hold it in position. Also there are two holes drilled thru the upper ends of the two sides of the "U" thru which a rod passes, which supports the spool.

This rod should have two holes drilled thru it on either side to accommodate cotter pins so that it will not slide out of place. Sometimes the iron support of this type is used to hold three or more spools of wire of different size, especially where the device is placed behind the lathe in a shop where a great deal of this sort of work is regularly carried on.

BANDING ARMATURES.

Figure 3 shows the process of armature banding. The armature core usually has grooves in its surface where the bands are to be placed, so that when they are finished their exterior surfaces will be flush with that of the core teeth proper. While some bands are wound over thin fiber or other similar insulating strips, the standard practice calls for a mica insulating band under the wire.

Banding mica, as it is commonly called, is a pure grade of mica of fair quality, measuring about 5" by 1", but several sizes of this mica are of course available from the mica supply houses. The thickness of the mica used will depend upon the size of the armature. A very thin piece of mica will do for small fan motor armatures, while for large armatures measuring one to two feet in diameter a much more substantial thickness of mica insulation must be used. The sheets of banding mica are first to be placed around the armature where the band is to be put in place, and these are overlapt a short distance as shown in the drawing—each successive piece of mica being held in place by a layer of friction tape, for example. One or two turns of the tape is first taken around the armature directly alongside of the spot to be occupied by the finished band, and then the operative proceeds to carefully place and bind on in position, with the tape just lapping over the edge, the successive pieces of mica. All of the mica insulation must be put in place first.

Having set up the stock wire spool and tension clamp, the banding wire (the sizes of which varies, of course, for different sizes of armatures, being small for small armatures and vice versa) is past thru the tension block, which is left loose so that the wire can be easily manipulated, and started on the armature core. Either on the lathe dog or on a piece of metal placed within one of the ventilating slots in the armature core or by some other means, the free end of the banding wire must be firmly secured. The armature, which is invariably placed in the lathe for this purpose, unless it is a very large one, is then given a turn or two, and one complete turn of the wire made on the mica.

At this juncture it is about time to put in place some small leaf copper or even thin brass strips, which are to be used in securing the band in place by soldering. The ends of these clips, of which a considerable number are put in place, depending upon the size of armature in hand, are eventually bent back over the banding wire, and thoroly soldered, as is the entire band, using a non-corrosive flux and a large soldering iron, as shown in Fig. 3, which is adapted to hold a great deal of heat, and which will not cool off quickly.

(*Continued on page* 1182)

ELECTRICAL—FIRES

are feared by all fire fighters. Water or ordinary chemicals are dangerous to use and have no effect on fire. A



NU-EX FIRE-KILLER

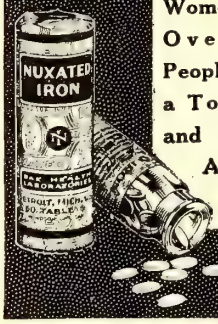
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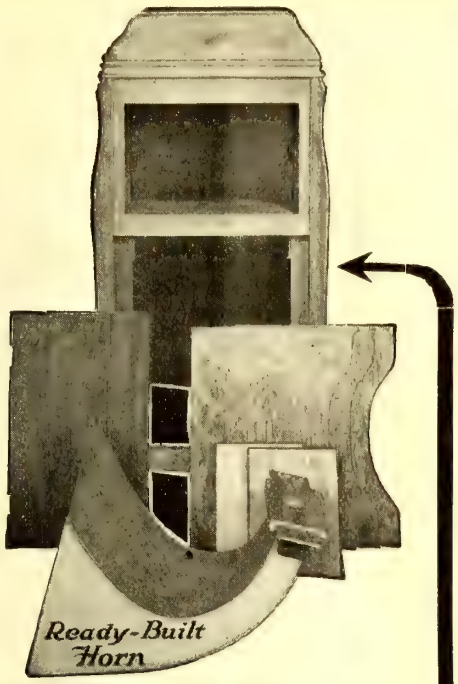
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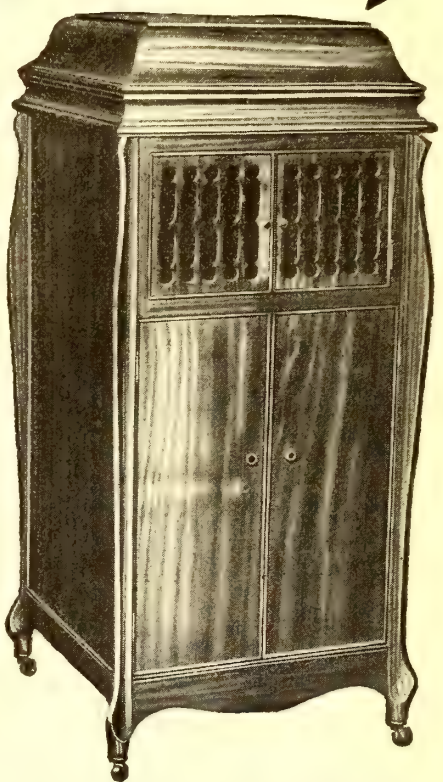
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The Electrical Machinist

(*Continued from page* 1180)

After the first turn of banding wire is put on, and the copper strips are in place, the tension block is tightened up more if necessary, and the successive turns of the band are wound on, side by side. Where the band is quite large, it is usually soldered every now and then, especially at the copper clips, as the winding proceeds. With the last turn of the band, the band in any case being always a little narrower than the mica, it is soldered all along its length and especially at the clips, with a good, hot soldering iron, so that the solder runs evenly along the turns. No lumpy solder should be tolerated, especially at the clips.

After the entire band has been soldered the ends of the clips should then be bent over, being cut in most cases so that they just meet evenly at the center of the band; these ends are prest down tightly and well sweated with the soldering iron, applying sufficient flux and solder of course. The start and finish of the band wire is usually terminated by clipping the wire on these two respective points a short distance beyond the nearest clip and bending the ends of the wires back about 1/16" along the side of the clip, altho in most cases the wire is cut even with the clip.

CANVAS HEADING OF ARMATURES.

The lead wires just back of the commutator are often covered or headed up with canvas or muslin. This trick is rather easy to perform, but it is rapidly going out of style due to the changes in design in armatures even of the smallest type. Fig. 4 shows some of the steps to be followed in heading up such an armature.

Large armatures require a piece of canvas, but small ones can be covered with a good strong piece of muslin. Unless the taper between the armature core and commutator is a very slight one, and if a decent job is to be done, then the cloth or canvas must be cut similar to the way in which lamp shades are cut, that is, in the form of a ring with a segment cut out.

For those interested in the exact procedure for the cutting of such a head to the right size, so as to make a smooth job, we would refer them to any elementary text-book on geometry, or also books on tin-smithing, as this is one of the first "tricks of the trade" that every tin-smith and sheet metal worker must learn.

The cloth head is not shellacked until it is put in place, and is often supported by a piece of paper or metal which has been cut, let us say, to approximately the proper fit, such as by cutting a templet or pattern of paper, which is laid under it. The cloth is first laid in reverse fashion around the commutator or held in place with a piece of cord temporarily. A substantial string band, not wire (which would soon cause short-circuiting of the coil leads), is wound around over the canvas and leads. This is given a coat of shellac and the cloth is then turned back over the cord, giving a very neat appearance, and is then pulled up over the armature core.

The cloth must be pulled or held very tight of course, as the banding proceeds, and if this is done carefully and thoroly a very satisfactory job will result. It is usual to simply lap the cloth where the longitudinal joint comes and to sew this up after the securing wire band has been finally put in place—but some prefer to sew it up along the joint between the commutator and the core, and "fit it," so to speak, before the wire band is put in place.

Now it is time to give this cloth head a coat of thin shellac which will cause it to shrink up in good shape.

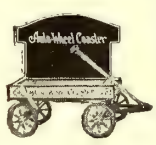
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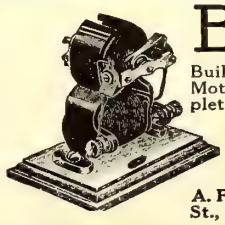
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What To Invent

By JAY G. HOBSON

(*Continued from page* 1162)

For the purpose of suggesting a possible plan for accomplishing this result, I have designed what I believe to be a practical machine in every phase of operation.

Figure 1 shows the front view of my machine. No. 1 is the concrete foundation, No. 2 is the cast iron base, No. 3 is the frame proper of the walnut-branding machine, No. 4 is the large wheel embracing the drive pulley, hollow spokes, center vacuum hub and automatic stampers attached to each individual spoke of wheel No. 4. No. 5 is the drive pulley for operating wheel No. 4. No. 6 represents the hollow spokes, No. 7 is the metal frame forming a cap for the hub of the wheel No. 4. No. 8 is the electric motor that drives wheel No. 4. No. 9 is the vacuum machine that furnishes required amount of vacuum suction for hub No. 7 and spokes No. 6. No. 10 is a large pipe connecting No. 9 with No. 7. No. 11 is the automatic stampers or branders which press down on walnuts at the proper time, thereby printing the desired trade-mark. No. 12 is the rod or shaft that operates No. 11. No. 13 is the opposite motion of No. 11. No. 14 is the receiving hopper for walnuts after having been branded. No. 15 is the delivering hopper which feeds spokes No. 6 at their periphery. No. 16 is the automatic inker that re-inks each stamp. No. 17 are the walnuts before being stampt or branded. No. 18 is walnut in process of being branded with desired trade-mark. No. 19 are walnuts after being branded with red indelible ink. No. 20 are small coil springs secured between small stamp pads and screw head on rods, No. 12. No. 21 are small rubber letters that stamp the desired trademark on walnuts.

The plan of operation of the above machine is as follows: When it is desired to brand walnuts, the feeding hopper No. 15 is filled with nuts. Then the vacuum machine is turned on, together with the electric motor. Large wheel No. 4 is now turning rapidly. The vacuum or suction pulls thru pipe No. 10, hub No. 7 and spokes No. 6. This strong suction causes walnuts in hopper No. 15 to adhere to each spoke passing thru the hopper. After spokes have passed above hopper No. 15, the small stamps No. 21 are caused to lower upon the nuts and are held tightly there until the other side is reached, when just before receiving hopper No. 14 is reached, the half-circle shaped trackage No. 25 recedes and permits spring No. 29 to pull stamp No. 21 up off the walnut. At the same time the half-moon shaped valve inside of hub No. 7 covers inner openings of spokes No. 6, thereby closing vacuum suction and walnut falls by gravity into receiving hopper No. 14.

Small stamps No. 21 proceed downward and are re-inked by automatic inker No. 16. Valve No. 23 shuts off vacuum on spokes No. 6 when they are passing under, which allows the entire vacuum force to be exerted on open tubes at the top, making for higher efficiency in operation of walnut brander. The capacity of this machine can be increased as desired by increasing the number of spokes and stamps of the wheel proper.

I thoroly tested out the vacuum principle of picking up and holding walnuts while being branded, and found it works perfectly. If my readers will utilize the power of vacuum in their designs, I feel certain success will crown their efforts.

(This is the second article on inventive suggestions by Mr. Hobson. The third will appear in an early issue.—EDITOR.)

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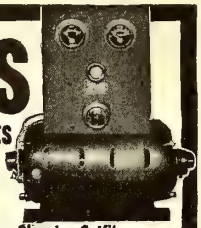
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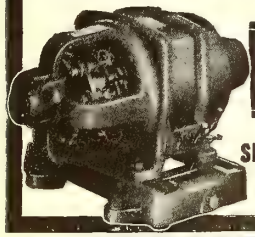
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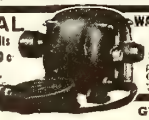
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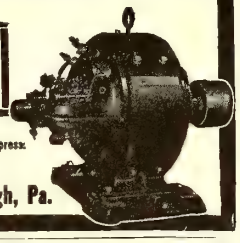
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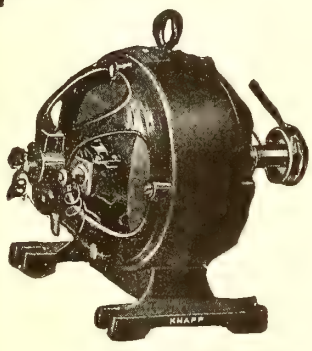
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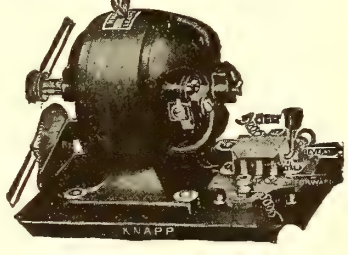
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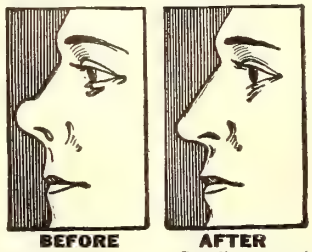
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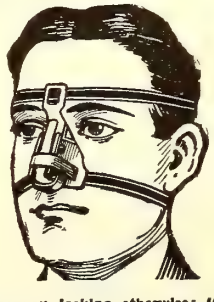
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WOMAN RADIO OPERATOR GETS CAPTAIN'S O. K.

"Thank goodness I wasn't seasick. I should never have heard the last of it," said Miss Cora T. Weber, the first woman radio operator to sail from the port of Philadelphia. She recently returned from a trip feeling "perfectly dandy," and best of all, she returned with the hearty congratulations of her captain, Edward Page.

"Miss Weber's work is excellent. I hope she will be on my ship again," said the captain, when the good ship *Grecian* docked recently.

"If I'd known I would have so much written about me, I never would have taken up this kind of a job. But I certainly do love my work. They want me to go to Baltimore to instruct in a radio school which has just been opened, but I've gotten the salt air in my nostrils and I know I'm going to turn into a regular old sea-dog, whatever that is," she smiled. "I've been offered a chance to go to Jacksonville for my next trip, and I would like to take that."

Miss Weber has gotten everything she wanted very badly, so she probably will have the honor of being the first woman operator on one of the big ocean liners too. She graduated from the Chambers School, Philadelphia, the only girl who had the courage to keep at it, out of a large class entered. Her grade in examinations was 97, and she got her first ship soon afterward.

$25.00 For A Poem

(*Continued from page* 1157)

But hist! "Whence come you little Audion? How came you to be cast upon the unhospitable sea? Your filament, your grid, your plate, ALL remain intact—only bent out of shape a bit, but you still can sing your electronic song. So we know that you were not cast upon the sea by a radio operator with murderous designs upon your frail life. Then what? Alas, you remain silent, while we gaze upon you. Were you wrecked at sea, did you go down with the ship? Did you hear your master send out his last S. O. S.? And did the ethereal reply of the responding steamer pulse thru your 'excited' body? But perhaps succor was too late, and your master was carried to the deep, clutching you in his right hand, till death parted you? Ah, we fain would know, but still you are silent. . . ."

Thus prompted we take recourse to soothing poetry, wherewith we flee to Edgar Allen Poe:

"Then this Audion-valve beguiling my
sad fancy into smiling,
By the grave and quiet decorum of the
countenance it wore,
"Tho thy grid is warpt and bent,
which De Forest did invent.
Audion! By what accident wert thou
thrown upon the coral shore?
Tell me what thy secret is on this
ether-throbbing shore?"
Quoth the Audion, "Nevermore!"

So you see the Audion either won't or can't tell its secret. Therefore we call upon our radio poets for the best poem explaining the deep mystery.

There are no rules, except that the poem must be a first class one. Dr. De Forest as well as several well-known poets will decide which poem is entitled to the $25.00 prize. We hope it will be a classic—and for that reason it must not be too technical—and not too lengthy, please.

The contest closes June 10, 1920.

Address all poems to:

Audion Poem Editor, care of this publication.

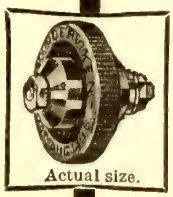
SKINDERVIKEN TRANSMITTER BUTTON

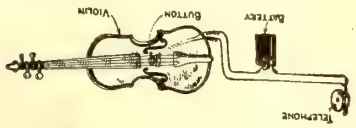
MOST SENSITIVE MICROPHONE

FOR $1.00

YOU can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

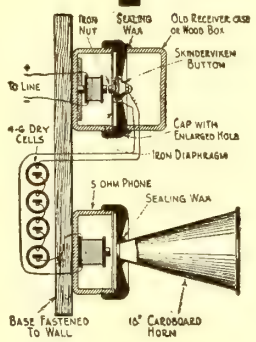
You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *This outfit was used by secret service operatives during the War. It is being used on the stage.*


Actual size.



So much for its commercial adaptations! *You* can procure apparatus of the same type.

One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons cannot be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.



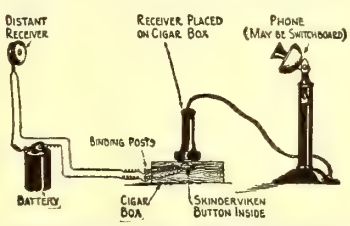
Full directions for connecting up the button for use as a detectophone are given in booklet which is sent with each button.





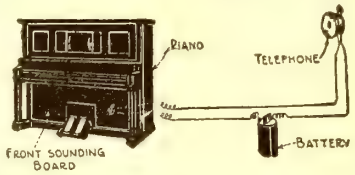


The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.



AMONG electrical experimenters the button has created a sensation. It is not uncommon to receive unsolicited letters like these: "I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

"I have been using one of these transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimenting." "I have been using one of these transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"

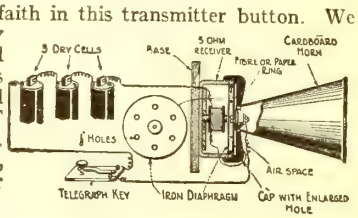


Mr. H. Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In the writer's opinion, obtained by actual elaborate tests, the Skinderviken Transmitter Button is probably the most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

We have the utmost faith in this transmitter button. We guarantee satisfactory service or we will refund the purchase price. Boys—Young and old—send in a dollar bill RIGHT NOW! You can't lose. If you're not satisfied, you receive your dollar back. Isn't that fair?



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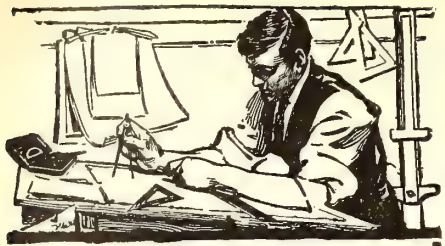
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New Researches in Gravitation

By QUIRINO MAJORANA

(*Continued from page* 1124)

What we see here as a delicate laboratory experiment may give us an idea of phenomena as grand as those of the attraction generated by the stars.
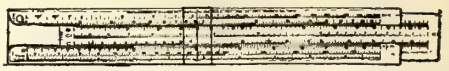
Now the Newtonian force is a sort of action at a distance, governed until now by a rigorous law. No special contingency has yet sufficed to weaken the rigor of that law. To explain this, I want to examine the other laws that seem to offer an analogy with that of Newton; these laws are those that govern the propagation of action at a distance. Known actions at a distance are often propagated through some medium. Thus the attractive action between two electric masses, that between two magnetic masses, those of electromagnetism, radio-telegraphy; those of optics, etc. All of these have principally a vibratory character, and it is admitted that the presence of a medium of propagation is necessary for their production. This medium is usually the cosmic ether. But as regards the propagation of such actions as these it is observed that when the medium is changed the measure and quality of the observable phenomena change also. Thus, if in the electric and magnetic phenomena we substitute some material substance instead of the merely hypothetical ether, the action is changed or is reduced as a consequence of the so-called electric or magnetic permeability of the medium. Then there are actions of a mechanical and others of a calorific nature which are not propagated in a vacuum (ether) and which need a material medium. From which we may conclude that all known action at a distance is in its manifestation dependent upon the nature of the medium.

For universal gravitation alone nothing of the sort has yet been found. The Cavendish balance always gives the same result, even if the medium thru which the forces of attraction are manifested be not the air but for example a heavy body like a lump of lead. An experiment performed by Laager several years ago was as follows: He weighed a sphere of 1.5 grams of silver, first free and then enclosed in a ball of lead of several kilograms. See Fig. 1. He figured that gravitation, having to traverse the lead in order to reach the silver, might be weakened somewhat and hence the silver weigh less. The result was negative, showing no variation in the weight of the silver greater than 1/100,000 of its weight, this being the limit of sensitiveness of the apparatus.

Laager's experiment may have confirmed the physicist's belief in the accuracy of the Newtonian law; but this is not necessarily correct. In fact, have we the right to believe that if the experiment were so modified as to make it more delicate and sensitive we should always obtain a negative result? Must we believe that if there were a means of determining the mass of the silver sphere when surrounded not by a few kilograms of lead (as in Laager's experiment), but by a mass like that of the earth, it must be unaltered? It seems to me not. And there remains the suspicion that the interior masses of such enormous agglomerations of matter as the earth and the sun may conceal more matter than appears to the astronomer. I should postulate a sort of progressive absorption of the force of gravitation. Considerations that would take too long to go fully into here make me hold that a certain flux of energy

(*Continued on page* 1190)

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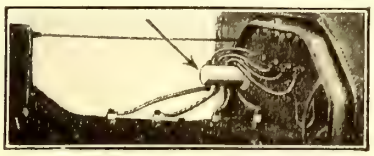
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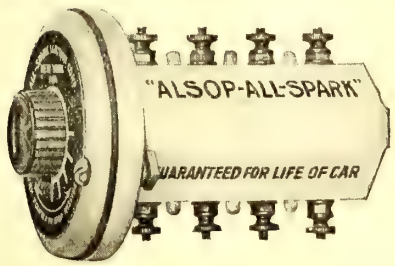
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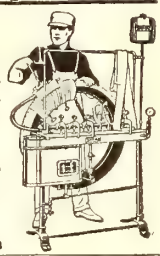
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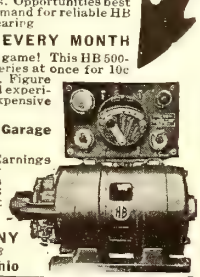
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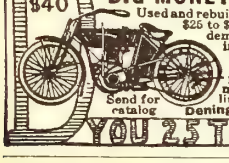
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New Researches in Gravitation

(*Continued from page* 1188)

is let loose from matter, and that this flux on coming into contact with other matter generates the force of attraction.

We may have a model of such a phenomenon by considering the phenomena of luminosity. A source which emits light appears enfeebled if there be matter intercepting the passage of the rays. Thus the rays of the sun reach us weakened by the air, or even more so still by water when observed from the bottom of the sea. Naturally, very thin layers of air or water do not weaken them, just as the force of gravitation is not weakened in Laager's experiment. The masses of the stars may be only apparent, since the force of attraction of their inner strata does not entirely issue forth. See Fig. 2. And each mass of matter would thus be characterized by a certain amount of *true mass* and another of *apparent mass.*

But, I may be asked, how do you explain that matter continues to emit such a flux of energy? Whence is it derived? For then the principle of conservation of energy is not respected, since you say that matter emits this flux indefinitely; hence the reserve of energy possest by matter must be infinite, which is absurd. To such an observation I answer by recalling the modern theories of corpuscular physics and the properties of radium. It is well known that this substance emits energy (electric and calorific), and that it is predicted that this phenomenon will continue for about 2,000 years. No more than that, for the radium is transformed. But the amount of energy that we may suppose to be emitted by any matter in a given time may be far less than that of radium; therefore, we must formulate our hypothesis by saying that any kind of matter must finally be transformed, just as in the case of radium. Therefore, it is to be held that while radium is transformed in 2,000 years, other matter requires millions or billions of years.

All this, however, leads us to another consequence. The energy emitted by matter and then absorbed must necessarily be transformed. Hence the formation of heat when notably large quantities of matter are in relations. We shall return to this towards the end.

Analytical Researches: All that precedes is hypothetical; it might be well to have an experimental verification of it. Now if the phenomenon of gravitational absorption is present in nature, it must be, to be found, preferably in the case of the larger agglomerations, the sun, for example. This star has a mean density of 1.41. One might make the hypothesis that this figure is only apparent and that its true density is actually somewhat greater.*

Is it possible to verify this?

I say it is; in fact, I have done it. I made use of a sensitive balance in a vacuum, each arm of which was laden with a leaden sphere of about 1.3 kilograms. One of the arms (that on the right) is situated at the center of a cylinder that can be filled with 104 kilograms of mercury. This adjustment is made with the greatest accuracy, so great that it may be held that the resultant action of the

*The problem is here treated by mathematics, by the author in his original paper, which tends to show that sun, for example, may have an apparent density, as known to astronomers, and a true density, having a value considerably greater. In other words the true density is not apparent by direct observation, but may be calculated from such experiments as those carried out by the author. He shows mathematically that the "true density" of the sun is 3.27 compared to its observed or "apparent density" of 1.41. The apparent density divided by the true density gives a ratio value of 0.433; or in other words the astronomically observed density of the sun is but .433 of the true density of that body.

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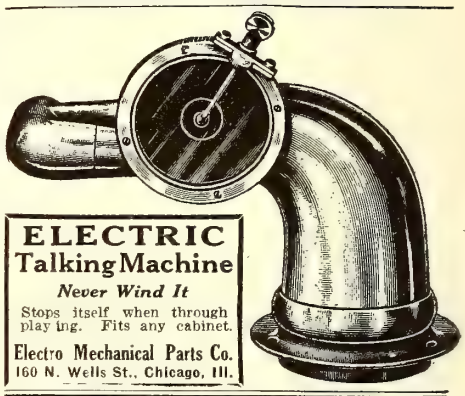


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mercury upon the ball of lead is exactly nothing. By observing with a microscope and scale, variations of weight as small as 1/1700 of a milligram can be detected in the balance. By causing the mercury to flow in and out of the cylindrical receptacle, and allowing for any causes of error into which I will not go here, I discover that the ball of lead diminishes in weight by about one billionth of its weight when it is surrounded by mercury. See Fig. 3. (It is not necessary to remark that the mercury does not touch the lead ball, this being adequately protected.)

This variation is actually due to absorption of the force of gravitation. In fact, the two chief accidental causes of error (calorific perturbations and asymmetry of mass) have been accurately eliminated. As to the first, I observe that the flowing in and out of the mercury can have no influence upon the temperature of the arm of the balance, since this is in a vacuum, protected by a thick metallic case covered with three layers of felt. Besides, the mercury, which is contained in suitable receptacles, cannot have a temperature differing from the balance by more than 1/10 of a degree more or less. The receptacles of the mercury are quite distant from the balance-arm. Finally, if the proven effect were due to such causes of error, it would not show itself always with the same sign. The four or five thousand observations of oscillations all agree as to sign. Asymmetry of mass might have caused a false effect if it had depended, for example, upon an error of about 4 m/m in the adjustment of the mercury to the ball of lead. But this adjustment was made with a precision of from one to two tenths of a m/m; hence such an error is impossible.

The proven variation in weight permits us to determine with fair approximation the value of h, the constant of amortization by unity of mean thickness and by unity of density. Thus we have $h = 6.18 .10^{-12}$. Knowing h, it has been possible to determine the relative density values for the sun, since its apparent density and the diameter (7.10^{10} cm, or 700,000 kilometers) are known; and finally, its true density, which remains fixt at 3.27, *that is, more than double the apparent or astronomic density.*

Unless there be causes of error that I do not know, my theory has thus a brilliant confirmation from experiment. It may be that my results are only approximate, but I hold that the new phenomenon of gravitational absorption really exists.

The experiment performed by me is exceedingly delicate; to be able with absolute certainty to exclude every possibility of concealed error, it will be necessary to repeat it under conditions in which the effect will be more conspicuous. For this purpose I have begun the construction, here in the Politecnico (at Turin) of two strong swinging armatures each of which will support five tons of lead ingots. I expect to get from this apparatus an effect about ten times as great as that already found.

In addition to this, in conformity with all the theory I have expounded, I am preparing an experimental apparatus to ascertain if matter is really heated in consequence of the earth's gravitational flux.

I shall report the results of both experiments in due time. But in the meantime I cannot resist the temptation to apply the foregoing results to the interpretation of celestial phenomena.

A first application has been made implicitly with the assertion that the sun's true density is double its apparent density. So in certain cases we could determine the true density of other celestial bodies. Those of the planets and their satellites would certainly differ very little from their apparent density; while in the case of the other suns of the universe, if the determination were possible, the differences would be quite noteworthy.



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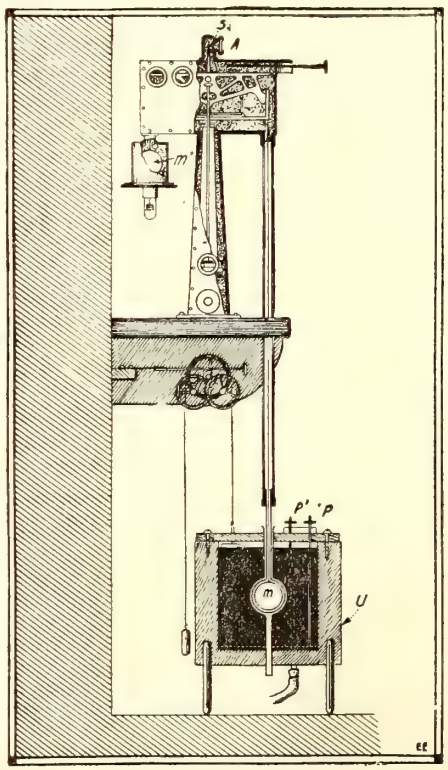
But the most important consequences which the present theories would have refer to the formation of the heat of the stars. Altho up to now I have not executed any experimental control of the following hypothesis, I hold it to be highly probable. The stars would generate, continuously and spontaneously, new quantities of heat, and this the more notably the greater their true mass. Reasons upon which I will not dwell make me hold that the quantity of heat developed by a star in a determined time is proportional to the square of its true mass. This hypothesis finds confirmation in a comparison of the sun's heat with that proper to the earth.

I do not exclude, however, that in some or in many cases the heat of the stars may not depend at least in part, upon facts corresponding to the old theories: heat occasioned by cataclysms that took place at more or less remote epochs, or due to Helmholtz's contraction. But, according to my ideas, these causes could only add their effects to the new cause that I have suggested.

As I have already said, both the hypothesis of gravitational absorption and the other of the emission of heat would lead us to the consequence of a progressive transformation of matter. Perhaps this is degrading in its energy; how and for how long it is not yet possible to say. Certainly, if such degradation exists it corresponds to a slow transformation of matter itself. Perhaps it is passing from states of complex atomic agglomeration to others more simple, as take place in the case of radium. But this has little importance for us.

What, instead, is most important is the discovery of a new cause for the generation of heat by the stars. This enables us to conciliate the existing controversy between the physicists and astronomers on the one hand and the geologists and biologists on the other. In other words, the theories I have set forth would contribute in a most important way to the interpretation of the life of the stars in general and of our life in particular.

Lecture delivered by Prof. Quirino Majorana, at the Società di Fisica, Turin, December 4, 1919.



The Actual Apparatus Used by Prof. Majorana, in Determining the Decrease in Weight of a Lead Ball Surrounded by Mercury.

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The Positions of Atoms in Metals

By Dr. A. W. HULL, Ph.D.

(*Continued from page* 1134)

compound, containing only two kinds of atoms, whose structure is so simple that it cannot be misunderstood. Examples of this type will be included in the following discussion.

I have referred to the location of atoms as next to last in the series of atomic discoveries. For in order to complete the picture, one more discovery is necessary, *viz., the shape and size of the atom.* An excellent beginning in this direction has already been made by Langmuir whose theory of atomic structure predicts the shapes and relative sizes of all the atoms, and gives strong chemical evidence in favor of these predictions. The author hopes soon to be able to add the evidence of X-ray measurements, which will determine not only the shape but the exact size of the atoms, that is, the positions of the electrons in the atoms.

Summary of Results. The most striking result of these investigations is the extreme simplicity of arrangement of atoms in common metals. Among the metals thus far examined only three types of atomic arrangement are found, and these are, with one exception, the three simplest geometrical arrangements known. The simplest arrangement of all is not found among metals, but is characteristic of salts, which are composed of equal numbers of positive and negative ions.

The most common arrangement in metals is the *face-centered cubic* arrangement shown in Fig. 1. This is also the most important since most of the useful metals,—*e.g.,* aluminium, nickel, cobalt, copper, silver, platinum, gold,—have this arrangement of atoms. Perhaps it would be better to say that those substances are most useful as metals which have this arrangement, since, as will be shown later, their ductility is due largely to this arrangement.

The face-centered cubic arrangement is obtained by dividing the space occupied by a single crystal or "grain" of metal up into a system of equal, closely packed cubes (Fig. 1) and placing an atom at each cube corner and at the center of each cube face. All the atoms in this arrangement, both corner and face atoms, are similarly situated as regards symmetry and relation to neighbors. Each atom is surrounded by twelve others, all equidistant and exactly similarly situated for every atom. It is this high degree of symmetry, combined with the close packing, that makes substances of this type so ductile.

The Measuring Machine. The determination of these atomic arrangements requires the measurement, in as many different directions as possible, of the distance between consecutive *planes of atoms.* The arrangement of atoms, whatever it may be, is assumed to be a regular one which repeats itself thruout the crystal. This assumption can be checked by the result. Thru such an arrangement a system of equidistant parallel planes can be drawn in any direction whatever so as to pass thru all the atoms. In most directions, these planes will be very close together and sparsely settled with atoms. In a few particular directions, however, they will be far apart and densely populated. These are the directions of easy cleavage and gliding. It is these densely populated planes whose distances apart are measured.

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this paper were made with a modified form of Bragg machine. The original machine was applicable only to large perfect crystals, required careful manipulation, and was subject to serious error unless the crystals were very perfect and the number of observations large. The author's modification is free from these errors, requires but one simple observation, and is applicable to all substances which are crystalline, *i.e.*, all in which there is any arrangement to measure.

The complete machine is shown in Fig. 2. It consists of a small transformer (or other source of high potential) capable of supplying 1 kw. at about 30,000 peak volts; a Coolidge X-Ray tube, X; a thin sheet of properly chosen material, f, serving as filter; a pair of slits, s_1 and s_2, in metal sheets, to limit the beam of X-rays; a tiny glass tube, T, containing the powdered substance to be measured; and a photographic plate or strip of film bent in arc of circle, F. The operation consists in filling the glass tube with a few milligrams of the substance to be analyzed, powdered as finely as possible; "loading" the photographic film holder; exposing over night to X-rays at 30,000 peak volts and as many milliamperes as the tube will carry safely without watching (a maximum exposure of 300 milliampere hours) and developing the film.

A typical photograph is shown in Fig. 3, and this is a photograph of aluminum filings, taken with a plate and very short slits, so that the trace of the direct beam in the center of the plate is a circular spot. The circles and lines are due to the "reflection" of the X-rays by the tiny crystals in the tube, as will be described later. The distances of these circles or lines from the central line on the film are nearly proportional, inversely, to the distances between the planes of atoms, and from them these atomic distances can be easily and quickly calculated.

The Measuring Rod. The measuring rod by which these atomic distances are measured is the wave-length of a particular X-ray.

The possibility of measuring the dimensions of any physical body depends, primarily, upon the possession of a measuring rod of length comparable with the dimensions to be measured. Thus, the discovery and calibration of wave-lengths of visible light opened up a whole new field of measurements, comparable in length with this new measuring rod, such as the thickness of films, imperfection of polished surfaces, displacement of vibrating membranes, increase in length due to thermal expansion, etc. In the same way, the discovery that X-rays are of the same nature as light, and the isolation and calibration of X-ray wavelengths, opened up a vast new field of measurements of dimensions comparable with the wavelength of X-rays; *viz.*, atomic dimensions.

We are accustomed to think of the measurement of things too large or too small to see and touch as necessarily very rough and approximate. It is somewhat of a surprise, therefore, to note that the only measurements accurate enough to justify the use of eight-place logarithm tables are those of astronomy; that wave-lengths of light are measured to 1 part in 10,000,000; and that the wave-lengths of X-rays, and by means of it, the distances between atoms, can easily be measured to 1 part in 100,000.

The spectrum of X-rays is exactly like that of *visible light* except that the wavelengths are shorter. It consists of bright lines superimposed upon a continuous spectrum. The wave-lengths in the X-ray spectrum depend upon anode material and voltage in exactly the same way that the wave-lengths in the visible spectrum depend upon incandescent material and temperature. And just as it is possible to obtain nearly monochromatic yellow light by putting salt in a flame under proper conditions, so by running an X-ray tube

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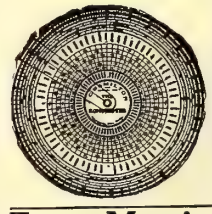


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with proper anode at the right voltage, it is possible to produce a single wave-length (line) of such great intensity that practically all the rest of the spectrum can be absorbed by a properly chosen filter, leaving nearly monochromatic X-rays. It is in this way that monochromatic X-rays used in these measurements are produced. The measurements described in this paper were made with X-rays from a molybdenum target operated at 28,000 volts constant potential, and the filter was powdered crystal zircon, pressed, with a small amount of organic binder, into a sheet ¼ mm. thick. The X-ray wave-length thus calibrated can now be used to measure atomic

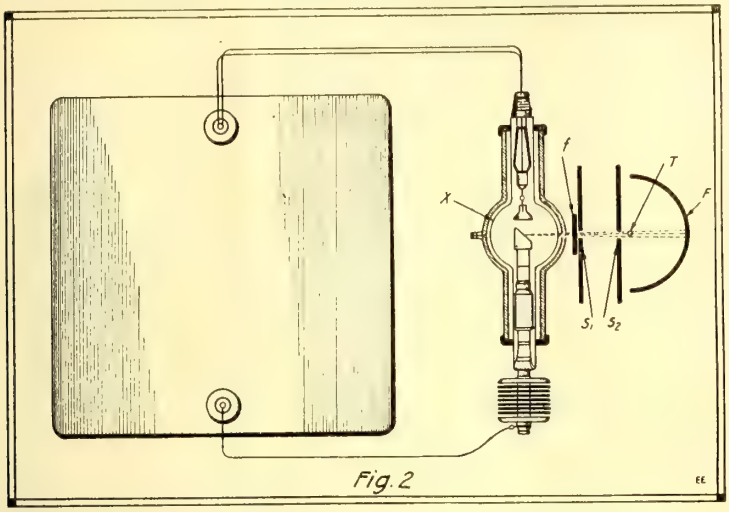


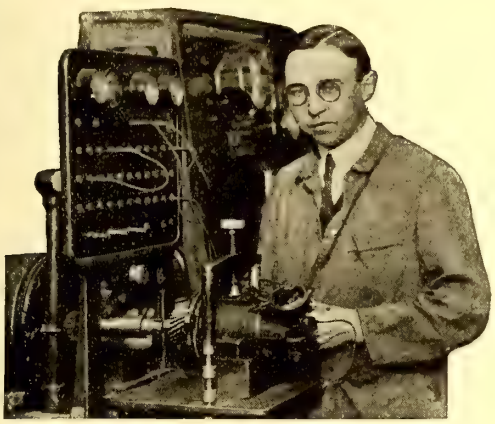
Fig. 2, Above, Shows the Unique X-Ray Apparatus, Which Was Employed for the Purpose of Photographing the Atomic Structure of Metals.

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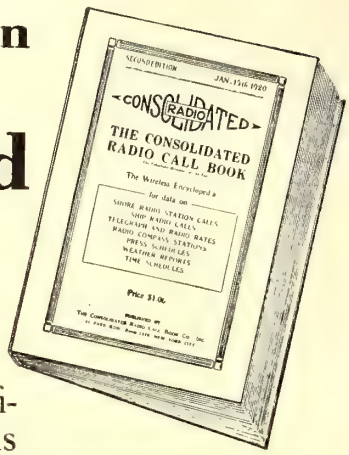
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distances. If, as shown in the original paper, the X-rays are made monochromatic by proper voltage and filtering, then as the crystal is rotated a series of intense reflections will be observed at angles whose sines are in the ratio of 1 : 2 : 3, etc., corresponding to successive integral values of n in Eq. 1. If a new face is ground on the crystal at an angle to the first, and exposed to the rays in the same way, another similar series of reflections will be observed, at different angles, corresponding to the different distance (d, Eq. 1) between the planes parallel to this new face. The process of analyzing a crystal consists in observing these reflections from as many faces as possible, and calculating, from Eq. 1, the distance between the planes parallel to them. When a single crystal is used this requires many observations. The work is greatly simplified by using a powder, in which all possible orientations are represented at the same time by one or more of the tiny crystals, and photographing simultaneously the reflections from all these little crystals. This is the method sketched in Fig. 6 of the original paper. It might be expected that the number of lines in these patterns would be infinite, since there is an infinite number of different possible planes in any crystal. The reflections from most of these planes, however, come at angles whose sines are greater than 1 (as is evident from equation [1] when d is small), and which therefore do not exist.

The analysis of these photographs is very simple in the case of simple substances, like pure metals. It consists in finding, by successive trials, an arrangement of atoms whose planar spacings, beginning with the planes farthest apart and skipping none, exactly fit the observed pattern of lines. The calculation of the planar spacings for all the important planes is not difficult, and with simple substances but few trials are necessary.

The electrical conductivity of metals depends on the ability of electrons to move between the atoms. A discussion of this without a better knowledge of the shape and size of atoms would be premature. It can be seen at once, however, why "ion salts" and crystals like diamond are non-conductors. In each of these arrangements the electrons in the atoms are in complete groups of eight, which is such a stable arrangement that large forces (corresponding to the dielectric strength of the substance) are required to remove them. The atoms of metals, on the other hand, have extra electrons which cannot find places in these stable shells, and are therefore "free" to move from atom to atom.

MAGNETIC PROPERTIES.

It is well known that the ferro-magnetism of iron is not a specific property of the iron atom, since iron in solution and in compounds is in general not ferro-magnetic. The ferro-magnetism must depend, not only on the nature of the atoms, but on the way in which they are grouped together. It might have been anticipated, therefore, that the cause of ferro-magnetism was the *centered cubic arrangement* which is characteristic of iron. A glance at the results tabulated so far shows that this is not the case. Nickel, which is ferro-magnetic, has a face-centered cubic arrangement, like copper. Cobalt is sometimes like copper, sometimes like magnesium. Neither is like iron. Chromium, on the other hand, which is not ferro-magnetic, has a centered cubic arrangement like iron. Manganese has not yet been obtained sufficiently pure to determine its arrangement. It is evident, therefore, that while the centered cubic arrangement may be favorable to ferro-magnetism, and may make iron more magnetic than cobalt and nickel, it is not the principal or even an essential factor.



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Of late we have received so many letters from our correspondents regarding patent advice, that it has been quite impossible to publish all of them. Altho printed in the smallest type possible, we cannot accommodate more than ten or twelve answers a month. At the present time we are about four months behind. Of course, if our correspondents have time, no harm is done! We would, however, advise that if a quicker answer is wanted, correspondents should avail themselves of our special service, as per the notice printed at the head of this column.

All letters are answered in turn as they come into this office, and for this reason it will be understood why it takes so long for an answer to be publisht. Will correspondents please bear this in mind?—EDITOR.

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(375) Mr. Maurice Goldberg, of St. Paul, Minn., writes:

Kindly tell me if I can obtain a patent on the following:

(1) A hole is cut out of the mica sheet in automobile shades and a flap sewed on, so that when shades are down and the driver wishes to put out his hand telling which way he is going to turn, he can shove his hand thru the hole in the curtain, the flap being pushed outward, and when the hand is taken in, the flap falls back. The flap should be made a little larger than the opening, which will be about six inches in diameter, round or square, and set a little to the front as the hand naturally reaches a trifle forward. Flap to be placed on each side of the driver.

A. We doubt whether a device of this kind would find much favor with automobilists. One of the troubles immediately would be that the flap in question would flap violently against the sides of the automobile, due to the wind action, producing an irritating noise. The mechanical pointers on the market at the present time solve the problem better.

(2) An attachment to a talking machine whereby the reproducer and needle are lifted up at the end of the record and placed at the beginning, keeping this up indefinitely until the motor is unwound or some person stops it.

A. There is nothing new about this invention. Any modern phonograph shop will sell you an appliance that will do what you claim for your device. There are several good devices of this kind on the market; the best one being known as the "Encore." This will reset the tone arm at the beginning of the record as soon as it has reached the end. It will continue playing the same record over and over, 'till the machine runs down.

(3) A gyroscope of suitable dimensions geared or belted or in some manner with the shaft of the engine or motor of an auto to steady it when going around turns, speeding along rough roads, etc.

A. We doubt whether this scheme would be feasible in practice, besides some automobilists have large fly wheels which acts as a gyroscope, in a small way. We doubt whether automobilists would pay an increased price for a gyroscope, just to keep a car from skidding around the corner.

Hard Copper.

(376) C. E. Nichols, of West Philadelphia, Pa., writes:

I firmly believe I have discovered the key to hardening copper. I have been a reader of the ELECTRICAL EXPERIMENTER for a long while.

Will you please refer me to some one who will help me to commercialize and develop this process and determine the value.

A. If you really have invented a way of hardening copper, we can say truly that you have struck not a copper mine, but a veritable gold mine. We have heard much of hardening copper recently, but most of it turned out to be some sort of bronze or copper mixed with other metals to harden the copper,—in other words, an alloy.

We have as yet not seen copper that has actually any degree of hardness as compared to good bronze. Any large companies, such as you will find in your city, we think would be glad to take up the matter with you if you have something really worth while.

Auto Device.

(377) Stephen Juva, of Lawrence, Mass., writes:

Please tell me if a patent can be obtained on an automatic power device on an automobile. The device is such that when the auto gets to a hill the device inclines and lets in more "gas," and when going down hill it inclines to reduce the supply of "gas," according to the grade of the deline.

A. This seems to be an excellent idea and we know there would be a good market if such an attachment could be produced at a reasonable cost. We think many automobilists would install it. If you have actually tried it out, and know it works, we would advise you to get in touch with a patent attorney.

Chemical Hood.

(378) Mr. Morton Bermann, of Newark, N. J. writes:

Please let me know whether or not a patent can be obtained on an adjustable hood for chemical laboratories.

It is to be much the same as the ones now in use, excepting that it can be adjusted to absorb gases from any part of the work bench.

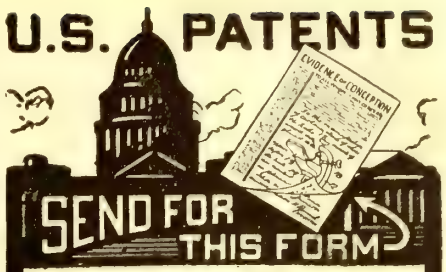
A. There certainly is a great demand for a hood of this kind, if it is as you say. We are certain that most factories which have much to do with obnoxious fumes, would be glad to buy a device of this kind. It would be advisable for you to get in touch with a patent attorney if you know for sure that the device works well.

Valve.

(379) David C. Bramley, Shamokin, Pa., writes us as follows:

"I am interested in some of your answers in *Patent Advice* section and would like to ask you a question regarding my patent or improvement. I am employed at one of the coal companies as pumpman which includes much pipe fitting of all sizes, and have occasion to change valves when they eat thru the seatings such as, namely, Lukenheimer, Globe, and many others on the market today. I find during the 15 years' experience with them they last but a short time, unless continually opened or closed, the valve is then removed which causes at times a great deal of trouble, labor, time and expense. Now I have a method of repairing those valves in five minutes so that it won't be necessary to disconnect or throw them away, and they can be repaired time and again less one-third the cost of the valves, and again they need not be made of brass, still

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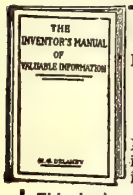
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further reducing cost. Will those valve concerns allow me to use one of their valves to produce the improvement? How can I locate their address? It is a simple construction and I think would be valuable to many as I have seen many shipped away considered useless on this slight account. I have tested the improvement under 100 lbs. steam and 250 lbs. water pressure per square inch."

A. We can only say that if you really have such an improvement, we are quite certain that you will have no trouble in making a large amount of money out of the invention. If this idea has been tested out and found to work, we would advise you to get in touch with a patent attorney. To use the improvement in the patented valves of the firms you mention would require their permission, we think.

The Amateur Magician

By JOSEPH KRAUS

(*Continued from page* 1140)

the gruff reply. Then, addressing me, "Here, you hold her, while I talk to her, or place her on the table if you desire, she's too desperate for me." Continuing his conversation with the skull, he added, "Do anything?"—"I would like to do you," came back the snappy retort.

Well, that was enough. I wanted to see how it was done. So going over to the side and examining the wires which held up the plate, I was surprised to see the professor remove the glass shelf and proceed to question the skull and receive just as many answers to his queries as he had received before.

"Come, don't keep me in suspense!" I exclaimed. "How is it done, that is just what I want."

"Well," he said, "very simple, nothing to it, and I am really surprised that more magicians do not carry a device of this nature around with their usual outfit."

Removing the top portion of the skull, he showed me simply a coil of wire arranged so as to fit snugly inside the vault and consisting of 300 turns of No. 38 enameled magnet wire connected to a telephone receiver having a horn attached to the hard rubber cap. Looking at it I could see no wire coming from it and finally an idea beamed!!! "INDUCTION?" I asked.

"Exactly," he exclaimed, "and very simple at that. You were examining the glass shelf and the wires leading to it and like everyone else discovered nothing, because there is nothing there to discover. The entire trick rests not in the glass shelf but in the table under it." Lifting this up and turning it over, he showed me a microphone attached to a large diafram. "That is the communicating phone by means of which my assistant in the other room knows of the skull's affairs."

This microphone was connected to two wires which ran down to two metallic floor connectors and in series with a battery and a pair of phones to his assistant in another room. Two other wires running up the leg of the table terminated in a coil, about 1½ feet in diameter, consisting of 300 turns of No. 22 D. C. C. magnet wire. To all appearances this was all there was to the apparatus, but following the professor from the room, I came upon the *operator-in-chief* of the device. There he sat, with a pair of phones clapt over his ears enjoying a hearty laugh.

A telephone transmitter was fastened to the table and this in series with the typical audion amplifier. This is how he managed to get such a powerful voice, the professor explained. You see, even the finest telephone transmitter is capable of delivering but a very small amount of current. In order, therefore, to get sufficient induction in the coil inside the skull, at least enough to make the sound emitted by the 75 ohm loud-talker sonorous enough to be heard, we must employ an amplifying circuit. The ordinary audion bulb is used and connected directly with the small induction

(*Continued on page* 1210)

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Practical Chemical Experiments

By PROF. FLOYD L. DARROW

(*Continued from page* 1143)

FREEZING WATER

In a small flask or beaker place 15 c.c. of carbon disulfid and 5 c.c. of water. The water being much lighter than the carbon disulfid floats on the surface of the latter. Standing by an open window or in a good draft blow into the carbon disulfid thru a bent glass tube. The rapid evaporation of the carbon disulfid produces a temperature as low as 15 *degrees below zero* and the water quickly freezes.

The experiment may be varied by placing the beaker containing only carbon disulfid on a block of wood with a little water between the beaker and the wood. Upon blowing thru the liquid in the beaker the wood and beaker are quickly frozen together.

THE BROMINE GUN

Fit a hydrogen generator having a side neck with a stopper and dropping funnel. In the bottom of the generator place a little red phosphorus and moisten with water. In the dropping funnel place a little liquid bromine. See Fig. 8. Upon opening the stopcock of the funnel and allowing a few drops of bromine to fall upon the phosphorus a flash of light fills the generator and a puff of vapor issues from the side neck. The operation may be repeated as often as desired.

The bromine and phosphorus unite to form the unstable compound-phosphorus bromid, and this is decomposed by the water forming hydrobromic acid which issues from the generator.

SMOKE RINGS

Arrange two bottles having their bottoms removed as shown in the diagram.

To cut off the bottom of a bottle tie around it a hemp string soaked in kerosene. Ignite the string and when it has ceased burning, gently strike the bottle near the bottom. It will break along the line of the string.

With the pinch cock between the bottles closed, fill the upper bottle with hydrochloric acid gas as by downward displacement and the lower bottle with ammonia gas by upward displacement. The hydrochloric acid is generated by heating sodium chlorid and concentrated sulfuric acid in a Florence flask fitted with a stopper, thistle tube and delivery tube. The ammonia gas may be obtained by heating in a flask with delivery tube some strong ammonia water.

When the two bottles are full, open the pinchcock and the ammonia will rise into the bottle of hydrochloric acid forming a series of smoke rings. See Fig. 9.

POURING THE NATIONAL COLORS FROM A PITCHER OF WATER

Fill a pitcher with clear water and add a few cubic centimeters of ferric chlorid solution, stirring well. Place three tumblers on the table. In the first place a few drops of a solution of ammonium sulphocyanate. Leave the second empty. In the third place a few drops of potassium ferrocyanid solution. Now pour from the pitcher into the tumblers in the above order and the national colors—Red, White and Blue will appear!

(The next installment will appear in the April Issue.)

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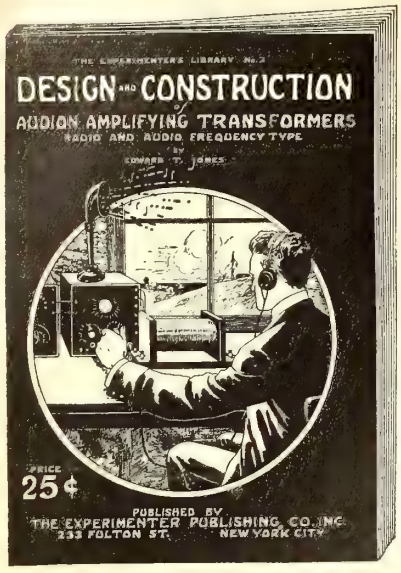
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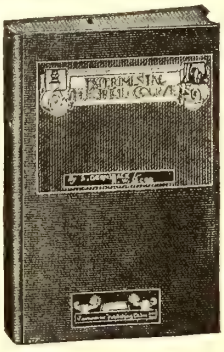
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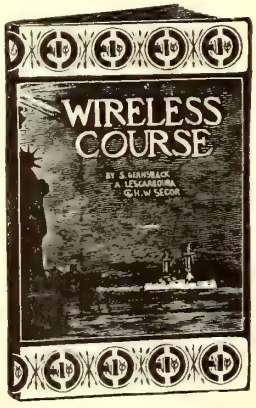
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Gaseous Telephone Transmitters

By RICHARD A. ENGLER

(*Continued from page* 1155)

Fig. 7 illustrates how the throttling of the gas or vapor path may be accomplisht in one way by purely mechanical means. A mercury arc tube is shown wherein are placed several perforated insulating discs of light-weight material. The tube can be mounted upon a sounding board or otherwise vibrated. The obstructing discs can move freely because of the vacuum within which they operate; disregarding the vapor pressure.

Both anode and cathode should be of mercury in this case so that when the mercury condenses more on one side of the obstructing means than on the other, the current can be reversed to carry the mercury to the other side again.

When the sounding board is vibrated, the tube vibrates, as do the light-weight insulating discs also, with the result that the perforations in the discs close more or less and thus throttle more or less the vapor path and therefore throttle the current flow more or less. The discs are mounted in the tube so that they cannot rotate around their axes and also so that they do not close each other's perforations completely by the vibration. The two discs shown in the center fit loosely between the two end ones and also loosely between the walls of the tube, while the two end discs fit snugly in the tube, thus the two central discs only vibrate.

A method of employing dynamic electricity as the throttling means is shown in Fig. 8. Here the well-known "Audion" and circuit are employed and the grid is vibrated *into* and *out of* the ion stream more or less by the exterior vibrating diafram and magnet. The grid may also be caused to approach and recede from the filament or plate or otherwise moved while being completely *immersed* in the ion stream. The grid current will also be varied and its effects can be added to the plate circuit effects. The grid battery may flow with or against the plate current and ion stream.

A Bell magneto-electric transmitter may provide current to the grid circuit of an "Audion" and thus obtain a very neat form of transmitter by the combination.

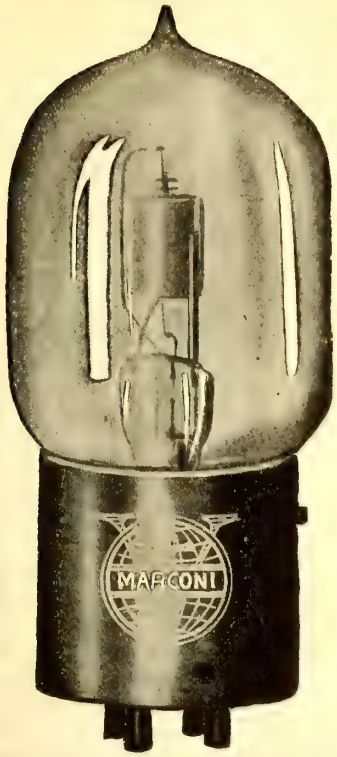
The movable discs in Fig. 7 and grid in Fig. 8 may be mechanically connected thru the glass wall to the diafram instead of being operated by magnetic means, altho the latter is more desirable from a constructive and operative point of view.*

Now let us take a battery, a primary coil, two electrodes and an air space between the two electrodes and all in series. Then by means of X-rays let us ionize the air space and make it conductive. Current from the battery then flows across the air space. This air space may then be used not only as a transmitter, but in many ways like the mercury vapor arc and the "Audion" are used. The ionization of the air space may be local or not. When not local, the ionized air can be brought between the electrodes as a stream of air which has past an X-ray field, because air keeps its ionization for some time after passing thru an X-ray field. A manometer may be used to inject ionized air between the electrodes.

*The glass wall of the tube itself may be the diafram in such a case.

When a magnet is used as the throttling or varying means, the tube can be replaced with less expense and more ease than where mechanical throttling or varying means or where mechanical connections are employed because in the latter cases the operating means are within the tube or part of the tube.

(*Continued on page* 1202)



Fleming Pat. No. 803684
De Forest Pat. Nos. 841387-879532

A WARNING

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United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

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Gaseous Telephone Transmitters

(*Continued from page* 1200)

If a mouthpiece is placed near this ionized air space as shown in Fig. 9, a very perfect form of transmitter is possible, because the rarefaction and condensation of the ionized air causes a variation in the current flowing thru the air space. Ionized air has never been used as herein described and should be of great value in the art.

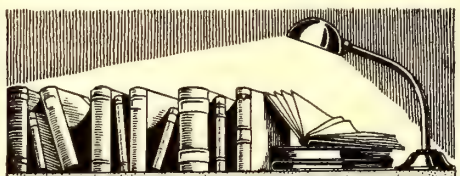
Other gases confined in vessels may be substituted for the air space. Air is more powerfully ionized by X-rays, however, than other gases; and devices using such an ionized air space are free from the disadvantages peculiar to devices which require a vacuum tube. X-rays do not affect a vacuous space nearly so much as air and some other gases.

When a stream of ionized air is used and such throttling means used as in Fig. 7, then not only is the electric current varied, but also the air current, and this latter variation of pressure may be utilized to operate another transmitter.

Suppose the space between the electrodes in Fig. 9 should be somewhat greater and the X-rays from an X-ray generator are projected from one electrode to the other, then a high tension current would traverse the space and a kind of wireless transmission of power is available, the earth in this case being used as a return path. X-rays have been detected as far away as 60 feet in ordinary apparatus years ago.

I believe this is enough to show what a useful and interesting field *gas and vapor paths* offer in the way of transmitters; and I believe that many suggestions will be induced in other minds by this disclosure in such a rich and fertile field. I may say, therefore, that I have taken necessary precautions long ago to well protect the entire field I have opened.

It seems peculiar that such simple and effective transmitters have not before made their appearance in view of the great activity of late in gaseous devices of all kinds.



BOOK REVIEW

DESIGN AND CONSTRUCTION OF AUDION AMPLIFYING TRANSFORMERS—RADIO AND AUDIO-FREQUENCY TYPE. By Edward T. Jones. Cardboard cover, 16 pages, 12 illustrations, size 5⅛x7¼ inches. Publisht by Experimenter Publishing Co., of New York.

This book deals with the construction of audion amplifying transformers of the air core type for radio frequencies, and is a most timely and important subject in view of the great strides which the audion has taken in recent years.

Amplifiers are essential and their prices generally are exorbitant for the real good kind. Mr. Jones, who readers of both this magazine and *Radio Amateur News* know, to be a celebrated writer and authority on the subject of radio, has given clearly and concisely the essentials of the construction of these transformers so that a boy 12 years old can understand them and follow the necessary details required in constructing them.

With but two steps or stages of amplification, a resultant of 400 times the original is obtained, and stations heretofore unheard, come bellowing in on the ether. The book deals with the subject as thoro as any amateurs who know nothing at all about the construction of such transformers may desire. No one then need question his ability to construct one suitable for any work. In addition, hook-ups are given, together with dimensions and constructional data for a small capacity condenser.

Mr. Jones has succeeded in bringing these devices into the hands of all "Radio-bugs" at a surprisingly nominal cost, particularly those who handle audions in any way whatsoever.

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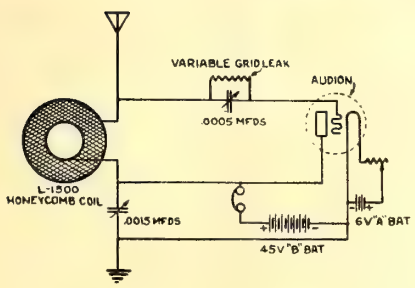
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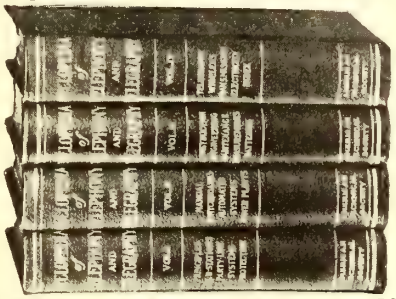
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Vacuum Tube Amplification

By PIERRE H. BOUCHERON

(*Continued from page* 1159)

a signal amplification 10^{12} times greater than a single VT circuit! As will be noted, VT No. 1, No. 2 and No. 3 are for the purpose of amplifying the received signals at their *radio* frequencies thru radio frequency amplifying transformers T1, T2 and T3. VT No. 4 is made to act as a *rectifying detector* by introducing a grid condenser GC, shunted by a grid leak resistance GL. Vt No. 5 and No. 6 amplify the resultant *audio* frequency signals which are in turn intercepted in the telephone receivers. Another important operating factor to be noted in both Fig. 3 and Fig. 4 is the use of a common "A" and a common "B" battery. The "A" battery furnishes filament current to all combined tubes (provided, of course, that all tubes employed are of the one standard type), properly regulated thru the use of the common rheostat R of about 5 to 10 ohms variable resistance; while the "B" battery supplies the necessary plate potential to all tubes used. It is sometimes advisable, particularly for experimenters, to make the plate "B" battery variable in potential by means of individual cell tapping. This "common battery" method effects a considerable saving of additional batteries as well as space. It is, of course, evident that the "A" battery must be of sufficient ampere-hour capacity to properly take care of all tubes at one time.

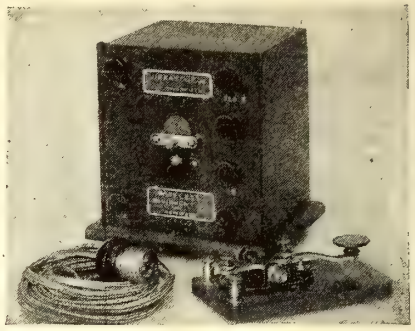
A FEW WORDS ABOUT AMPLIFYING TRANSFORMERS.

As explained before, *radio* frequency transformers are employed in amplification *before the detection and rectification* of the incoming signals, while *audio* frequency transformers are used to amplify the rectified audio or comparatively low frequency. Contrary to the belief of some, an open air-core transformer *is not necessarily* a radio frequency one, and likewise an iron-core transformer *is not necessarily* confined to audio frequency amplification. As a matter of fact, both air-core and iron-core types are used for *either* purpose, providing they are suitably wound. In general practise, the design of a transformer must be such as to meet the characteristics of the tubes employed, either at radio or audio frequencies. That is to say, the ratio between the primary and the secondary winding of an amplifying transformer must be such that the secondary will give a maximum potential to the grid circuit of the next tube in cascade.

Consistent with that which has previously been said, it is therefore up to the experimenter to decide which method of amplification is best suited to his need before securing either *radio* or *audio* frequency couplers or transformers. For instance, if his means are limited, he may prefer to first experiment with grafite rod couplers, which, of course, are much less expensive than the transformers and will give fairly good results, particularly with radio frequencies. If he wishes, however, to construct an efficient two-stage amplifier for the purpose of amplifying previously detected signals, he will want to use the popular, iron-core audio frequency transformers. Any of the transformers mentioned here may be designed and constructed by the average amateur, but unless he has access to a lathe or a winding machine, the job had better be left to the regular manufacturer. Since audio frequency amplification is probably the most popular method at present among amateurs, atten-

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tion is invited to a very compact and much used laminated iron-core audio frequency transformer and which may be had for a few dollars. Of course, there is a great deal of pleasure to be had in building one's own apparatus, so if you have the facilities, why, "go to it."

Electroscope for Radio-Activity

By FRANK M. GENTRY

(*Continued from page* 1146)

A brass rod, K, 3/16" in diameter and 5¼" long, was threaded on one end for a distance of 3/16". The other extremity was cut with a hack-saw to a depth of ¼", X, Fig. 2. A ¾" brass ball, L, was drilled and tapt to take the threaded end of the rod. The strip, Q, Fig. 2, was cut from 1/32" brass sheeting the shape shown at N, Fig. 1. The strip was 3½" long and ¼" wide. For a distance of ¼" from the top it was narrowed to 3/16" in width. The projecting pieces on one side of the strip were ¼" wide and 5/16" long. They were bent at right angles to the strip along the dotted lines shown in Fig. 1 so as to form a means of attaching the scale to the electroscope, R and S, Fig. 2. The narrow end of the strip, Q, was then inserted in the slit provided in one extremity of the rod, K, and soldered in place as shown at X. When the superfluous solder was removed, the brass was polisht with pumice stone.

A piece of stiff white cardboard, V, was cut as the sector, embracing an angle of 45°, of a circle whose radius was 3". The arc was divided into a scale of degrees for the purpose of measuring the angle of divergence.

The rod, K, was roughened for a small distance ¾" above where the brass strip was soldered so that the insulation, M, would hold it in place. The rod was then placed in the center of the hole in the top, O, Fig. 1, and embedded in molten sealing-wax. The scale, V, was fastened to the strips, S and R, provided for the purpose.

Two circular discs, F and E, Fig. 2, 4" in diameter, were cut from 1/16" brass or copper sheeting. Two knurled battery thumb nuts, G and D, were then soldered in the center of each disc. These formed the condensing plates of the electroscope.

A 5/32" brass rod was bent L-shape so that one arm was 1¼" long and the other was 4¼" long, C, Fig. 2. Each end of the rod was threaded to a distance of 3/16". One of the condensing plates was screwed to the short end of the rod while the other end was secured to one side of the container. 1½" from the top, by means of nuts, B, Fig. 2. Another piece of 5/32" brass rod was bent similar to the rod, C, except that the long arm was 5½", H, Fig. 2. When the threading was completed, the remaining condensing plate was screwed to the short arm while a binding post, I, Fig. 2, which had previously had a 7/32" hole drilled in its face, was fitted to the long arm. The rods and condensing plates were polisht with pumice stone as before.

The most difficult operation of all was then encountered; that of cutting and attaching the gold-leaf. Several sheets of gold foil were obtained at the glazier's and cut into strips ¼" x 3¼" while sandwiched between layers of paper. The strip, Q, was moistened at T for a distance of ¼" with a weak solution of gelatine in warm water which served as an adhesive in affixing the leaf. The fact that the gold foil could not be touched by the hands and that it could only be handled by some

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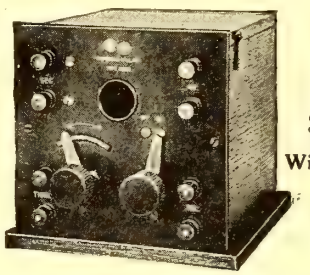
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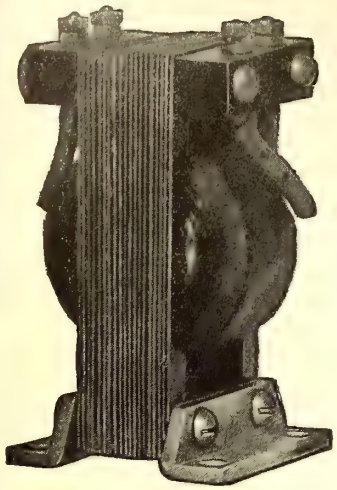
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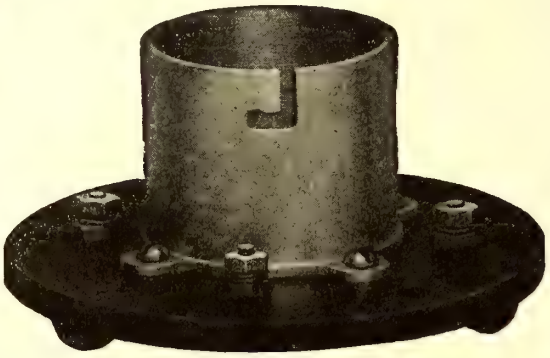
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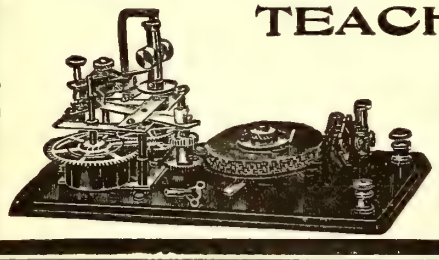
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This Liberty Vacuum Tube is manufactured and sold as a genuine Audion, licensed under two DeForest patents, to be used only for amplification in Radio communication and only for experimental and amateur purposes, and only in Audio Frequency circuits. Every Liberty Audion Amplifier is a highly sensitive and carefully tested Audion tube. No infringement. Insist on the Liberty Audion Amplifier. The one you will eventually buy. Price $6.50, licensed for experimental use. Send stamp for bulletins on tuners, and Audion Amplifier and control cabinets for the above tube.

THE RADIO APPARATUS CO.
Pottstown, Penna., U. S. A.

WIRELESS AMATEUR

Send a 2c stamp for full description of the most efficient detector in the wireless field today.
Tested by Marconi Wireless Telegraph Co. and U. S. Government. Instantly adjustable at a constant pressure.
L. STEWART BARR, Inventor, Vice-President of The Service Radio School
THE BARR MERCURY-CUP DETECTOR Dept. A, The Wyoming, Washington, D. C.

improvised instrument such as a knife blade served to multiply the difficulties. After due patience, however, a leaf was successfully attached and the final assemblage was all that remained.

The top, N, Fig. 2, containing the rod, K, etc., was then shellacked and made fast in place by round-headed brass screws, P and O. The rod, K, was slipt thru the 7/32" hole in the face of the binding post and the charging ball, L, screwed into place.

When in use the thickness of the dielectric of the condenser was varied by sliding the rod, H, up and down the rod, K, while the area of the condensing surface was varied by revolving the rod, H, about K as an axis, the final adjustment being maintained by the set screw, J, in the binding post, I.

Charging was accomplisht by the usual method of induction to avoid the possibilities of a rupture often incurred by the conductive method.

It can readily be seen that when the lower condensing plate is grounded by means of the ground connection, if any ionizing agent such as a radioactive substance be brought near the instrument, the gaseous dielectric of the condenser ionizes and suffers the immediate discharge of the electroscope. Fig. 3 shows the finisht electroscope detecting the presence of a capsule containing a minute quantity of the radioactive substance, Uranium X.

A system of quantitative analysis of radioactive compounds can be devised if the charge, the distance of the substance, the dielectric constant, the distance between and the area of the condensing plates, the temperature, the barometric pressure, and the period of collapse are taken into consideration.

Copyright 1920, by Frank M. Gentry

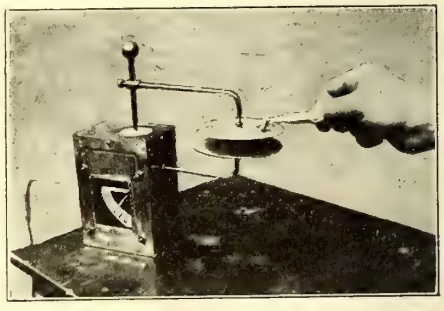


Fig. 3. The Finished Electroscope Detecting the Presence of a Capsule of Uranium X.

FOREST RADIO-PHONE PROVES VALUE IN TEST.

The forest service wireless telephone works fine in Portland, Ore.

C. M. Allen, telephone engineer of the Forest Service, recently conversed with a friend eight miles distant with perfect clearness.

"In fact," said Mr. Allen, "the sound of the voice came thru the instrument much plainer and clearer than over the wire."

The sets are installed upon the summit of Mount Hood and at the Zigzag ranger station. Mr. Allen therefore tested out the wireless telephone before taking it up the mountain.

Further experiments were made at Government Camp and Camp Blossom before the summit set was packed up the mountain.

The experiment conducted at Portland was between two points of comparatively equal altitude about eight miles apart. A wave length between 400 and 600 meters was used and the sounds were caught by several amateurs who later telephoned to Mr. Allen telling of their experiences listening in.

GENERAL ELECTRIC AND MARCONI COMBINE.

The following statement was issued by Edward J. Nally, vice-president and general manager of the Marconi Wireless Telegraph Company of America, following a meeting of the board of directors of the company:

"The American Marconi Company has the disadvantage of having a substantial percentage of its stock held abroad, and because of patent agreements with the British Marconi Company, of having its operations limited in the United States.

"The research laboratories and engineering force of the General Electric Company have been working for a number of years on radio matters and radio apparatus of great value has been developed which was used by the government during the war for important communications.

"A new corporation has been formed called the *Radio Corporation of America* which has taken over the radio rights of the General Electric Company, and which has proposed to the American Marconi Company to take over its patents and stations and some other of its assets.

"Arrangements will be made such that the new company must permanently remain under American control. It will be amply provided with capital; none of its stock is offered on the market."

World's Big Telescopes

By FLOYD L. DARROW

(*Continued from page* 1139)

removed from disturbances that interfere with astronomical observation, being one and one-half miles from a railroad and seven miles from electric lights.

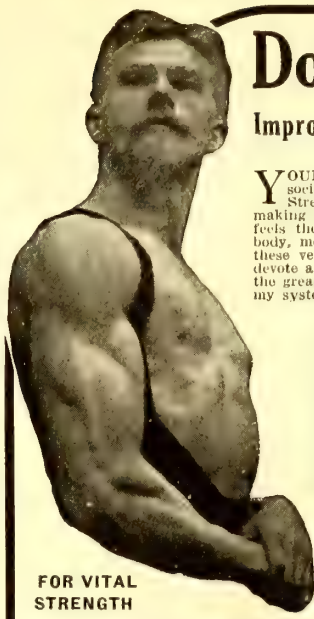
The erection of this observatory was made possible by a gift of Mr. Yerkes to the University of Chicago. The lens was shaped and figured by Alvan G. Clark and was the last work to be done by this famous family, so wonderfully skilled in the technique and artistry of lens grinding. After having made the large Lick lens the Clarks were for the fifth time in their career summoned to construct "a telescope lens more powerful than any in existence." And again they succeeded, surpassing all previous records set by their handicraft with the big 40-inch refractor. Two and one-half years were spent in preparing the lenses and the cost was about $125,000. The unground blocks of glass cost in Paris $20,000.

The lens with its iron ring and cell weighs 1,000 pounds. The crown glass lens is 2½ inches thick in the middle and ¾ inch at the edge. The focal length is 61 feet. Its light gathering capacity is 20 per cent greater than that of the Lick glass and therefore has a greater penetrating power into the infinite depths of space than any other telescope of this type. Only 28 per cent of the light falling on the lens is lost by reflection and absorption. Fully 72 per cent passes thru, but this is larger than with most other lenses. It gives a magnification of 4,000 diameters and has a resolving power sufficient to separate stars about 1/10 of a second of arc apart.

The first observations were made with this giant refractor on the night of May 21, 1897, and the dedication ceremonies took place October 18-22 of the same year.

The family of the Clarks has past away and the world no longer possesses master craftsmen of the highest skill in the difficult art of lens grinding. Therefore the Yerkes refractor will doubtless long remain the largest instrument of its type and

(*Continued on page* 1216)



Double Your Strength!

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YOUR Success In Life—your business, your happiness, your social position, your future—all depend upon your Health and Strength. No other two factors are so vitally important in making good as a man and a leader of men. Every Real Man feels the ever present desire for a healthy, perfectly developed body, more nerve force, greater endurance and control. And yet these very gifts are within reach of any one who is willing to devote a few minutes each day to health-building, with the aid of the greatest invention of its kind in existence. I Guarantee that my system of Condensed Exercise with the scientifically perfected



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IF YOU ARE BATTLING WITH FUNCTIONAL WEAKNESS IN ANY FORM, SEND FOR

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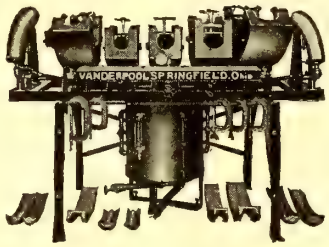
which gives a full description of the Automatic Exerciser, how it works, what it will do, etc. Don't judge my machine until you have read this booklet. I will send it on receipt of 4c postage. Kindly spell out your name and address plainly.

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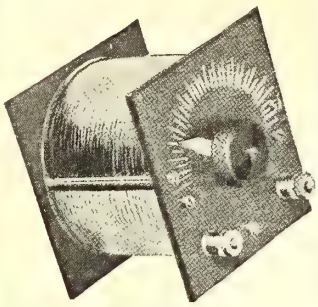
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"Tewno" Variable Condenser



The rotary variable condenser is a necessity for all experimental wireless work and one or two of them are to be found in almost any wireless station. The two most popular types are the 43 plate and 21 plate with capacities of .001 mfd. and .0005 mfd., respectively. The large size has 21 rotary aluminum plates and 22 stationary aluminum plates. The small size has 10 rotary and 11 stationary plates. The ordinary rotary variable condenser is mounted in a cheap round metal case with a cheap composition top and coarse scale. Its plates are 0.15" thick and the shaft is 3/16" in diameter.

The "Tewno" Rotary Variable Condenser has two genuine "Formica" ends, a clear glass case, a ¼" shaft and plates .024" thick of a special grade of aluminum. However, the biggest feature in favor of our condenser is the form of end-piece used. It is square, facing the operator. It is not necessary to look over one's hand to see the scale, as was the case in the old upright type of condenser. The scales on these instruments are calibrated to 2½ degrees.

We recommend our 43 plate condenser for primary and secondary tuning on sets of fair range and for use in oscillating circuits. Our 21 plate condenser is well adapted to short wave tuning for use in small wave meters and a great variety of work calling for a small variable capacity.

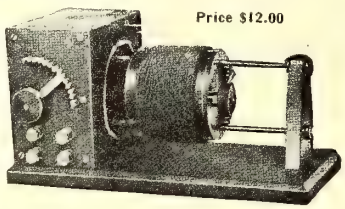
Do not be fooled by an instrument that is "just as good." These are to date the best condensers on the amateur market.

No. 53—21 plate—.0005 mfd.....Price, $4.75 No. 43—43 plate—.001 mfd.....Price, $5.50

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Directly prior to the war, the amateurs were doing wonderful work with specially made short wave couplers of their own construction and through the use of Armstrong circuits or with straight audion circuits. Up to that time no manufacturer had placed such an instrument on the market.

In our short wave receiving transformer the amateur will find the embodiment of all of his ideals. It is designed for use on amateur aerials of from 150 to 200 M. fundamental wave length and with a small capacity of variable condenser across the secondary will easily tune to 600 M. The windings are of the very efficient type known as bank wound (an expensive process) and are of heavy stranded conductor in silk sleeving. They are wound upon non-shrinkable tubes. Variation is obtained by means of two 12-point switches mounted upon "Formica." Switches and contacts are satin finish, nickel plated, which is in accord with the Government's specifications. All other metal work is polished and nickel plated. Woodwork has a beautiful hand rubbed mahogany finish.



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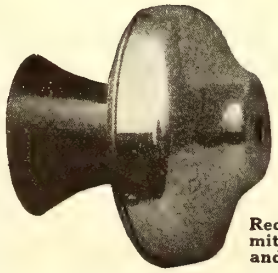
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THE ELECTRO IMPORTING CO., 231 Fulton St., NEW YORK

"Whispering Ether"

By CHARLES S. WOLFE

(*Continued from page* 1131)

He was talking again. "My man," I wriggled when he spoke, "the men for whom you work are imbeciles. I have named my price for Chero, and they don't want to pay it. They believe they can wrest it from me by force or trickery. You are their first emissary, and it is my wish that you be their last. I am going to convince them that it is useless to attempt anything of the kind with me. I am not going to turn you over to the police. I am going to show you something, and then I am going to send you back to your masters to tell them what you have seen. After that," he smiled, "I don't think I shall be troubled by them. Come!"

He stalked into the next room, me at his heels. There wasn't much in that room—just a table covered with apparatus. I have seen a wireless set. It looked something like that, only—well, there was something different about it.

He pointed to it. Oh! I can see him yet, with his flashing eyes, and his big dome. "There," says he, "is the mind machine. And you, a criminal, are the first man to see it except its creator."

I'm getting on my feet again, and not so scared, and so I gazes at it curious. "What is it, Doc?" I asks.

"It reads your thoughts," he says, just as solemn as an owl.

That's right, laugh. I don't blame you. I grinned myself. He saw me grin, and he turned on me like a tiger.

"Dolt," he hollers. "Clod! You doubt. Pig! Your type has retarded the progress of mankind throughout the ages. You sneer—you imbecile!"

Well, just then I'm like the doctors. "A nut!" I thinks, "and loose with that bottle of Chero in his pocket!" And it's up to me to soothe him.

"How does it work?" I asks, to gain time. When you're in a room with a nut that's nursin' a bottle of H. E. your one thought is to go away from there. And this particular nut don't want me to. But I have hopes.

By dumb luck I hits the right chord. "How does it work?" gets results. Right away he seems to forget he's mad. He seems to forget I'm a yegg. He gets kind of dreamy, and he runs a caressin' hand over the shiny brass of the nearest instrument.

"Simple," he says, "very simple. It is based on the electro-magnetic wave and the conducting ether theories." It's over my head, but I listen. "Have you ever considered just what happens when you think intensely? By an effort of what you call the Will, you concentrate on what you are thinking. Emotion, too, plays its part. You are intensely angry, intensely worried, intensely interested. This concentrating acts physically on the brain. There is a call on the heart for more blood. And the heart responds, sending a thicker, faster stream to the affected locality. Now what happens?" He turned to me like my teacher used to do in school when there was a question to be answered.

"Search me," I murmurs.

But he doesn't even see me, I guess. "The increased stream, rushing at an unusual rate, rubs against the walls of the veins and arteries of the head, *producing friction.*"

"I see," I says, politely. But I don't.

"This friction is the physical result of the mental action. Your purely mental process has, by the mediumship of the rushing blood and its attending friction,

been transformed into, or has produced, a physical manifestation."

His voice sank to a whisper. "It is this fact that makes my great invention possible. The friction set up produces faint currents of electricity. It is Nature's own generator. The currents are faint, weak, but they are there. And they vary in intensity in proportion as the rushing blood stream surges and ebbs. Thus they have imprinted on them all the characteristics of the thought that gives rise to them. They vary in the individual. Some minds can generate a current one hundred—yes, one thousand—times greater than others, but all minds generate to some extent.

"And these electrical impulses are thrown out into space in wave trains, exactly as the radio telegraph throws them out. This accounts for the phenomena of mental telepathy. If conditions are just right, the receiving mind in perfect tune with the transmitting mind, and sensitive enough to interpret the received impulses, you have accomplished telepathy. All that remained for me to do was to measure the intensity and characteristics of the generated current, its frequency—and it is high—and——"

He paused and fixt me with that fishy stare. I didn't know just what to say, so I took a Brody. "And what, Doc? Slip it to me quick."

"And the length of the emitted wave," he comes back at me, triumphantly, "It might be one millionth of a meter or it might be one million meters. Or it might be any length between those extremes. Or beyond them, for that matter. I succeeded in making these measurements."

He laughed. Or, rather, he laughed and snarled all at once. I'm telling you straight, fellow, your hair stands on end when Proctor laughs like that.

"I fancy some of your radio experts would gape if they were permitted to see my wave meter. I believe it would cause some excitement in the laboratories of Lodge or Marconi. I—Proctor—I measured these waves which, of course, means that I found a detector for them. Our friend De Forest thinks that he has a monopoly on ultra-sensitive detectors. Proctor's detector is to the audion what a stop watch is to a wheel barrow!

"And the frequency. It is beyond the limits of audibility, as that term is understood. I wound 'phones that will render the received signals audible. And the task was done."

Most of that stuff had gone over, but like a lightning flash the big idea burst thru' my shrapnel-proof cranium. I fairly stuttered as I got his drift. I'll bet my eyes popped as I gaped at that machine. "Good God!" I spluttered, "Do you mean that that thing can hear you think?"

Proctor smiled the nearest to a human smile that I ever saw on his mug. "You have glimmerings of intelligence," he said, in a gratified way; "I mean just that."

And then he went off his handle again. "And I mean," he roared, "that you are to go back to the scum that sent you and tell them that it is useless for them to plot against me, for I can hear their very thoughts as they think them. I can read their miserable souls! That's how I knew you were coming here to-night! That's how I knew that your lethal weapon contained no charge! And," he seized me and shook me until my heels nearly broke my neck, "And that's how I know, you swine, that even now you don't know whether to believe me or not."

He released me and tore the telephone things from off his ears. "Here!" he bellowed, clamping them over my ears, "here! Listen, and be convinced."

He wheeled to the table and whirled knobs and dials. A continuous humming and buzzing sounded in the 'phones.

LEARN WIRELESS AT HOME

The Demand for Wireless Operators Far Exceeds the Supply

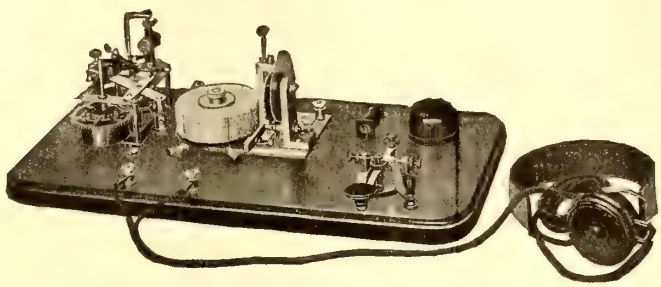
The New York Wireless Institute will make you an operator—AT HOME—in your spare time—quickly, easily and thoroughly. No previous training or experience required. Our Home Study Course has been prepared by Mr. L. R. Krumm, Chief Radio Inspector, Bureau of Navigation, N. Y. Radio experts able to impart their practical and technical knowledge to *YOU* in an *easy to understand* way, will direct your entire Course. The graded lessons mailed you will prove so fascinating that you will be eager for the next one. The instruments furnished *free*, will make it as easy to learn the Code as it was to learn to talk. *All you will have to do,* is to listen.

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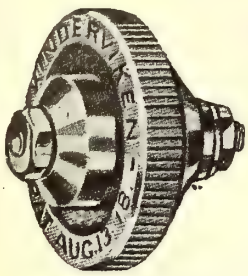
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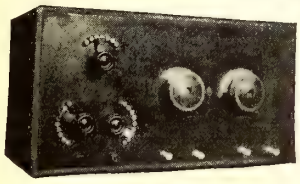
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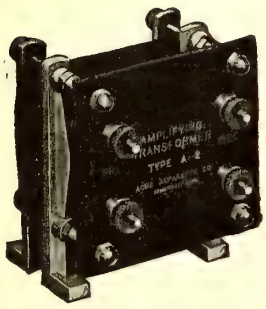
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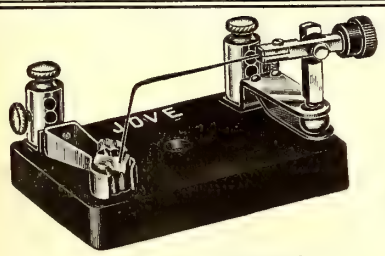
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And then it happened. Listen to me close. I know they labeled Proctor "squirrel food" for telling them less than this, but—— This was *July of* 1914. Get that?

Suddenly something like a voice—no, not like a voice, either—like a voice inside my own head, if you can get me, said, masterfully, *with a strong German accent, "Serbia will, because she dare not submit. France must, because she will see my hand behind it. England must as a last desperate effort to save herself. But my armies will grind them like grain in the mill. And then——"*

Proctor tore the 'phones from me. I was like a stuffed doll and I never raised a mitt. He grabbed me, and it was just like being caught in the jaws of a vise. "You have heard," he thundered. "Now go."

The last thing I remember was that he heaved me toward the door. I remember spinning toward it. And that's all.

The next thing I remember is waking up in that hospital ward. It was July of 1914 when Proctor chucked me, and it was late August when I found myself in that hospital.

As near as I can learn I missed the door, hit the wall and a bottle of that Chero stuff got knocked off a shelf. They dug Proctor and I out of the ruins, and we were both pretty well messed up.

Proctor raved about his ruined mind machine, and it got him a pass to the squirrel cage.

If you read the papers at the time you'll remember Proctor wanted me to back him up, but I wouldn't talk. Least said, easiest remedied.

Now you got all I know about it. I spilled it once to Gentleman Joe, a high-browed crook, who soaked up all they pass you at Harvard when he was young. Joe said maybe Proctor fooled me with a camouflaged phonograph.

Maybe he did. I might think so myself if it had happened in *September* instead of *July*, 1914. Get me?

The Amateur Magician

(*Continued from page* 1198)

coil to the transmitter. This will magnify any voice undulations about 400 times with a two-stage amplifier, *i. e.,* an amplifier using two bulbs. This current then passes into the large table coil. The operator in this room can hear everything you say because of the dictagraph device under the table made possible by use of the *Skinderviken* transmitter button, a minute transmitter answering the purpose very nicely. Upon hearing your question and giving sufficient thought to the matter (if any thought is necessary), he formulates an answer. This then is transmitted into the table coil and by *induction* is heard from the loud-talker within the skull."

"It is, I believe, the simplest trick that has ever been used," said Professor Hargrave, "and is original in the present adoption, inasmuch as the voice is amplified, which is contrary to other devices of similar nature. The transformer used in the diagram which I am about to draw is the ordinary audio-frequency iron-core transformer used in radio circuits for a one-stage amplifier; employing only one bulb, this is entirely unnecessary. An ordinary telephone transformer answers the purpose very well. A heavy duty transmitter is used at this end of the line, and a *Skinderviken* microphone button at the other end (the skull end). A good 75 ohm telephone receiver, such as that built by the leading telephone companies, answers for the loud-talker, as a horn is added to it. Carefully checking over of the diagram will show exactly the set-up and arrangement of the apparatus, together with dimensions necessary for duplicating this stunt."

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New Commutatorless A. C. and D. C. Machine

By RICHARD A. ENGLER

(*Continued from page* 1145)

coils; that is, causing them to consume power in driving.

In Fig. 3, a position G, unit one, the lines of force affecting the secondary in any way are nil because the fields of the co-operating coils are short circuited thru the pole tips as shown; and in position G', unit two, there are no lines of force threading thru the secondary in any way because the co-operating fields neutralize each other.

In Fig. 3 one revolution of the rotary coils causes one complete cycle or alternation of magnetism in the pole tips; that is, a certain polarity rises and falls in one pole tip and the reverse polarity also rises and falls in the same pole tip; all in one revolution of the rotary coils.

Noting positions H-H', we see in a given pole end one polarity, while in positions J-J', one-half revolution beyond, we see in the same pole end the reverse polarity. It will also be observed that one polarity uses one pair of the four split pole tips of each unit which are diagonally opposite each other, while the reverse polarity uses the other split pair of diagonally opposite pole tips.

A falling N pole and rising S pole both induce E.M.F.'s of the same direction in the secondaries, while a falling S pole and rising N pole induce the reverse E.M.F.'s. These falling and rising periods are notated in this Fig. 3 and have reference to the upper pole ends. The arrow heads on the secondaries indicate the direction of the E.M.F.'s induced at each rise, fall and reversal.

In Fig. 3 the secondary may surround the primary or co-operating rotary field coils and be wound at right angles to the stationary coil of the primary, then the reactionary fluxes of primary and secondary act mutually on one another more perfectly due to their close proximity and hence increase the efficiency of the transformer.

The secondary may also be wound over the rotary coil or over the stationary coil or over both. Then the induction will be due to rise and fall of the same polarity and not from an alternating polarity.

The small auxiliary secondary shown in the photograph on the rear unit functions like the main secondaries.

The polarity produced in one unit by one stationary co-operating coil in Fig. 3 and the model is opposite to that produced by the other stationary coil of the other unit. This is not necessary, but it allows of having the same polarity in the upper pole ends of both units, and this makes possible *one* magnetic circuit for *both pairs* of co-opertaing coils.

In the positions H-H', Fig. 3, the inert half of each pole tip does not interfere with the operation of the homopolar rotating field, because as can be seen at these points covered by these half pole tips, the S pole of the stationary coil and N pole of the rotary coil and vice versa face each other and produce, therefore, a neutral condition. This same condition is met with in the coils of the Tesla rotary magnetic field.

At H the two coils will oppose any further motion tending to close them; at H' this opposition will be neutralized by the lines of force passing into the short circuit stage by further motion and thereby reaching around the rotary coil and drawing it open, all in accordance with the principle explained under Fig. 2. The same

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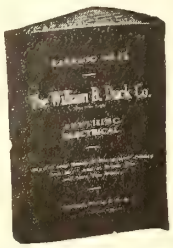
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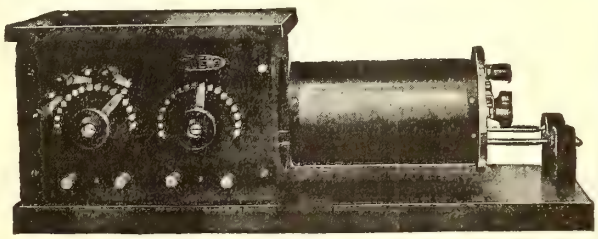
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New Big-264 Page No. 13 Wireless and Electrical Catalog

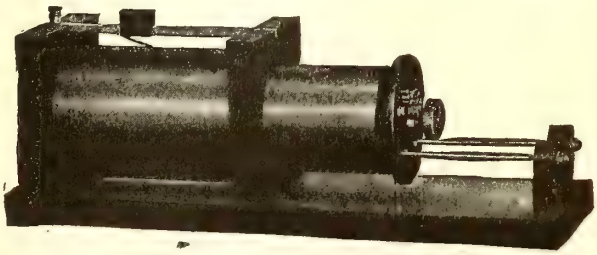
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A big improvement over our former model. Primary divided into four sections, with three dead end switches, greatly improving selectivity.

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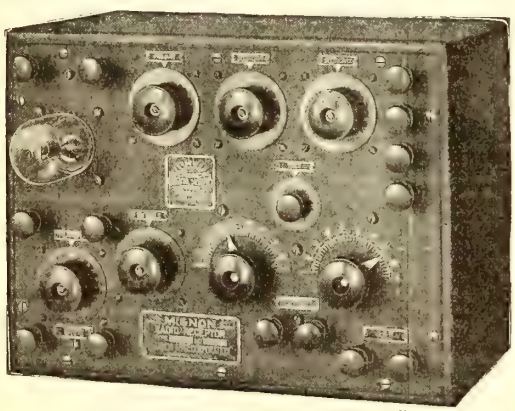


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conditions obtain in positions J-J', but in the reverse order with respect to the units.

If a pair of units with coils in the positions such as G-G', Fig. 3, are combined with a pair with coils in the positions such as H-H' and so that all rotary coils are mounted upon the same shaft, then polyphase E.M.F.'s can be drawn from the secondaries, because when the G-G' poles are at zero, those at H-H' are at a maximum, consequently these E.M.F.'s cause currents to flow in the H-H' secondaries which are a quarter period behind those in G-G'.

If the stationary secondaries are replaced by properly connected rotary ones, we arrive at the "Induction Motor," one with staggered rotor coils instead of staggered stator poles in this case with such a polyphase arrangement of units. We then have in reality a *commutatorless D.C. motor,* a much desired and long looked for machine as well as a very simple one.

True Tesla rotary magnetic fields can be produced by a proper combination of the polyphase poles of the several homopolar rotary field magnets.

Tesla (and Ferraris) past several A.C. out of phase with each other thru several pairs of stationary coils with phase displacements and obtained from the combination a rotating magnetic field of constant value just as if the same had been produced by a single D.C.

Here we pass a single D. C. thru several pairs of coils, of which one of each pair is stationary, while the other of the pair passes thru phase displacements from zero to maximum and back to zero, thereby obtaining from the combination stationary alternating magnetic fields, just as if the same were produced by several A.C.'s of different phase. Tesla's motor based on the above rotary field is self-starting, whereas my motor based on this homopolar rotary field is not, but is *easily* made so.

Thus the conditions in and results of one method are just the reverse of those in the other. Being just the exact reverse of the Tesla rotary field method or system is alone proof positive that the principle disclosed herein is correct in theory and practice.

We may use these homopolar rotary magnetic fields to drag around iron masses which is then another form of motor.

If the stationary co-operating coils in such an apparatus as Fig. 3 are placed so that they are at right angles to the position now shown in Fig. 3, then instead of alternating magnetic fields we obtain simple rising and falling magnetic fields in each of the magnetic circuits.

With a pair of such units we can also obtain magnetic fields of constant values, because as the magnetism of one unit falls the same polarity of magnetism rises in the other unit and the rise and fall are equal in degree. Hence, the combination of the two are equal to a constant magnetic field just as if it had been produced by an ordinary D.C. electromagnet.

An iron core is provided in Fig. 2 upon which the rotary coil is wound. This core may have a segment cut away on each side as shown by the dotted lines in unit E. This form of rotary coil and core is useful when this homopolar rotary field electromagnet is used as the armature of another type of commutatorless D.C. or single phase A.C. motor. This form of motor has also been experimentally proven.

If we have three sets of co-operating coils with the rotary coils all keyed upon the same shaft and spaced 120° apart, then we obtain a three phase system and the actions and reactions between the fields of the rotary and stationary coils of the several units neutralize each other so that no power is consumed in driving the rotary coils.

The homopolar rotary field coils may be variously formed and disposed; and the

magnetic fields produced by them used and combined in a great variety of ways, and the magnetic circuits may vary in form in any way to suit any particular use of the homopolar rotating magnetic field; and both D.C. or A.C. may be used in the co-operating coils; and when D.C. is used in the co-operating coils, its strength may differ in the stationary coil from that in the rotary, thereby making possible magnetic fields of various wave forms. By varying the widths of the co-operating coils we may vary the wave form of the magnetic field also.

Besides single phase, polyphase and direct current motors and transformers, this electromagnet lends itself to various new types of A.C. rectifiers; but all the above it is best to treat of in separate papers.

There is an equivalent system which may be possible, in which the coils and their magnetic lines aid and oppose each other at alternate successive periods, but in which the coils are not caused to be differential and non-differential by being wound over each other, but it is evident that such a system must be far inferior (if at all operative or practical) to the system shown and described herein where both magnetic fields are enclosed by both co-operating coils within the same space.

Since only one coil of the pair revolves, only one-half of the windings of the electromagnet rotate and these windings are in the form of simple coils thru which *D.C.* is flowing, hence centrifugal force and high voltage are no bar to rotation; and direct E.M.F. produces less strain on the insulation than an alternating E.M.F.; and all coils being in series reduces the voltage at the terminals of the rotary coils so that excessive voltage can be used in the various applications of the electromagnet.

Either the stationary or rotary coils, however, must produce polarities of opposite direction in a pair of units in any case. Fig. 2 has the rotary coils with polarities in a different direction in each unit.

Any number of sets of units such as Fig. 3 may be used and thus obtain any number of phases by giving each set a proper phase displacement.

Tesla uses a continuous magnetic circuit. I use a discontinuous magnetic circuit. The lines of force in the magnetic circuit surrounded by the coils in the Tesla system reverse in direction, whereas the lines of force in the magnetic circuit surrounded by the coils in my system do not reverse in direction.

My motor starts with full load just as Tesla's does, because the starter is applied on the co-operating coil shaft and not on the main shaft and in this respect it differs from all other non-self-starting motors, whether A.C. or D.C., which latter must all have the starter on the main shaft.

Three such sets of units as Fig. 3 may also be employed to get a three phase system, each set with the rotary coils at 120° displacement from the others.

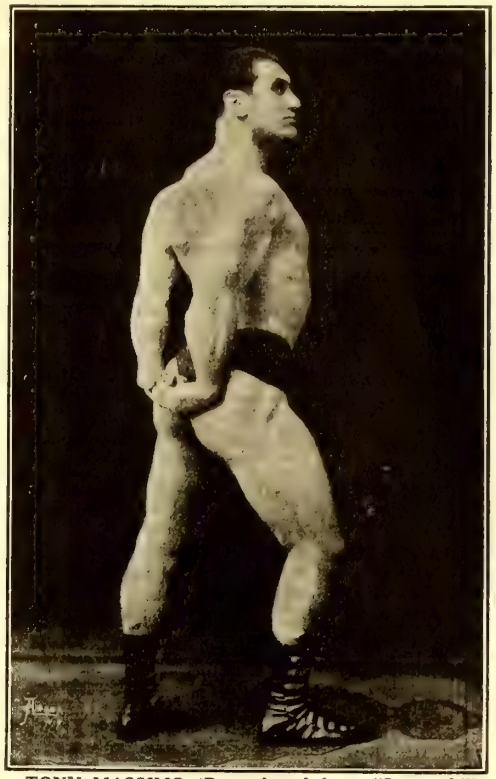
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Six high-powered stations controlled by the Radio Corporation of America were taken over at the outbreak of the war. They are at Marion, Mass.; New Brunswick and Tuckerton, N. J.; Bolinas and Marshall, Cal., and Kahuku, Hawaiian Islands.

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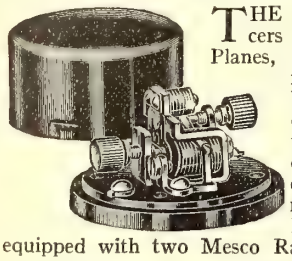
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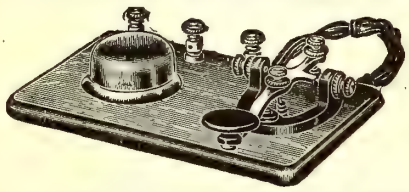
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MESCO WIRELESS PRACTICE SET



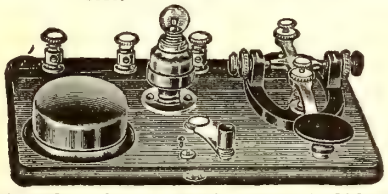
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Invisible Optic Telegraphy by Infra-Red Rays

By HENRY de GALLAIX

(*Continued from page* 1127)

of the parabolic mirror; it then runs over a second roller O¹ which tightens the ribbon and finally comes back to the box. Like a transmission tape, this band of paper always follows the same circuitous way. The speed of the movement is regulated according to the speed of emission of the Morse signals. If the transmission of the messages is speedy, it is convenient to give a greater speed to the ribbon and vice versa. The whole of the receiving mechanism, clockwork ribbon and its bearing can, by means of a micrometric dead-end screw and sliders P and R, move forwards and backwards so as to make it possible to always obtain the absolutely correct focus. At the top of the transmitter is an ordinary lens T, permitting a clear inspection of the telegram written on the endless paper ribbon.

Now let us see the physical phenomena which takes place in the receptor when the infra-red rays are received. These rays having gone thru the colorless glass fall on the parabolic mirror, which reflects them to a spot called the focal point. All rays are concentrated at the focus before dispersing again.

Therefore at this focal point the paper tape is arranged to pass, and which receives all the infra-red rays concentrated in one spot. This ribbon, the composition of which is quite special, and in which enters a good deal of zinc sulfate in allotropic condition, has the curious peculiarity of turning black instantaneously, when subjected to infra-red rays. The ribbon forming a closed circuit, it seems unavoidable that, after a full turn of the ribbon, fresh signals should be inscribed over the old ones. But a second and wonderful peculiarity of that paper is then used. The spot on the ribbon which has already recorded a signal, before coming for the second time to the focus of the mirror, goes thru a small closed chamber where it bathes in *blue light,* which has the effect of blotting out the black traces left on the paper by the infra-red rays.

From a military point of view, this has great significance. An apparatus of this type falling into the enemy's hands, even intact, will not reveal anything about the messages previously received, since soon after their emission and after they have been read, they are utterly effaced and could not be reproduced by any means. [*The signals would efface themselves in a short time anyway without the blue light bath, even tho a little more slowly, as Dr. Peter Cooper Hewitt has pointed out.—Ed.*]

Now that the description of the transmitting and receiving apparatus is complete, we may say a few words about their use and efficiency. To make telegraphic communication possible, the transmitter and receiver must face each other, so that the central longitudinal axes of the transmitter and receiver line up. Therefore careful aiming is necessary, and it is the first operation to be done when transmitter and receiver are set up first. For daily transmission transmitter and receiver are provided with a tubular sighting device without lens, but when the distance between the two apparatuses increases to one, two or three miles, telescopic sight is then required. If the sighting is done at night, the same devices are used, but the position of each apparatus is indicated by a quick flash of light produced by an ordinary electric flashlight. The receiver playing but a passive part in the invisible optic telegraphy, the

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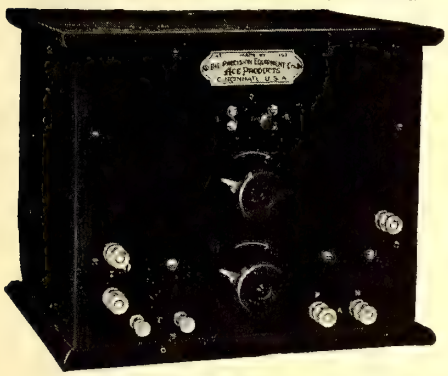
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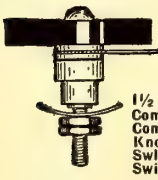
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distance at which messages sent by infrared rays can be received depends almost entirely on the power of the transmitter. Having had, at the battle front, the opportunity of testing the apparatus which I have just described, the numerous practical tests to which they were submitted gave the following results:

A transmission of one-half mile for a transmitting apparatus of a diameter of one foot; and a transmission of one, two and three miles for transmitters of two, three and five feet of diameter. These transmitters were electric searchlights on which a red manganese glass had been adapted. To be impartial, after enumerating the many advantages of the invisible optic telegraphy, I might as well confess its principal defect, for which no remedy has been found so far, but which it is hoped will soon be found. That defect is the great loss of energy incurred by first producing a source of white light and then in using only the infra-red rays incident to it. It is the greatest portion, say nearly 99/100ths of the luminous energy, which remains unproductive and thus the efficiency of invisible optic telegraphy compared to ordinary telegraphy is greatly reduced. But the advantage of its invisibility compensates in a large measure for this loss of energy. On the other hand, the solution which seems the simplest, i. e., to create directly a source of pure infra-red rays and emit them without the help of a manganese glass, which would no longer be of any use, has been studied for a long time.

INVISIBLE LIGHT IN WARFARE.

When a source of light is put at the principal focus of a converging lens the emergent beam consists of parallel rays and consequently does not change in cross-section as it proceeds. Often the narrowness of such a beam prevents its being observed. Greater accuracy was obtained by using a filter which permitted only the extreme red rays to issue. These would be invisible to an observer unless he protected his eyes from daylight by a similar screen, says R. W. Wood in *Proceedings of the Physical Society, London.* Through such a screen *only the red light could penetrate* and the eyes of the observer would be in a sensitive state owing to the exclusion of ordinary light. By such an arrangement secret signals can be transmitted. A variation of method was the use of a screen transmitting only ultra-violet light, which was received on a fluorescent screen. The range of signaling in both cases was about six miles.

The following arrangement proved of great value in maintaining communication between ships of the same convoy at night. In this case the light was sent out not as a parallel beam, but as a beam diverging in all directions. A Cooper-Hewitt mercury arc was the light source. It was surrounded by a glass chimney thru which only ultra-violet light emerged. This caused parts of the eye and natural teeth to fluoresce, while false teeth were black. The receiving apparatus is a barium-platino-cyanide screen placed in the principal focus of a converging lens. The range was about four miles.

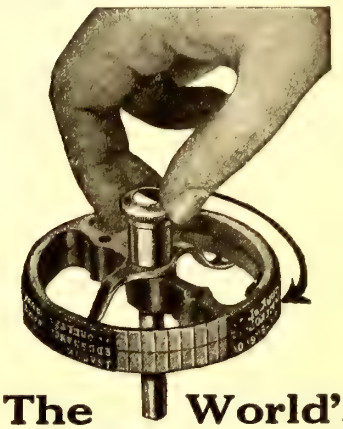
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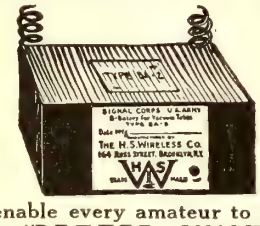
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By FLOYD L. DARROW

(Continued from page 1207)

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This article will not be complete without some brief account of the casting and grinding of a large lens. It is a task of unparalleled difficulty and requires the highest skill and the utmost patience. The big crucible in which the glass is melted consists of the purest clays and is made by specially trained craftsmen. Before receiving the "batch" materials it is heated very gradually for a week to a high temperature. Every step of the process is under perfect control and the stirring and melting proceed for days. When the glass is ready, skilled workmen lift the crucible from the furnace and pour its molten contents of dazzling brilliancy into an iron mold lined with sand. The mold is covered with an iron plate and lifted into an annealing furnace, *where it remains for a month very gradually cooling* from its high temperature down to ordinary temperature. But, if this annealing is not properly done, the glass will possess strains and inequalities that render it unfit for optical purposes.

Next comes the preliminary, rough grinding which alone requires several weeks. At frequent intervals the glass is examined for strains, veins and bubbles—flaws which may destroy its optical qualities. In this inspection work the *camera,* the *microscope* and an instrument called the *polariscope* are employed. The glass for the Lick objective was poured twenty times, with a month consumed for annealing after each pouring, before a satisfactory result was obtained.

Then comes the work of the skilled lens grinder, who polishes the glass with infinite care and shapes it in accordance with the curvatures calculated by the optician. And these curvatures are calculated by pure mathematics. Finer and finer grinding materials are used and very frequent tests are made to determine the progress of the work. Two lenses are ground simultaneously—the double convex crown glass and the plano-concave flint glass. The curvatures of the two must agree perfectly, i.e., *within one two-hundred-fifty-thousandth of an inch.* The lenses are centered in a lathe and after grinding the edges they are fitted together for mounting in the telescope tube.

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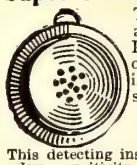
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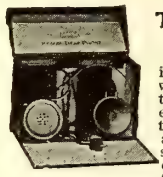
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Science In Slang

By EMERSON EASTERLING

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(*Continued from page* 1165)

tell how we are sending our text-books back to be altered to fit the latest model theory—one that seems to have come to stay—only time can tell that."

"You've told us all about the stuff now," Wyman Stewart spoke up, cramming his hands into a leather coat and looking intently at a picture of a girl in Los Angeles. "Now what *is* it—anything like babism or reverse English?"

"It—the theory of relativity is something to the effect that a light ray is deflected like radioactive emanations by certain forces. Take radium for instance. We find there are the emanations, the researchers nicknamed Alpha, Beta, Gamma. A, B, C, in English. One of these emanations seems to be nothing more than an ethereal disturbance, the other two are affected by the magnet; still the other is affected, if we could run across some affector—perhaps.

"In electricity we find that there is a strict relation between what we term electricity and magnetism, one induces a corresponding flow in the other. If we only could fathom it out we would find that that relation extends—later I look for the fact to be unearthed bringing to light the knowledge of the relations, and further knowledge of the extent of the relations—we would find that the light, current flow, magnetic flux, sound, etc., which are resultants of the working of a force we define as vibration, are able to be controlled by the proper manipulation of that force. What I mean is that we could shine a light around a corner without the use of a mirror, as we distort visions with lens and change sound vibrations with the audion amplifier. And that is not all. We would know more of mind and metaphysics as a result of our researches.

"The deflecting of the light beam by the sun proved that light rays were affected in much the same manner—perhaps—as the magnetic and electrical fields deflect the Alpha and Beta rays——"

"And I heard something about the old chronometer being given the cold hand as far as universal time was concerned," Punk interrupted.

"Yes, for the very simple reason that TIME exists ONLY in man's mind. Nature knows no such thing as TIME. Anyone can see that time would be different at different places in the universe. We gage our Ingersolls by the revolution of the earth on its axis and its annual trip around Old Sol. The Martians set their Walthams by another scale. As the Centigrade and Fahrenheit scales don't change the temperature, neither do our conceptions of time alter the seasons. Because the inhabitants (were there any) on the moon and those of Mercury couldn't agree about a certain stellar happening—one saying it was so many days ago, the other saying it was so many months or years (if they calculated so)—wouldn't make either one necessarily incorrect. There still exists the mathematical relations, and by clever computing we could devise a schedule card for interplanetary communication that would keep the peace and harmony of the universe uninterrupted."

"An' they couldn't be much worse than our railroad time-tables at that," added Bender.

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The wonderful machine God gave you was built to run a hundred years or more, but it will burn itself out and break down long before that, like any man-made piece of machinery, if you abuse it and let it get into a dilated state, and then fail to make the necessary repairs. The distress occasioned by constipation, indigestion, headaches, nervousness, or any other ailment, is merely a warning flashed to your brain—and by the brain to the sensory nerves—that one or more of your vital organs are not running right; that they need attention and need it **quick.** You would be poisoned to death within a few days if your kidneys went on strike. And you are being poisoned by constipation just as surely, although more slowly, when your intestines lose the power of eliminating promptly and thoroughly the waste matter in the food you eat.

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I have spent my life studying out the means whereby these wonderful, hidden forces of Nature may be brought into play and utilized to their fullest extent in the upbuilding of weak, ailing, discouraged men and women. By means of them I built up myself until I am called the most perfect and the strongest man in the world. By the same method I have brought and am bringing health, strength, vitality, confidence and courage to my pupils in every part of the civilized globe. What I have done for **them** I can do for **YOU**—there isn't the slightest doubt of it. **I guarantee results.** I GUARANTEE to improve your condition—whatever it may be and whatever brought you to it—if you will follow my directions.

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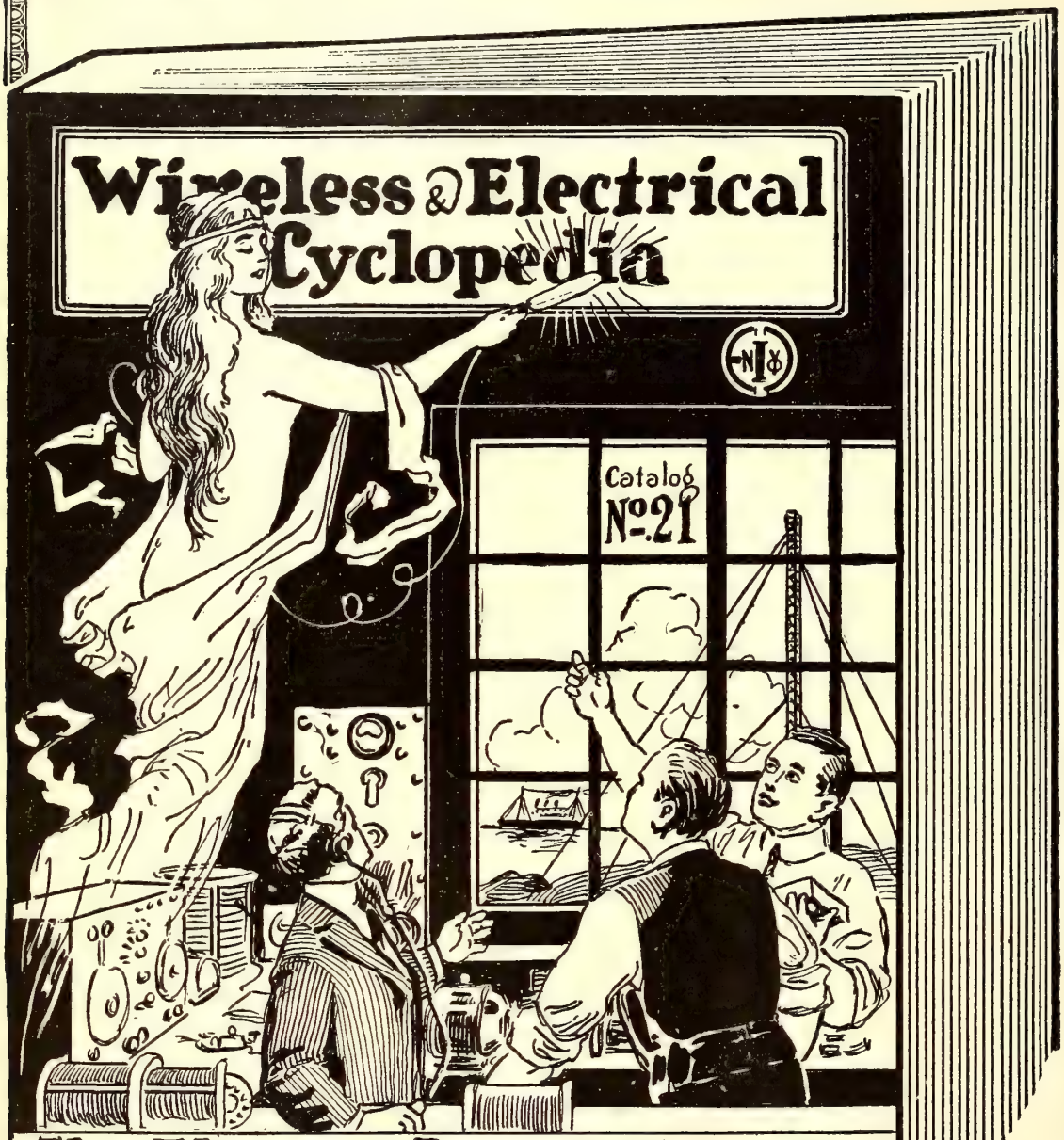
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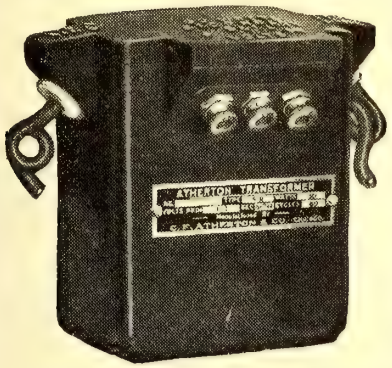
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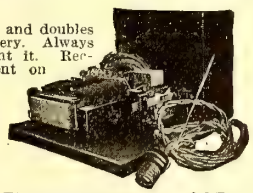
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A Land and Water Speed Demon

By EMERSON EASTERLING

(*Continued from page* 1129)

on the lashing deep—that don't mean the ocean; it's the *briny deep*. Forgot to mention that machine is steered in water by means of disc on front wheel, which cannot be seen in picture.

What do you think of the idea of escaping from the Federal authorities—you know that you just can't cut out your wireless experimenting, even if the Government says *NO* to you, er, ah, *us*—after they have discovered that you have an active set in your garret in one of the Frymobiles?

Of course, all "Radio-Bugs" will not be satisfied with such an invention unless it has a set of ether machinery aboard. Wouldn't it look great to see yourself whizzing along with a dot-and-dash hook stuck up on *her?* I'll bet you would have to drive down by Maggie's house, wouldn't you?

But if you should, don't start up your motor when friend Maggie—or is it Jane—is near the rear, for fear that your dear would be swept clear of the sidewalk—the old boat has some breath (no, not any per cent).

Also, kids, if you should change your mind as to destination you could get around pointing in the other direction in as quick a time as any other vehicle. The—aeromobile, if you care to—can turn in its own length.

But as yet our friend Byron has no reverse. But it is in its experimental stage now.

But the machine is equipt with brakes—for land use—so that when friend driver spots a "speed cop" in the distance he can slow down before he gets the polite request to appear before the judge the next day.

If you have traveled in an airplane, a Ford and a submarine you should complete your variety by a ride in the—land-flivver. It takes the roads like a ten thousand dollar and twenty cent car.

Silvering Mirrors

By D. McCLANAHAN

(*Continued from page* 1147)

trated or 26% ammonia—when the silver has dissolved add ½ pint of distilled water and let it stand 24 hours—filter and it is then ready for use.

Solution No. 2—Dissolve 8 ounces of tartaric acid in one quart of distilled water, let it stand for 24 hours—the older this solution gets the better. Reduce this to 10% by using an acid hydrometer—if it should be stronger than 10% add distilled water until it becomes so. Filter before using.

To silver, take 4 ounces of Solution No. 1, put it into 1 quart of distilled water. Take 4 ounces of Solution No. 2, put it into 1 quart of distilled water—next mix Solutions No. 1 and No. 2 by pouring from one pitcher to another—then flow the solution on the glass, allowing it to remain for one hour.

Metallic Mirror Process.

Make a liquid preparation by melting into a porcelain vessel 1 dram of lead, 1 dram of tin, 1 dram of C. P. Bismuth. When these are melted together add 10 drams of mercury before the mass has cooled. The mercury will cool it sufficiently for use. Lay the glass flat with the clean side up and pour the metallic liquid over it, completely covering. Raise the glass almost perpendicular, letting the amalgam drain off. When the coating has become hard and dry, coat with drop black ground in Japan, and then thin with turpentine.

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GEORGE HEINEMANN
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January 15, 1920

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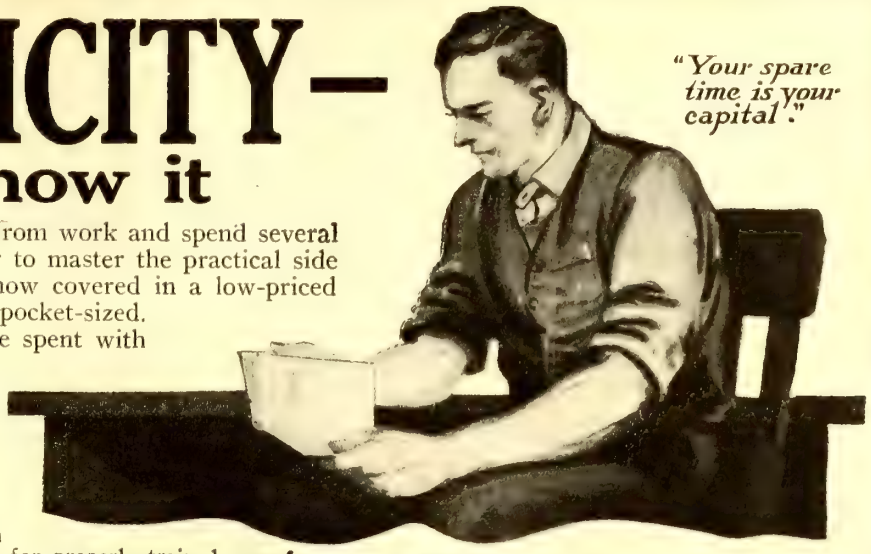
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EDITORIAL



The Earth's Interior Molten?

MANY things that we take for granted sometimes turn out to be very much different than we first thought them to be. Take for instance the earth's interior. Our physics instructors and scientists taught us for years that the earth was once a huge molten sphere, just beginning to cool down. The interior and center is supposed to be entirely fluid—a huge molten mass where all the known elements "including rocks" are in a liquid state, at a tremendously high temperature running up into thousands of degrees Fahrenheit. Our physics instructors by way of impressing us were wont to tell us that the hard crust of the earth is just about as thick in proportion to the rest of the earth as the peel is to an orange.

And in order that we could not doubt their words our instructors give us "proofs" to back up their contentions.

First, we are pointed out that the volcanoes—the ventholes of the liquid earth's interior—prove that the earth is fluid inside. Witness the many volcanic eruptions belching forth molten rock, lava and brimstone. And to further disarm our suspicions we are shown that as we descend into the earth's interior, the temperature rises one degree Fahrenheit for every 40 to 50 feet. It matters not where we bore a hole or sink a shaft into the earth's interior; the rise of temperature as we descend is pretty uniform the world over, even in high latitudes. These are both *facts,* well authenticated and are not doubted by any sane person.

But recently scientists began wondering if these facts really proved that the earth's interior was in a molten state. And the more they wondered the more they learned. For one thing they said: If the earth's interior is really in a molten state, liquid in other words, why does not this molten mass rise and fall with the tides which undoubtedly *it would do* were it liquid or even plastic. Accurate measurements, however, show that there is no such tide in the interior of the earth. If there were, the crust of the earth, due to the tidal effects of the moon and the sun, would constantly rise and fall, for one thing, and we would have extensive daily earthquakes. But, you will say, the earth's crust is so solid that there may well exist a tide inside of the earth that we cannot perceive. This is hardly even probable, however, because in that case the gigantic tidal effects created—a million times greater than any ocean tide—would burst thru the earth's crust in short order. Do not forget that if the orange peel analogy holds good, there will be a liquid mass some 7,000 miles deep! Contrast that with the average depth of the ocean of less than one mile and then figure out the gigantic tides a liquid interior would produce!

But our modern scientist does not stop there. He goes and counts the very few active volcanoes and finds that as ventholes for a molten globe 7,000 miles in diameter, they appear preposterous. These few holes could no more serve as vents for this big globe than you could vent an armory with a soda straw.

On top of this our astronomers come along and prove mathematically, without a shade of doubt, that *the earth is at least as rigid as steel.*

But how explain the volcanoes and our deep hot shafts? Our scientists prefer to think—and they can prove it, too, that the earth's interior is not molten. The volcanoes are merely ventholes for local molten pockets. The earth's heat is produced by *radium,* or rather *radioactivity.* And while the earth's interior is hot—very hot—it is not fluid.

While boring the famous Simplon tunnel, many hundred feet *above* sea level, the heat became unbearable and artificial cooling became necessary. Recent tests showed that the radium contents of the rock could easily produce this great heat.

The solution of the earth's heat, then, doubtless is *radium.*

H. GERNSBACK.

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THOUGHT

The Greatest Commercial Product in the World

By Charles F. Haanel

YOU are, because you think. When you cease to think, you cease to exist. You are therefore what you think.

Thought is a spiritual activity; in fact, it is the only activity which the spirit possesses. All spiritual activities are creative, because spirit is the one creative Principle in the Universe. Thought is mind in motion just as wind is air in motion. When a thought goes out into the world, it combines with other similar thoughts and forms an idea. The idea then exists independently of the thinker. This idea becomes a seed-thought in the spiritual world and as soon as it finds congenial soil, it begins to sprout and grow and bring forth fruit a thousand fold.

FOR this reason, we find that the men who hold the $50,000.00 positions are always men who think, who know how to control their thought processes. A single idea is often of more value than all the lost mines of Mexico, all the argosies that ever sailed from the Indies and all the silver-laden ships of storied Spain. An idea has life, vitality; it is the essence of the creative spirit and can reproduce itself exactly the same as a germ or a cell, so that in an incredibly short time there may be millions of these ideas all clamoring for self-expression. As thought is creative, it is constantly trying to express itself in form. For this reason thought leads to action and actions bring about results and conditions.

CIRCUMSTANCES and environment are, therefore, the result of thought, but frequently of unconscious and destructive thought for thought will create disagreeable, discordant and destructive conditions, just as readily as it will create wealth, beauty, refinement and harmony. We may think what we will, but the result is governed by an immutable law. That we reap what we sow is scientifically exact.

THOUGHT was until recently the possession of the few, but it is now about to become the priceless possession of the many. Until recently, the few assumed the privilege of thinking for the many, but men are beginning to do their own thinking and this is multiplying results and bringing about a new era, an era containing limitless possibilities.

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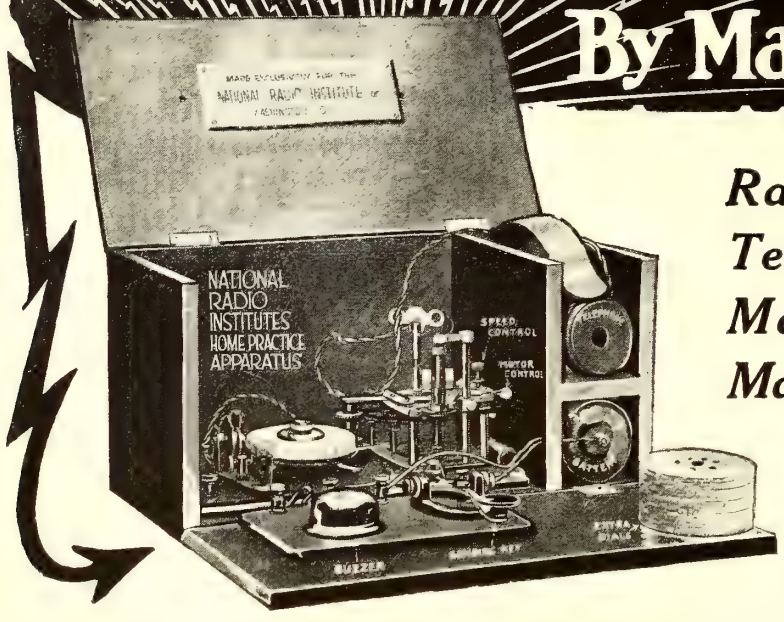
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I WANT the privilege of sending you a Master Key. You will find it a priceless possession, a Key with which many are converting loss into gain, fear into courage, despair into joy, lack into plenty, hope into fruition, a Key which thrills, fascinates, carries conviction, perception, understanding, power, a Key by which you will be enabled to organize victory, realize your ideals and make your dreams come true. Send me your address for a copy, it is free, there is no cost or obligation of any kind.

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Radio Telegraphy and Telephony Can Now Be Mastered At Home By Marvelous New Method

THROUGH our Famous Home Study Course and with the help of our wonderful Natrometer outfit you can quickly learn both Wireless Telegraphy and Telephony in a few short weeks in your spare time and at home—without inconvenience or loss of time from work. Students of this institute have finished the course and secured their official license after approximately only ten weeks' instruction.

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of the National Radio Institute. It is a wonderful set designed and built especially for us and comes to you complete in neat carrying case. It embodies the same type of wireless instruments which are used by the United States Bureau of Navigation in testing applicants for first grade wireless operator's license, with the addition of many improvements developed through our years of experience in this field. The Natrometer automatically sends you wireless messages just as you would receive them from a station thousands of miles away. We do not merely loan you the Natrometer. We give it to you. It becomes your personal property upon your completion of the course.

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Students of the National Radio Institute receive the following:

Complete combination course in Wireless Telegraphy and Telephony—Special post-graduate course at our large Washington school, if desired—

Five text books, one hand book, forty-six special lessons and eighteen personal examinations—

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First Grade License Guaranteed

Our course is so thorough and our method of instruction so practical that we are able to guarantee that, after successfully completing our course, you will be able to pass the examinations and secure a first grade government operator's license.

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The pay of Wireless Operators, Radio Inspectors, Wireless Aids, Machinists, Electricians and Wireless Engineers varies from $225 a month to start for operators to $15,000 a year and salaries should advance steadily in line with the rapid developments in this profession. The demand for wireless operators and workers in all branches of wireless is enormous and positions are guaranteed to all graduates of this institute as soon as they secure their first grade government license.

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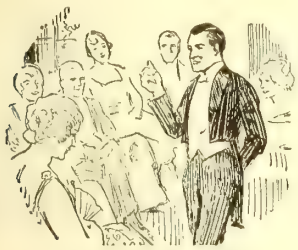
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—and the World is at Your Feet

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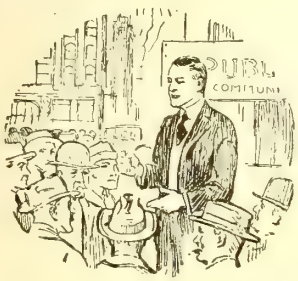
An interesting and convincing talker is popular—the center of attraction at all social affairs.

Not Only WHAT You Say, But HOW You Say It

The world is full of splendid merchandise that doesn't move—"order takers" who should be salesmen—political ideas that meet continual defeat—good men earning less, much less, than they're worth; all because so few know how to use that God-given faculty of speech which is one of man's greatest weapons.

Let Me Teach You

I can teach you how to carry conviction—how to make what you say have the effect you want it to, whether you talk to sell, to convince or to entertain. I can eanble you to overcome timidity—give you confidence in yourself, develop your personality, improve your memory.



If your words carry conviction you can influence a crowd to think as you do.

I can show you the art of brevity, the value of silence. Instead of being funny at the wrong time, I can suggest when and how to use humor with telling effect. Do you know the knack of making oral reports to superiors? Do you know the right and wrong way of presenting complaints, estimates, and to issue orders?

CAN YOU DO THIS?

Can you talk as well in public as at home?

Can you get financial backing when you want it?

Can you win confidence, friendship, love through your speech?

Can you make people listen when you talk?

Can you hold your hearers spellbound?

Can you give humorous, extemporaneous talks?

Can you address any size audience from one to thousands?

Can you get up and talk any time, any place, without nervousness?

I can show you how to answer complaints, how to ask the bank for a loan, how to ask for an extension on your note. Another valuable lesson I teach is how—instead of antagonizing people when they disagree with you, you may swing them around to your way of thinking in a pleasant sort of way. You will learn the best way to get things done—the secrets of diplomacy.

Results in One Evening

Now one of the remarkable things about my method is that it requires little study and time.



Among strangers or at home people listen eagerly.

Nearly anyone can grasp the principles in an evening. Hundreds of letters pour in every day proving that my method brings almost immediate results.

Thousands Have Benefitted

Among the enthusiastic students of my Course are thousands of prominent men in all walks of life—they include business men, preachers, lawyers, teachers, physicians, bankers, etc., etc.

Frederick Houk Law.



At a committee or board of directors' meeting you will be able to hold attention when you talk.

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You send no money. Just mail the coupon and, all charges prepaid, you will receive the Course—you are under no obligation whatever—and if you are not entirely satisfied send it back any time within five days after you get it—you will owe nothing.

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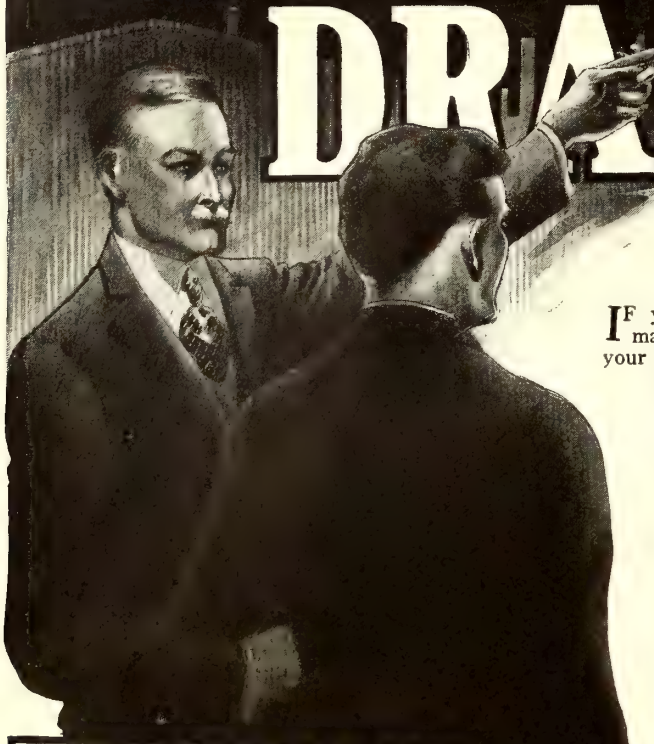
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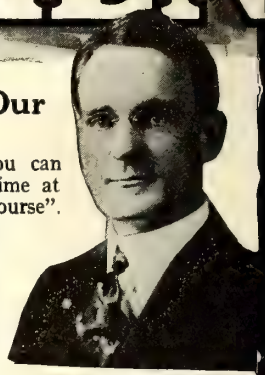
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IF you are a person of even average ability, you can master this profitable profession in your spare time at your own home through our famous "Home Study Course". You can in a short time become a first class Draftsman because of the fact that our training is most thorough and practical, and because you will be personally instructed and coached by the President of the school, Roy C. Claflin, whose long experience as a draftsman and a teacher especially qualifies him to give you the kind of training you need. We teach you to work from actual models just as you would in a drafting room, instead of merely copying from books.



Roy C. Claflin, President, The Columbia School of Drafting

Draftsmen Get $35.00 to $100.00 a Week

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General construction companies, manufacturers of machinery, locomotives, and automobiles, designers of tools and special equipment, makers of aeroplanes, large engineering companies; in fact, all branches of industry need DRAFTSMEN today in greater numbers and at better salaries than ever before.

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As our students are given practical Drafting work from the beginning of our course, they grasp the essentials quickly, so that no previous training or drafting experience of any kind is required to take up this work with us. You do not even need a high school education to learn Professional Drafting as taught by this school and the training we give you is all that is needed to secure a position as Draftsman (Read Lawrence P. Johnston's letter).

How Columbia Students Succeed

(More letters on request)

"I have accepted a position as draftsman, paying $2,640.00 a year to start. I had no previous drafting experience aside from my training with you, which has proven all that was needed for me to become a professional draftsman." Lawrence P. Johnston.

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In Three Months You Can Be A Master

Of All Starting, Lighting and Ignition Systems and Storage Batteries

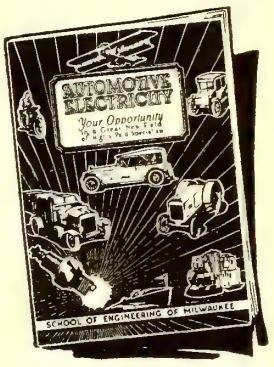
Our method of intensive, highly specialized training under practical experts in our big, fully equipped laboratories makes you a master of every phase of automotive and gas engine electrical equipment. You learn by actual work on models of every type of system in use. You are taught everything, from the fundamental principles of electricity to the most intricate problems in construction, operation, testing and repair. In three short months, by devoting full time to your training, you can be an expert.

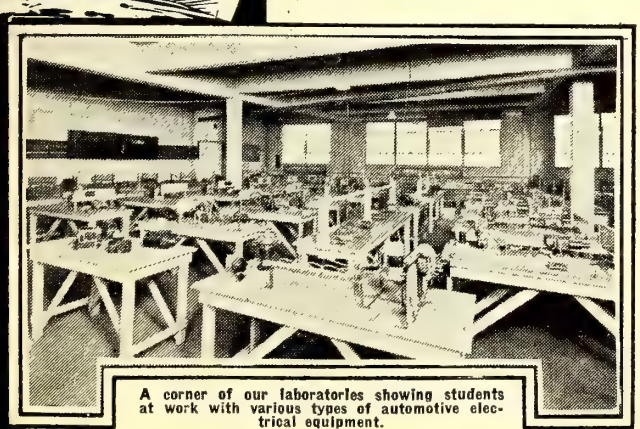
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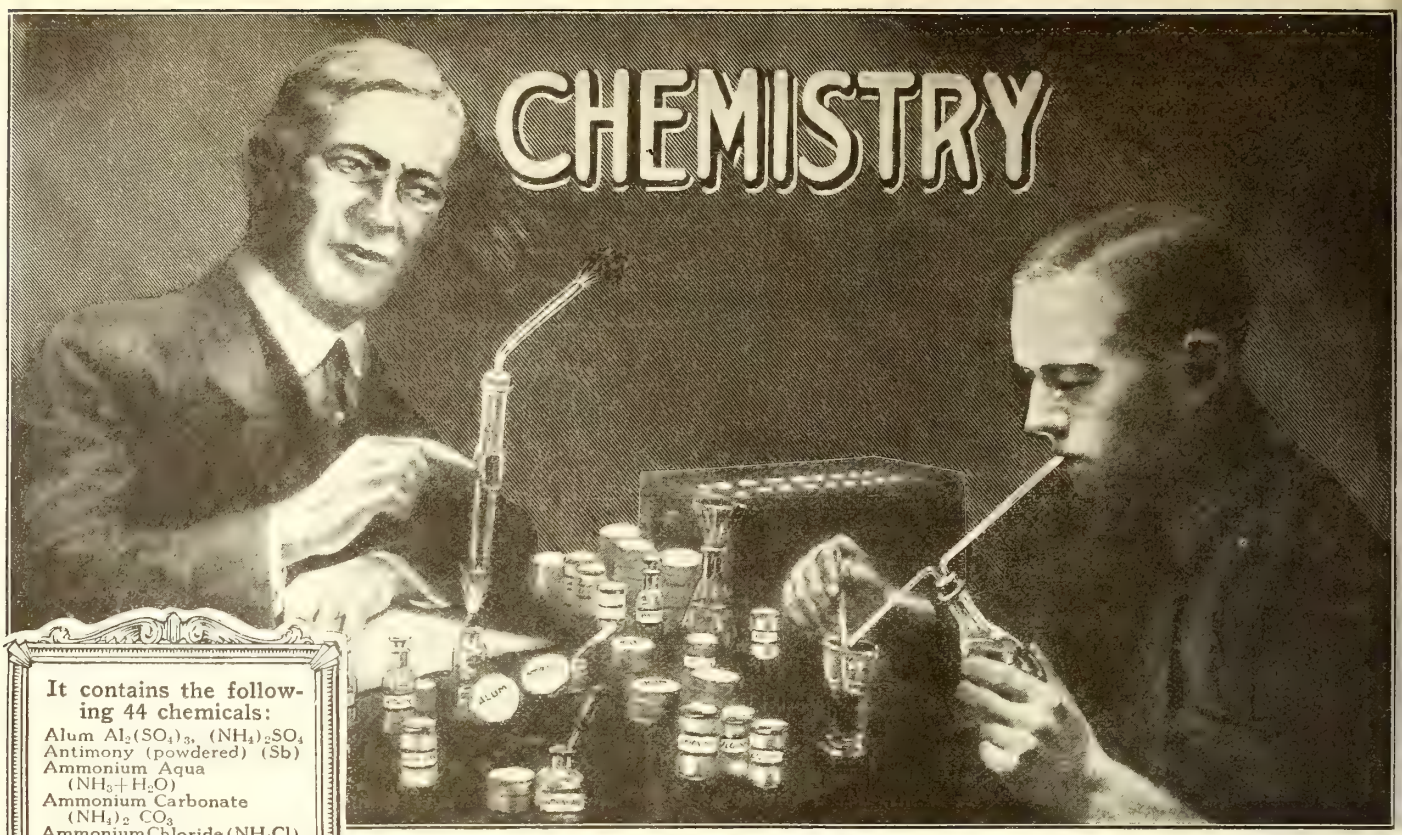
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DESCRIPTION OF THE OUTFIT:

The outfit consists of forty-four (44) Chemicals all C. P. (chemical pure) put up in appropriate wooden boxes, glass bottles, and hermetically closed jars. The acids are put up in glass bottles, with ground-in glass stoppers and there is a sufficient quantity of chemicals supplied (mostly one to two ounces) enough to make dozens of experiments with each. See list of Chemicals herewith.

The apparata furnished are all of the best obtainable make and of standard laboratory size and shape. A list of the 17 pieces of apparata furnished with this outfit is printed also herewith.

The Instruction book is a real **Chemistry Course for the Beginner.** Some of the Contents are: **Division of Matter:** This is a Treatise on Elementary Chemistry and deals with the theory of the Elements, Molecules and Atoms, etc. **Chemical Nomenclature:** This explains in simple language the derivation of the chemical names of the Elements and their compounds. There is a chapter on **Laboratory Operations; Glass Working; First Aid; Fire Extinguishers; Experimenters' Aphorisms,** etc.

A good part of the book is devoted to Weights and Measures. The Metric System, the English system and the U. S. System are fully explained.

The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

Among the **100 Experiments** are:

How to make chemical tricks; How to make invisible and magic inks; How to test flour; How to test soil; How to Make Chlorine Gas and smoke (German War Gas); How to bleach cloth and flowers. How to produce Oxygen and Hydrogen; How to make chemical colors; How to test Acids and Alkalies and hundreds of interesting hints and formulas.

It contains the following 44 chemicals:

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Antimony (powdered) (Sb)
Ammonium Aqua (NH_3+H_2O)
Ammonium Carbonate $(NH_4)_2\ CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride $(BaCl_2)$
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride $(CaCl_2)$
Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_4 2H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate $(MgCO_3)$
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
Sulphate of Nickel $(NiSO_4)$
Sulphate of Zinc $(ZnSO_4)$
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
Zinc Carbonate $(ZnCO_3)$

The following apparata are furnished:

One Standard Washbottle
One Alcohol Lamp
One Conical Glass Measure
One Erlenmeyer Flask
One Glass Funnel
One Delivery Tube
Six Assorted Test-Tubes
One Test-Tube Holder
Ten Sheets of Filter Paper
One Glass Dropper
One Spoon Measure
Glass Tubing
One book containing Treatise on Elementary Chemistry and 100 Chemical Experiments to be performed with this outfit.

The price is still $5.00. **Shipping Weight 10 lbs.** **(Can be shipped by Express only.)**

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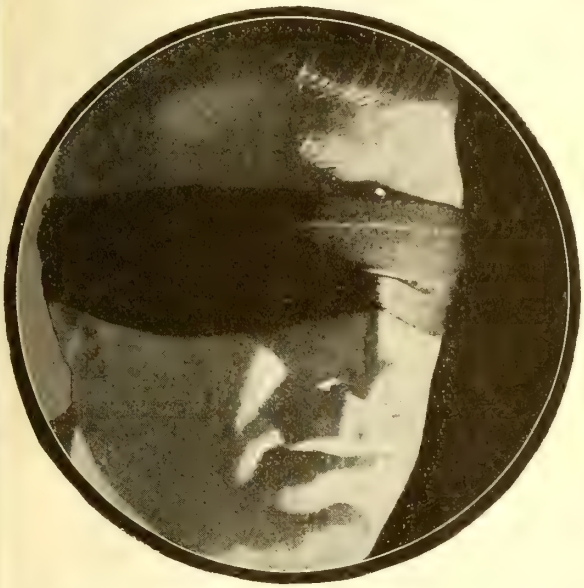
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A Startling Memory Feat That You Can Do

How I learned the secret in one evening. It has helped me every day



WHEN my old friend Faulkner invited me to a dinner party at his house, I little thought it would be the direct means of getting me a one-hundred-and-fifty per cent. increase in salary. Yet it was, and here is the way it all came about.

Toward the close of the evening things began to drag a bit, as they often do at parties. Finally some one suggested the old idea of having everyone do a "stunt." Some sang, others forced weird sounds out of the piano, recited, told stories, and so on.

Then it came to Macdonald's turn. He was a quiet sort of chap, with an air about him that reminded one of the old saying that "still waters run deep." He said he had a simple "stunt" which he hoped we would like. He selected me to assist him. First he asked to be blindfolded securely to prove there was no trickery in it. Those present were to call out twenty-five numbers of three figures each, such as 161, 249, and so on. He asked me to write down the numbers as they were called.

This was done. Macdonald then astounded everyone by repeating the entire list of twenty-five numbers backwards and forwards. Then he asked people to request numbers by positions, such as the eighth number called, the fourth number, and so on. Instantly he repeated back the exact number in the position called. He did this with the entire list—over and over again, without making a single mistake.

Then Macdonald asked that a deck of cards be shuffled and called out to him in their order. This was done. Still blindfolded, he instantly named the cards in their order backwards and forwards. And then to further amaze us, he gave us the number of any card counting from the top, or the card for any number.

You may well imagine our amazement at Macdonald's remarkable feat. You naturally expect to see a thing of this sort on the stage, and even then you look upon it as a trick. But to see it done by an everyday business man, in plain view of everyone, blindfolded and under conditions which make trickery impossible, is astonishing, to say the least.

ON THE way home that night I asked Macdonald how it was done. He said there was really nothing to it — simply a memory feat, the key to which anyone could easily learn in one evening. Then he told me that the reason most people have bad memories is because they leave memory development to chance. Anyone could do what he had done, and develop a good memory, he said, by following a few simple rules. And then he told me exactly how to do it. At the time I little thought that evening would prove to be one of the most eventful in my life, but such it proved to be.

What Macdonald told me I took to heart. In one evening I made remarkable strides toward improving my memory and it was but a question of days before I learned to do exactly what he had done. At first I amused myself wth my new-found ability by amazing people at parties. My "memory feat," as my friends called it, surely made a hit. Every one was talking about it, and I was showered with invitations for all sorts of affairs. If anyone were to ask me how quickly to develop social popularity, I would tell him to learn my memory "feat"—but that is apart from what I want to tell you.

The most gratifying thing about the improvement of my memory was the remarkable way it helped me in business. Much to my surprise I discovered that my memory training had literally put a razor edge on my brain. My brain had become clearer, quicker, keener. I felt that I was fast acquiring that mental grasp and alertness I had so often admired in men who were spoken of as "wonders" and "geniuses."

The next thing I noticed was a marked improvement in my conversational powers. Formerly my talk was halting and disconnected. I never could think of things to say until the conversation was over. And then, when it was too late, I would always think of apt and striking things I "might have said." But now I can think like a flash. When I am talking I never have to hesitate for the right word, the right expression or the right thing to say. It seems that all I have to do is to start to talk and instantly I find myself saying the very thing I want to say to make the greatest impression on people.

It wasn't long before my new-found ability to remember things and to say the right thing at the right time attracted the attention of our president. He got in the habit of calling me in whenever he wanted facts about the business. As he expressed himself to me, "You can always tell me instantly what I want to know, while the other fellows annoy me by dodging out of the office and saying 'I'll look it up.'"

* * * * * * *

I FOUND that my ability to remember helped me wonderfully in dealing with other people, particularly in committee meetings. When a discussion opens up the man who can back up his statements quickly with a string of definite facts and figures usually dominates the others. Time and time again I have won people to my way of thinking simply because I could instantly recall facts and figures. While I'm proud of my triumphs in this respect, I often feel sorry for the ill-at-ease look of the other men who cannot hold up their end in the argument because they cannot recall facts instantly. It seems as though I never forget anything. Every fact I now put in my mind is as clear and as easy to recall instantly as though it were written before me in plain black and white.

We all hear a lot about the importance of sound judgment. People who ought to know say that a man cannot begin to exercise sound judgment until he is forty to fifty years of age. But I have disproved all that. I have found that sound judgment is nothing more than the ability to weigh and judge facts in their relation to each other. Memory is the basis of sound judgment. I am only thirty-two, but many times I have been complimented on having the judgment of a man of forty five. I take no personal credit for this—it is all due to the way I trained my memory.

* * * * * * *

THESE are only a few of the hundreds of ways I have profited by my trained memory. No longer do I suffer the humiliation of meeting men I know and not being able to recall their names. The moment I see a man his name flashes to my mind, together with a string of facts about him. I always liked to read but usually forgot most of it. Now I find it easy to recall what I have read. Another surprising thing is that I can now master a subject in considerably less time than before. Price lists, market quotations, data of all kinds, I can recall in detail almost at will. I rarely make a mistake.

My vocabulary, too, has increased wonderfully. Whenever I see a striking word or expression, I memorize it and use it in my dictation or conversation. This has put a remarkable sparkle and pulling power into my conversation and business letters. And the remarkable part of it all is that I can now do my day's work quicker and with much less effort, simply because my mind works like a flash and I do not have to keep stopping to look things up.

All this is extremely satisfying to me, of course. But the best part of it all is that since my memory power first attracted the attention of our president, my salary has steadily been increased. Today it is many times greater than it was the day Macdonald got me interested in improving my memory.

* * * * * * *

WHAT Macdonald told me that eventful evening was this: "Get the Roth Memory Course." I did. That is how I learned to do all the remarkable things I have told you about. The publishers of the Roth Memory Course—The Independent Corporation—are so confident that it will also show you how to develop a remarkable memory that they will gladly send the Course to you on approval.

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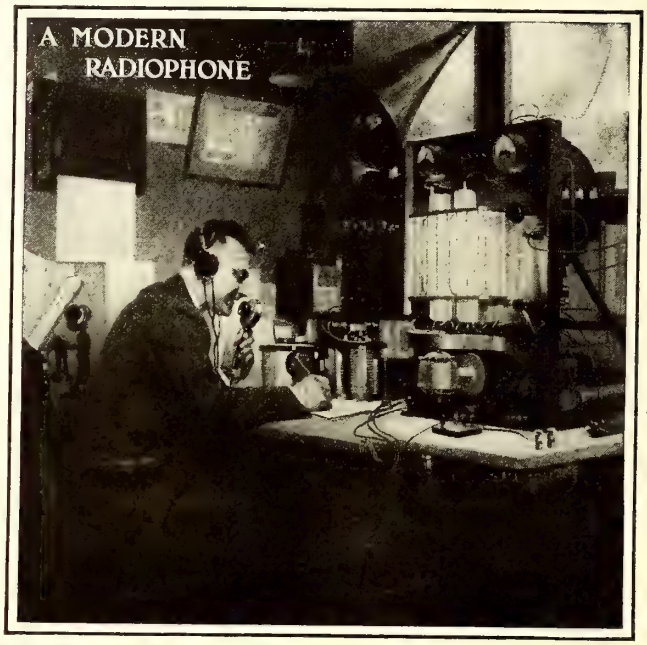
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From the longhand letter *l* rub out everything except the upper part—the circle—and you will have the Paragon E. ○

Write this circle at the **beginning** of / and you will have Ed. /

By letting the circle remain **open** it will be a **hook,** and this **hook** stands for **A.** Thus / will be **Ad.** Add another **A** at the end, thus / and you will have a girl's name, **Ada.**

From *n* eliminate the initial and final strokes and ○ will remain, which is the Paragon symbol for **O.**

For the **longhand** *m*, which is made of 7 strokes, you use this **one** horizontal stroke —

Therefore, —○ would be **Me.**

Now continue the **E** across the **M,** so as to add **D**—thus / and you will have **Med.** Now add the **large** circle for **O,** and you will have / (medo), which is **Meadow,** with the silent **A** and **W** omitted.

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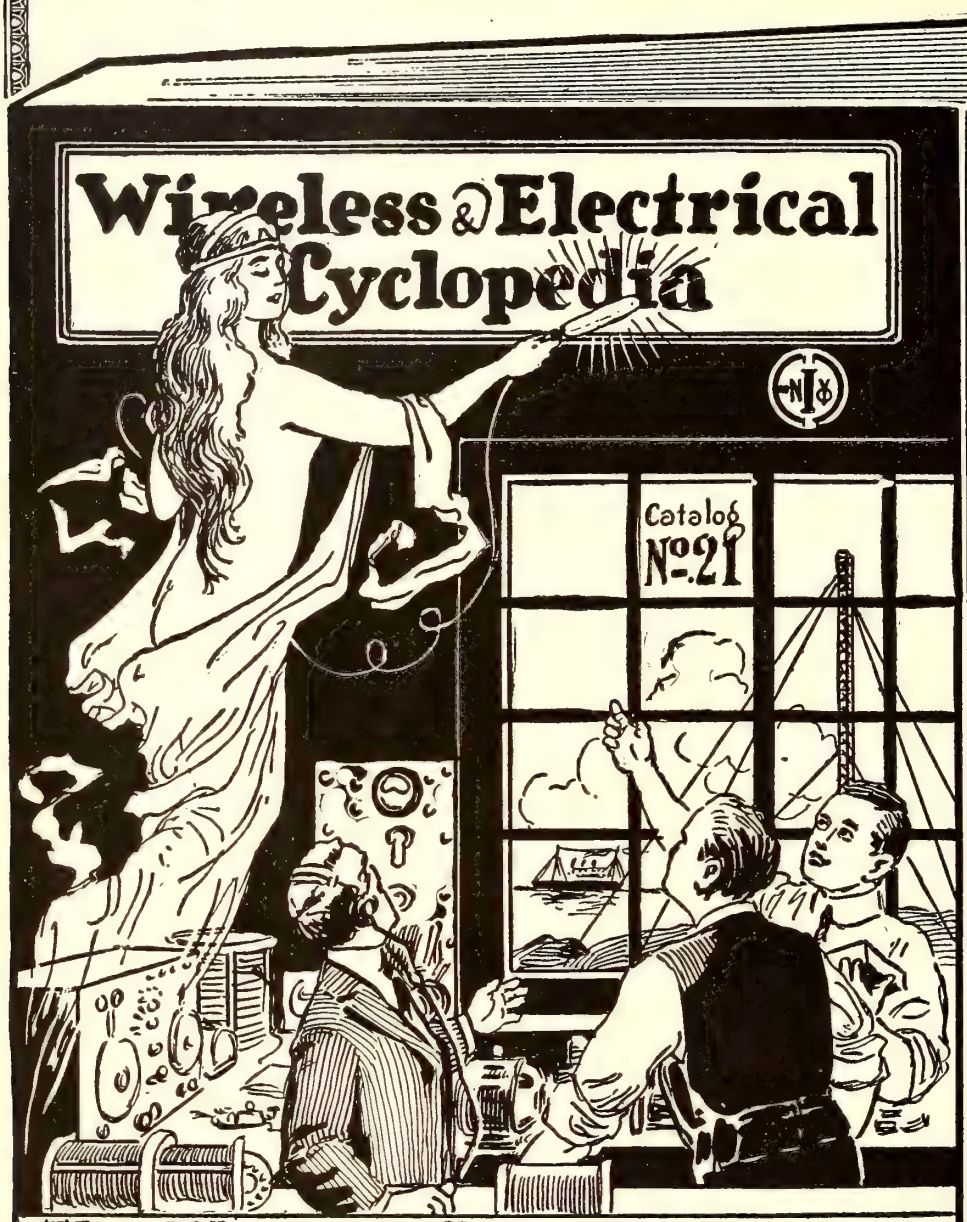
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By A. L. Pelton



MY name is Pelton — Albert L. Pelton. Four years ago I was as poor as a church mouse. I was out of a job, $300 in debt, and my wife and two children were living on starvation rations. Yes, I've known the bitterest kind of want.

Today I have money and all that money will buy. I have my own home. I have no worries about high prices of food or clothing or rent.

Even if I never make another nickel, I don't think I will ever have to worry about money matters.

During the past three years I have been making on an average of over a thousand dollars a week.

That's quite a change from the time I was "on my uppers", isn't it?

Now let me tell you how I did it.

You will probably think I'm funny when I tell you that for twelve years I held in my hand the secret that at last won me riches.

But it's true.

For twelve years I struggled—with gold right in my hand.

It was this way.

I used to sell books—from door to door—eking out a poor man's living.

One of the books I sold was written by Dr. Frank Channing Haddock.

I never thought much about the book—although I sold a few from week to week.

For twelve years I never even took the trouble to read it.

It was called "Power of Will".

I didn't know anything about will power.

What's more, I didn't care.

I thought it might be a good book for fellows who *had* to read it.

But I was too busy earning a living to bother about will power.

Probably I thought then, as tens of thousands think today, who've heard and read about this great book—that will-power was some myth, or impractical thing for dreamers.

You see—I hadn't analyzed the lives of the world's greatest men then, and discovered that will-power is the mightiest force men have ever known.

I was fooling myself—cheating myself fearfully, as I found out later.

One day I ran across a man who had purchased the book from me a few months back.

He stopped me on the street and said, "Hello, Pelton, say, I'd like to have another copy of that Haddock book,—can you send it up right away?"

I told him I would. Then I asked him casually if he liked it.

What he told me made me go home and *read* the book myself—for the first time since I began to sell it twelve years before.

That same evening I borrowed $300.

The next day I was in New York.

I secured the exclusive selling rights to the book.

Then I spent $150 for a page "ad" in the Review of Reviews magazine.

It brought me about $2000 in cash.

As fast as the money came in I shot it back into advertising.

When I got $2500 in cash I bought a half page "ad" in the Saturday Evening Post.

The first year I spent $50,000 in advertising.

The next year I spent nearly a hundred thousand.

I guess I've spent over half a million dollars since my first $150 "ad", and already 450,000 men and women—including great executives, international diplomats, famous authors, etc., also have taken up this study.

At first some people said I was crazy to advertise that book.

When they found that the book was selling—and that I was spending as high as *$20,000 a month* telling people about it, they said I had more nerve than sense.

But, my friends, all this time I was simply taking my own medicine.

I was telling people that the will was the motive power of the brain—that a strong will could batter down every obstacle to success—that weak will-power could be made strong, as easily as the muscles of the arm could be made strong—and that most people had weak wills made strong—and that simply because they didn't *use* their will power.

I had strengthened my own will and was *using* it when people were calling me "crazy". And it was my *will power* that people called "nerve".

Anyway, it was the secret of my success. Without it I might still be plodding — still canvassing.

Or even if I had gotten up enough courage to advertise I might have made only a piker's success.

It was my will power that got me the $300 loan.

It was my will power that got me exclusive sale of Dr. Haddock's book.

It was my will power that made me plunge into advertising instead of going slowly.

And finally, it was my will power that made me say to the public—"Send No Money—Read Power of Will 5 days free. Pay me if you decide to keep it—Send it back if you don't want it."

That was a new sort of proposition to most people. They had nothing to lose—and a lot to gain, if the book was worth while.

So the orders came in by the hundreds—then by the thousands.

At times I was 15,000 orders behind—just couldn't print books fast enough.

And letters from readers came pouring in so fast I simply couldn't read them all. Col. S. W. Wilkie of Roscoe, S. D., wrote that one day's study of "Power of Will" netted him $300 cash, and that four years later, by using the methods Haddock formulated, his earnings had risen to nearly $1,000,000 a year. V. P. Coffin of Rochester, N. Y., wrote, about *one month* after getting the book—" 'Power of Will' already has produced an increase of $5,000 a year in my income." J. F. Gibson of San Diego, Cal., said that since reading "Power of Will" his salary jumped from $150 to $800 a month.

Men like Judge Ben Lindsey, Supreme Court Justice Parker, Asst. Postmaster-General Britt, Governor McKelvie of Nebraska, Senator Capper of Kansas, Secretary of Agriculture Meredith, Governor Ferris of Michigan—and a host of other big men, show the class of leaders who have studied Haddock's methods.

Surely there must be something in "Power of Will" for you, my reader.

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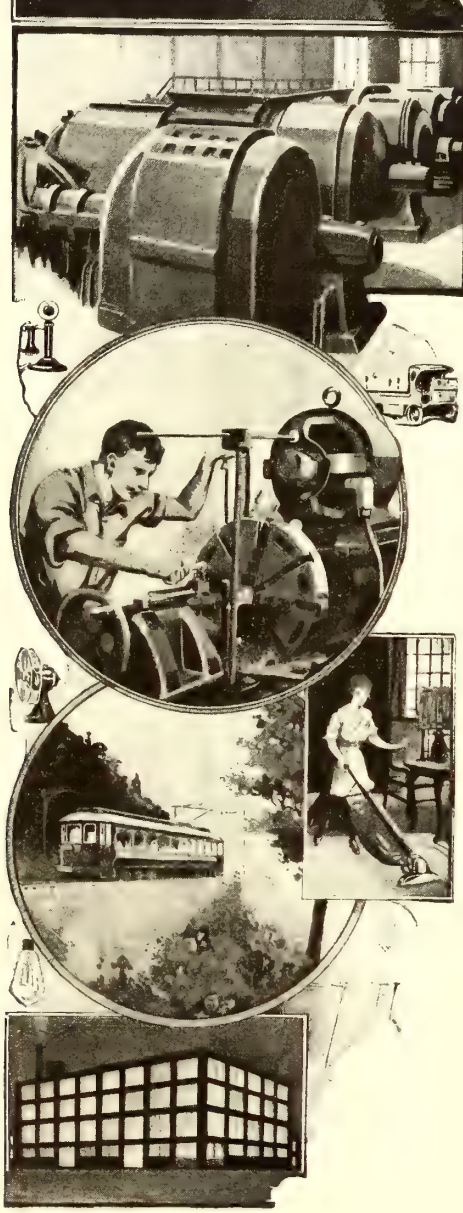
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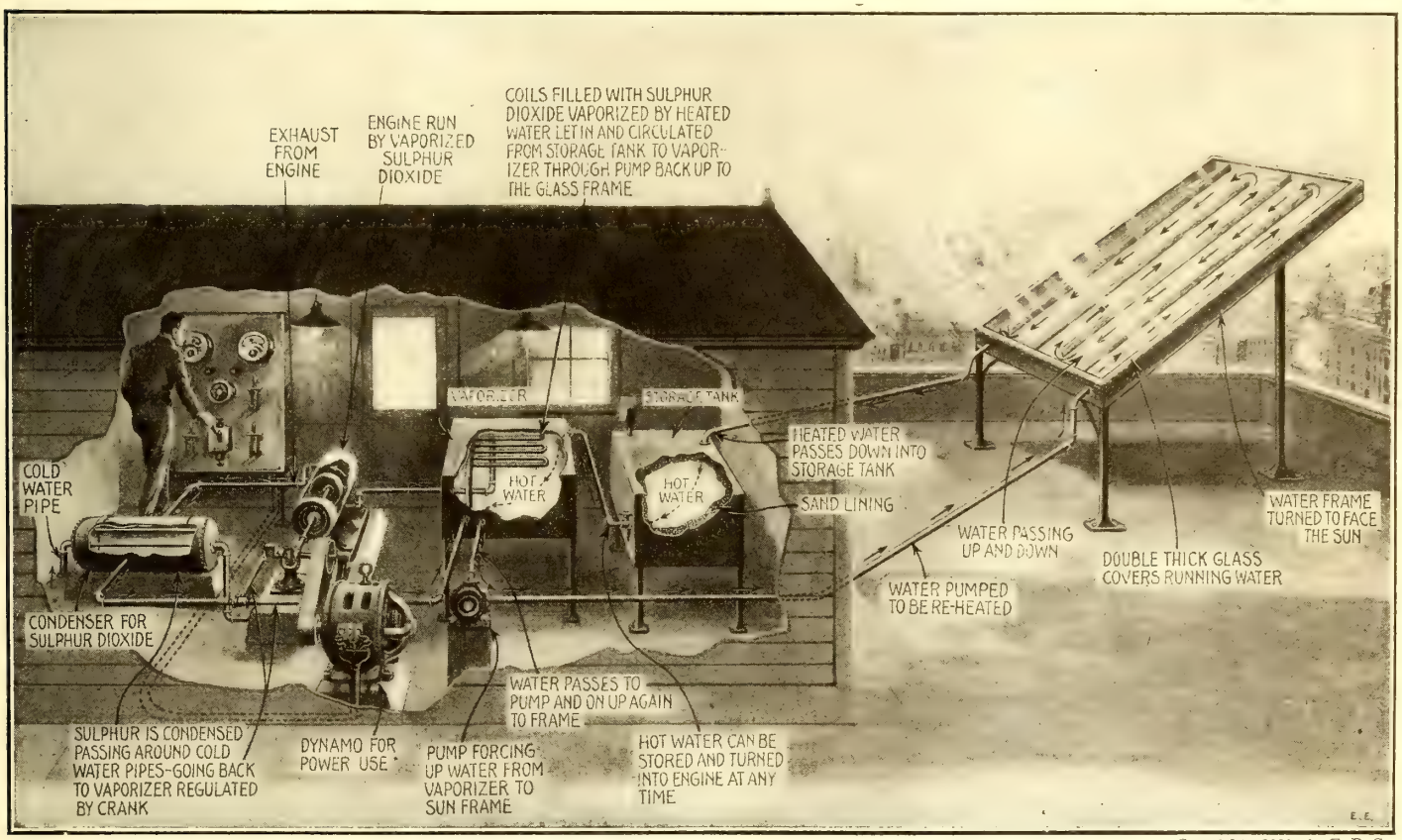
H. GERNSBACK – EDITOR
H. W. SECOR – ASSOCIATE EDITOR

Vol. VII. Whole No. 84 April, 1920 No. 12

APR 19 1920

Electric Power From The Sun

FROM time to time we hear of new schemes devised by inventors for harnessing the tremendous energy shot earthward every minute of our lives by "Old Sol." An American scientist, Mr. Henry E. Willsie, has rementing in the wilds and barrenness of an Arizona desert, where sandstorms, cloudbursts, thirst and poisonous reptiles all combined to threaten their very existence. All these experiences are interestingly told in an absorbing novel written by power, particularly in the southern part of the United States and other more tropical parts of the world, experience has shown that the sun's heat will cause the temperature of the water to increase to about 150 degrees. The heated water passes into a



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The Latest Sun-Power Electric Plant. By Following the Pipe Lines Conveying the Sun-Heated Water to the Sulfur Dioxid Boiler, and the Course Taken by the Sulfur Dioxid Steam Thru the Engine and Condenser, Thence Back to the Boiler Once More, a Clear Idea Is Had of Just How This "Free Energy" Power Plant Works.

cently proposed a new form of Solar Power Plant, which comprises a number of very interesting and radical features which would seem to promise a successful future for it. Not only is Mr. Willsie a scientific theoretician, but also a man of practical deeds, and to this end he built, some years ago, a solar light and power plant on a small scale out in Arizona. The development of this plant nearly caused Mr. Willsie and his wife their lives during their many exciting adventures while experi-

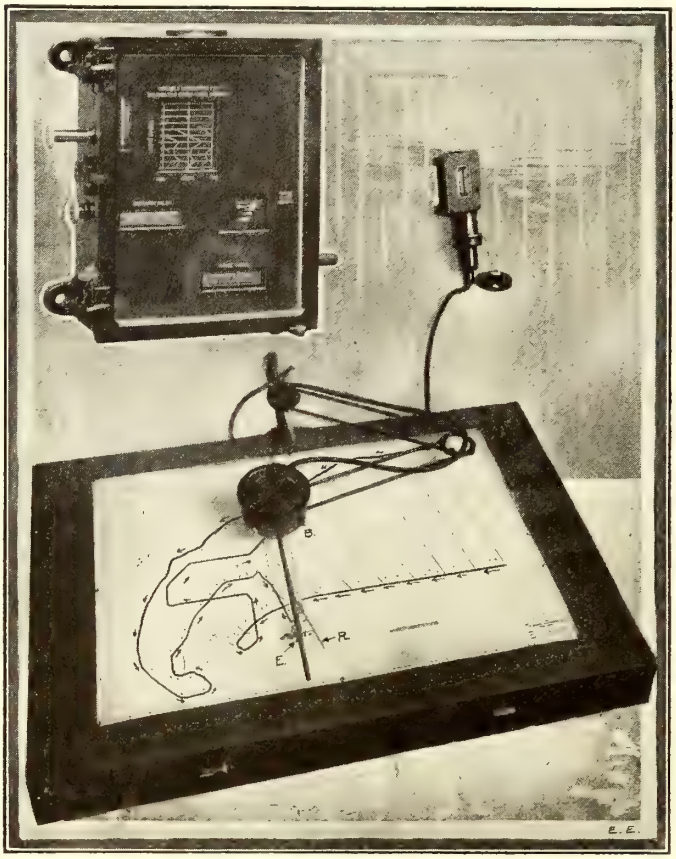
Mrs. Honoré Willsie, entitled "The Forbidden Trail."

Coming back once more to the scientific side of Mr. Willsie's interesting invention, which is shown in the accompanying illustration in one of its applications, we learn that the underlying principle is the drawing of the heat from the sun's rays into a *moving sheet of water*, which passes up and down thru a series of zigzag passageways, under a double thickness of glass. Where the sun has considerable thermal sulfur dioxid boiler, and eventually this water returns to the glass heating tanks or planes exposed to the sun's rays.

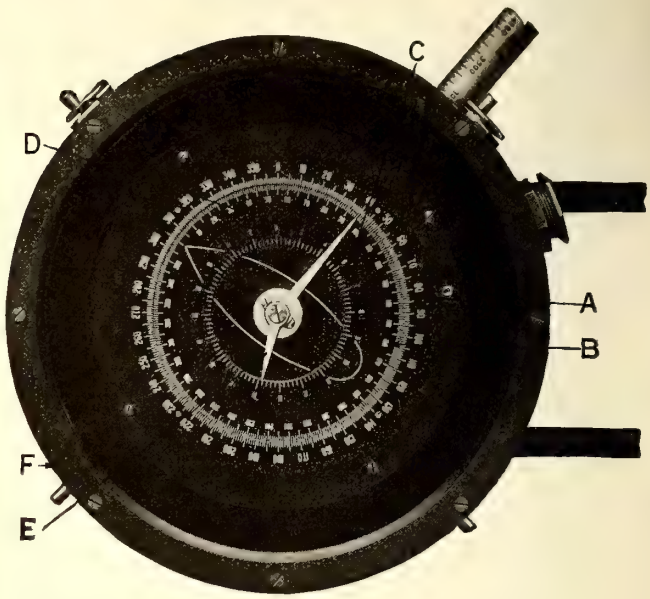
Where a large plant of this type is properly laid out, the mirrors or glass-covered tanks in which the water or liquid is heated by the sun's rays may be arranged in a fixt position, or also they may be designed so as to swing from east to west with the sun, so as to keep the rays perpendicular to the surface at all hours of the day.

(*Continued on page* 1310)

The Battle Tracer



The Sperry "Battle Tracer" Complete, and Also Revolution Converter and Auxiliary Range Transmitter. The "Battle Tracer" Records the Course Followed by their Own as Well as the Enemy Ship. E is the Enemy Arm Tracer and R, the Range Predictor.



Close-Up View of the Battle Tracer Motor Head, Thru Which the Graduated Enemy Arm Passes. This Connects With the Various Range Finding and Spotting Apparatus on the Vessel.

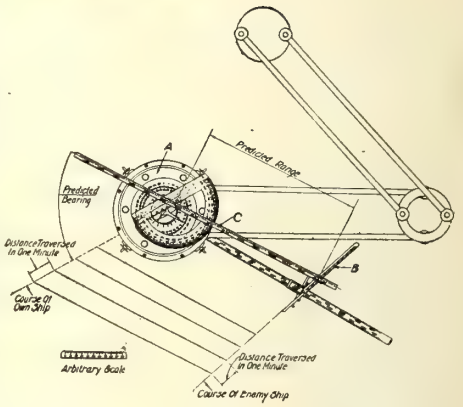


Diagram Showing How Range Is Computed Directly from "Battle Tracer" Plottings So That Guns Can Be Aimed Ahead of Time, to Hit the Enemy Ship, by "Prediction."

"YES, Captain, she was traveling at 18 knots; we were slowly closing in on her, and when 14 miles away we opened fire."

"The shells from the very first salvo struck her squarely amidship and blew her super-structure off——." Thus continued the gunnery officer's report of the Naval engagement just completed in which the very first shots found the enemy and silenced their guns before they had a chance to reply.

It is truly remarkable to think that not even a "finder" shot had been fired. In this case there was no need of firing the guns and wasting the big shells in order to get a "bead" on the fugitive vessel.

The vessel's range was computed to absolute accuracy and predetermined in time for the guns to be set and fired. All this computation with the aid of the device here mentioned *required but* 19 *seconds,* reducing thereby, past calculations several hundred per cent.

What is this remarkable equipment, you will ask. Essentially, it consists of a number of devices all working in conjunction with each other. The most important of which, perhaps, is the *Battle Tracer,* as it is called.

The object of the invention, which has proven itself to be of great practical use, is to provide a means whereby the course of our own ship is plotted automatically on a table similar to the table used for plotting navigation courses. In addition, an arm extending from the instrument proper, called the *enemy arm,* keeps track at all times of the enemy's movements. In this way, regardless of what our own ship's speed may be or what the enemy's speed may be, prediction of its probable location, allowing sufficient time for the gunners to change their range, can be made with remarkable accuracy and the guns can be fired so that very few shots will miss the target for which they were intended.

"Suppose the enemy zig-zags," you will say. "Isn't the art of shelling more a matter of mere guess work than of accuracy?" No, dear reader, no! You must remember that a ship eight to nine hundred feet long traveling at 20 knots, or perhaps, even more, cannot steer and squirm away with the same ease as an automobile.

It is not a question of a few seconds, but *minutes elapse* before one of these large floating fortresses can be turned completely in their course, particularly in view of the terrific speeds at which they move. Hence, when a computation is made via the tracer, and guns can be elevated within nineteen seconds, taking the corrected findings as data to work from; it then gives the enemy very little opportunity to change a predicted and predetermined range or bearing.

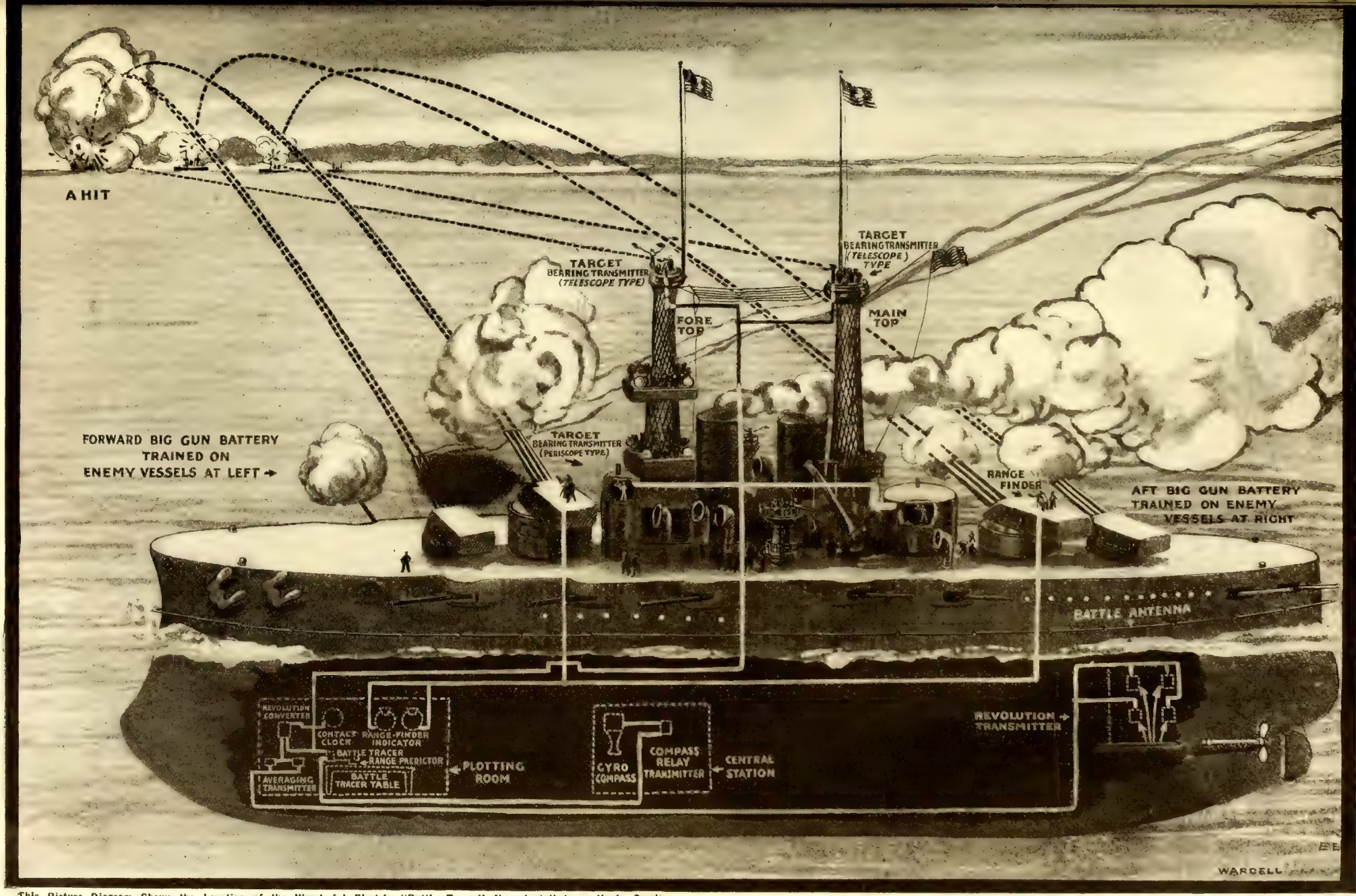
Essentially, the apparatus consists of a cylindrical box about 7 inches in diameter and 5½ inches deep, containing four motors, and necessary gearing. It is mounted upon a tracer table and guided by a system of parallel arms which allow free movement in any horizontal plane, at the same time, however, preventing the Tracer from turning on its axis. This allows the outer dial (A) of the Tracer to be kept in one position continually with reference to the table. (Accompanying letters refer to close-up view of Battle Tracer dials.)

This dial of which we have just spoken, is one of the three dials which perform varied functions. As will be noted, the outer dial is graduated to 360 degrees and is held on the table so that zero of the dial is north on the chart and is always at the upper edge of the table, altho capable of movement in any way except the turning movement.

Just inside of this dial and operating in juxtaposition with it, is another dial (B) similarly graduated but movable. This dial is controlled from the gyro-compass by one of the four motors inside the Battle Tracer head.

A pointer coming from the center of the Tracer head extends to the edge of this dial and the outline of a ship with its bow at zero is also engraved upon it. This pointer (D) which we have just spoken of is connected to the enemy arm and operates in conjunction with it, being moved by another motor connected to the Target Bearing Transmitters. Both the pointer and the enemy arm are capable of complete revolution. This movable dial (B) is mounted upon a movable post, to the bot-

(*Continued on page* 1332)



This Picture Diagram Shows the Location of the Wonderful Electric "Battle Tracer" Now Installed on Uncle Sam's Battle-ships and Which Was Used During the War. With This Device, Which Is Always Installed Well Below the Water Line in a Secret Part of the Vessel, the Ship's Mighty Guns Can Be Trained Ahead of Time So As to Hit the Enemy with Great Accuracy, As He Rushes Thru the Water At 30 Knots Or More Per Hour, At Any Position from the Vessel Which Carries This Equipment. The "Battle Tracer" Proper Comprises a Motor-Actuated Arm, Fitted with a "Range Predictor," All of Which Is Traversed Electro-Mechanically Over a Sheet of Paper Secured to the Top of the Battle Tracer Table. Connected with the Battle Tracer Are All of the Necessary Apparatus for Properly Coordinating the All Important Factors, Such As the Revolutions of the Ship's Screws or Propellers, the Direction of the Target As Recorded by the Men in the "Fighting Tops," Who Are Spotting the Enemy Thru the Telescopes of the "Target Bearing Transmitters," As Well As the Compass Bearings Transmitted to the Device from the Master Electric Gyroscopic Compass. The "Battle Tracer" Performs All of Its Functions in Exactly Nineteen Seconds, When It Is Possible to Telephone Directions to the Men Behind the Guns, Just Where to Aim to Hit the Enemy Ship At a Later Point in Her Course. She Might Zig-Zag You Will Say, and Fool the Battle Tracer and Range Predictor, But You Cannot Zig-Zag a Ship 600 Feet Long, or Switch Her Course At 20 to 30 Knots an Hour, As You Would a Baby-Carriage.—and Thus the Battle Tracer Gets in Its Deadly Work.

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Heat of Body Detected 600 Feet Away

ALTHO you do not know perhaps, or at least may not have stopt to think about it, one of Uncle Sam's military experts can spot you in the dark, and tell in what direction you are moving—and at a distance of 600 feet—all due to the fact that your body radiates HEAT! Not very much, it is true—but still enough to affect a sensitive electric thermopile of the type shown in the accompanying illustration.

A recent issue of the *Physical Review* contains a summary of a paper read by Mr. S. O. Hofman at the Washington meeting of the *American Physical Society* on this extremely interesting subject. In trench warfare operations on the Western front, maneuvers took place mainly in the night time, as any movement during the day quickly attracted hostile rifle and artillery fire.

An attempt was made, therefore, to detect the presence of men moving in "No-Man's-Land" at night by recording or indicating the heat radiated from their bodies. The receiver utilized a delicate heat-actuated instrument or heat indicator for this purpose, comprising an electric thermopile placed or mounted on the focus of a 14-inch parabolic mirror. This thermopile, which generates a very minute yet measurable electric current whenever a heat ray, even tho ever so slight, impinges on it, is connected to an extremely sensitive electric galvanometer or magnetic needle instrument of the D'Arsonval type.

Remarkable and uncanny as it may seem, it was actually found possible with this sensitive apparatus *to detect the presence of a man at a distance of* 600 *feet* or over one-eighth of a mile away, which gave plenty of time in most cases to organize a counter-attacking party, or extra guard.

This device proved very useful for detecting hostile raiding parties creeping towards the trenches in the darkness of night, and helped in many cases to capture some badly wanted enemy prisoners for the purpose of questioning by the intelligence officers, especially when an attack was about to be made by the Allied troops.

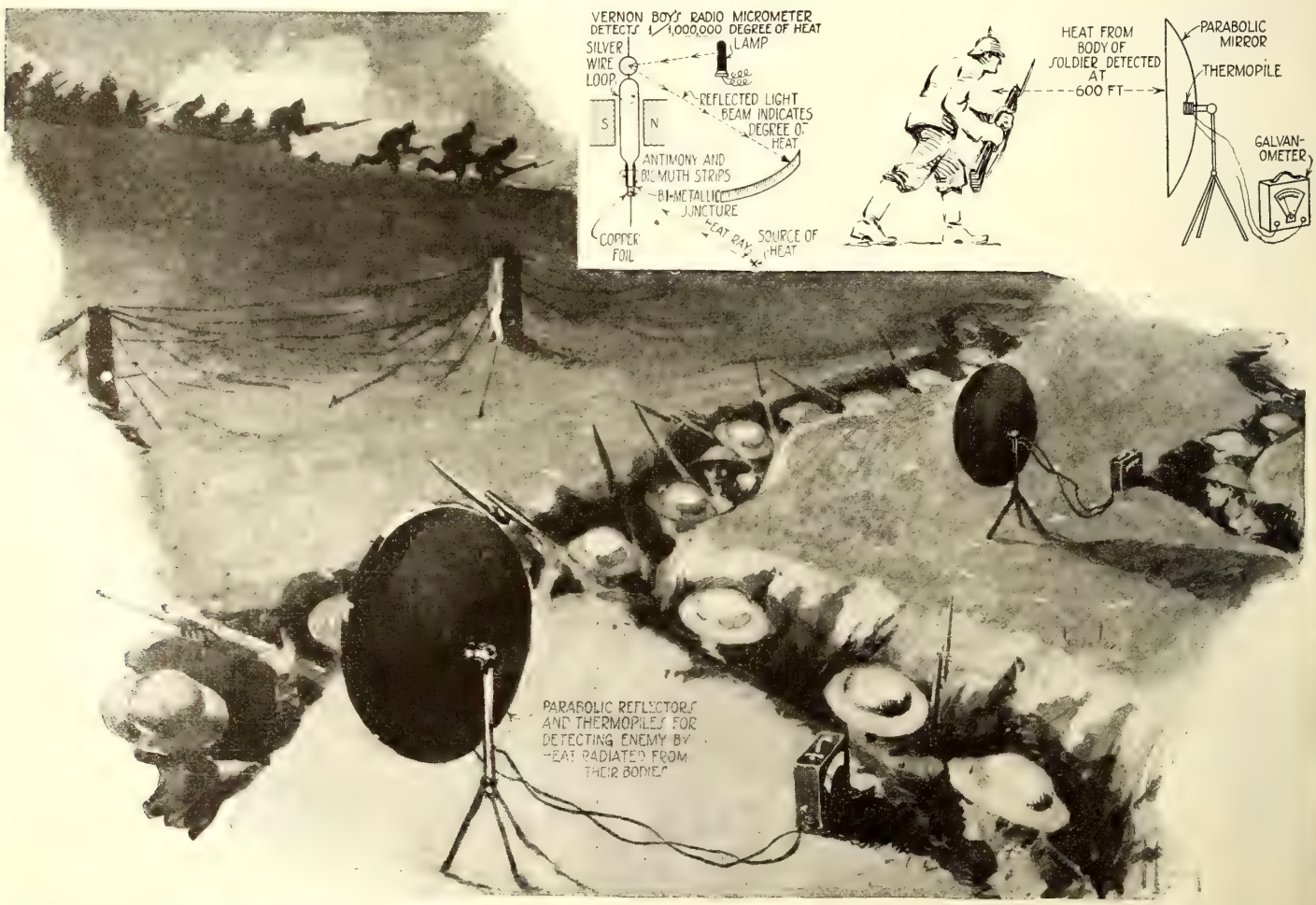
One of the accompanying illustrations shows an effective and sensitive form of thermopile. The minute electric current generated at the juncture of two dissimilar metals such as copper and iron, or antimony and bismuth, when heated by the impinging of a heat ray upon the juncture, will cause a deflection on a sensitive galvanometer connected to the opposite terminals of the thermopile.

Altho it is but little known, thermopiles so sensitive that they will record the heat radiated by distant stars have been devised and regularly employed in astromony work by those engaged in this work.

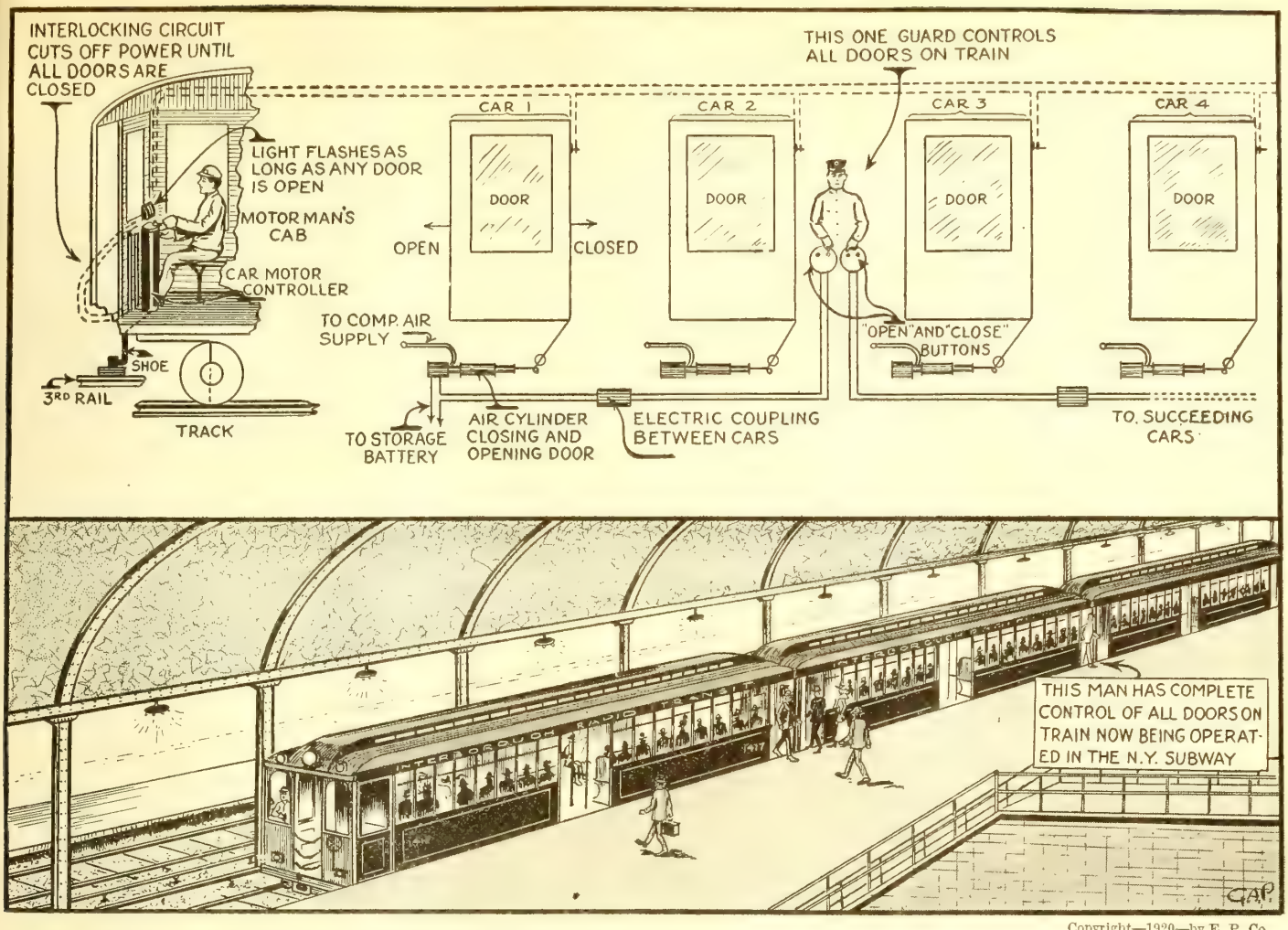
Dr. W. W. Coblentz, of the U. S. Bureau of Standards, has devised an extremely sensitive thermopile for this work, and this is built in an evacuated glass tube. On this measuring instrument are registered infinitesimal fluctuations of temperature.

A ray of light may have started ten years ago from some distant star, and may have spent all of these ten years hurtling earthward-bound thru space at a speed so astounding that it could girdle the globe in far less time than it takes to blink an eye—and yet when it falls upon the bolometers at the Bureau of Standards they will tell the observer how much heat that ray brought with it from the star to the earth!

As Silvanus Thompson points out, one of the most remarkable instruments of this type is the radio-micrometer devised by Vernon Boys. On this instrument a loop of fine silver wire is suspended by a quartz fiber between the poles of a magnet, and this loop of silver wire has its circuit closed at its lower end by a piece of antimony and a piece of bismuth (or alloys of these metals) soldered to a minute disc of copper foil. A rise of temperature in the copper foil, *even so small as one-millionth of a heat degree*, will generate an electric current in the loop and give a deflection over one division of the scale on the instrument. With a heat detecting instrument of this type the radiant heat of a candle can be detected at a distance of two miles, as Silvanus Thompson shows.



Imagine That You are a Soldier in the Dark At Night, and That You are Attempting to Raid the Enemy Trench. Likewise, Imagine That You are At a Distance of Nearly One-quarter of a Mile from Said Trench. If It is Pitch Dark, You Will Feel Very Confident in the Dark, That You Can Sneak Up On the Enemy Without Exciting the Least Suspicion On His Part,—But Foiled Again!—for It Now Develops, That the Electrical Experts of the Allied Military Engineers Had Developed and Utilized a Super-sensitive Electric Thermopile, Which Will Detect the Heat Radiated from the Human Body, At a Distance of from 600 to 1,000 Feet, and Many a Dead German Soldier Would Tell You the Answer, If He Could!



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One Man Controls All the Doors on This New Semi-Automatic Subway Train Now Being Tried Out in Actual Practise in the New York Subway. As the Diagram Shows, the Guard Stationed at the Center of the Train Can, by Pushing the Proper Electric Control Buttons, Cause Electro-Magnets to Control the Comprest Air Mechanism Opening and Closing the Successive Car Doors. The Motorman Can Start the Train Only When All the Doors Are Closed.

One-Man Subway Train

A TRAIN comes dashing into a subway station, stops, discharges its passengers and allows others to enter. There is nothing unnatural in this "train" of events, as hundreds of trains come tearing in and out of the stations in New York's subways every day in the year. You go to ascertain from the guard where the nearest station to somewhere is, and travel to the end of the car,—but no guard in sight! With a shrug of your shoulders and the thought "Hmmmm-m! Perhaps he is down the next car playing cards with his comrade," you travel thru another coach but still no guard, and so on down the 10 car train until you wonder whether you are paying for a ride or walking the distance, and then,—at last! *a guard!!*—right in the *middle* of the train.

After finding out that it takes exactly six blocks to the left and two to the north, with a couple of turns in the opposite direction thrown in, to get to the desired place, you stick around awhile, so to speak, in order to find out why but one guard is in the entire train. Cutting down expenses? Rather. Here in the middle car, his Imperial Majesty—"the Guard"—has control of the entire train and can aim the doors so that they will just miss you by a hair even tho he is two-hundred feet away from the door you enter.

In other words, by the press of a button, all doors on all cars either close or open at his volition. And months of experience has taught him exactly when to release the doors so that they will "clean up" everything in sight. The method of operation is very ingenious. Everyone living in the greater metropolis knows that the terminals of the subway have constantly sufficient guards to successfully jam in all the people a train will hold and shut the doors after them, so that they won't fall out again! Hence there is no necessity of having as many guards on the train proper as the company is now employing.

For this reason, they have stationed a guard in the center of this new semi-automatic train, so that he can command a view of both sides, by peeking out between the cars. At his right and left side are a series of push buttons for controlling electrically, all the comprest air operated doors either to the fore or aft parts of the train. When he presses a button, a series of solenoids automatically actuate the valves, allowing for the escape of comprest air from the cylinders operating the doors. The door is released and flies back, allowing the passengers of the train to be discharged. When other passengers have entered, he releases one button which shuts all the doors, from his position, up to the position of the motorman in the first car. He then actuates the button for performing the same function in the doors to the rear.

The instant all the doors are closed, an automatic control allows the motorman to throw his controller into the starting position which could not have been done before this. Likewise the signal light still lit while the door is open, is turned off automatically, and the light no longer flashes up toward the motorman, and interfering in this way, with his control.

Any of the doors may be instantly placed into an inoperative position, just the same as is being done at the present time, and very little change in the old cars, is necessary for adopting the new system.

Storage batteries are used to actuate all the electrical controls. Such apparatus, if put into universal use on all trains, would dispense with from 12 to 15 guards per train, who could do abler service perhaps, on the platforms of the subway stations.

Notice to Readers

In view of the fact that we are still handicapped due to the recent printers' strike, we have as yet not been able to catch up with our schedule. We would therefore ask our readers to be patient and not write us about the lateness of the issue for the next three months.

With the June issue we expect to catch up again with our regular schedule. In other words, the June issue will be out about May 25th. Several other publishers found it necessary to skip an issue in order to come up to date, but we prefer not to do this. We hope our readers will understand and bear with us until we are back to our former schedule again.

THE PUBLISHERS.

Watching Plants Grow

Remarkably Sensitive Instrument Devised by Sir Jagadis Bose of India

IF you have ever planted flowers or vegetables and watched them grow from day to day, and from week to week, you have undoubtedly been strongly imprest with the remarkable changes which sometimes occur in a single night in plant growth. But—did you ever notice the change in growth of a plant or flower in the course of an hour, or a minute, or a *second?* Quite possibly not—but if you are interested in the close laboratory study of plant growth, then it is possible today to make readily visible the minute growth of plant life, even over such short periods of time as one one-hundredth of a second.

While there are a number of very interesting and useful devices available in college laboratories for the study of plant growth, as well as the action and reaction of plants, due to the application of heat and cold, as well as various chemicals and electric shocks administered at different time intervals, et cetera, one of the most accurate and remarkable instruments ever devised for this study is the one recently used by Sir Jagadis Chandra Bose, hailed as the most eminent man of science that modern India has produced, and which device is known as the *Crescograph.* This instrument is shown in the illustration on our front cover, as well as in one of the accompanying drawings by our artist.

HOW THE "CRESCOGRAPH" MAKES PLANT GROWTH VISIBLE.

Before going into the details of the *crescograph* or the *auxanometer,* both of which show the growth of plants in a vivid manner, it will be interesting to note what a really wonderful magnification of minute movements of the plant the crescograph actually gives.

Recently a large audience seated in the council chamber of the India Office, in London, England, *watched the growth of a plant* and the effects of various stimulants upon it, as recorded upon the large screen on the wall. This was at a lecture given by Prof. Bose. Either sunlight or else a beam of light from a small incandescent lamp may be used in the crescograph, and this light beam is reflected thru a series of mirrors in the manner evident from the accompanying illustration, so that by the time it reaches the screen the relative movement between the mirror and the focal spot of the impinging light beam is very markedly magnified.

In the case of the lecture just cited, a magnification of from 1,000,000 to 100,000,000 times was achieved. This is tantamount to magnifying the highest powers of the microscope 100,000 times. The room being darkened, a mysterious *hook of light* past swiftly over the screen. This showed the actual growth of the plant as projected from the mirror of the crescograph, magnified many hundred thousand times. The lecturer pointed out that this hook of light illustrated the effect of electricity upon the plant—too great power having the opposite effect to the stimulation afforded by a reasonable amount.

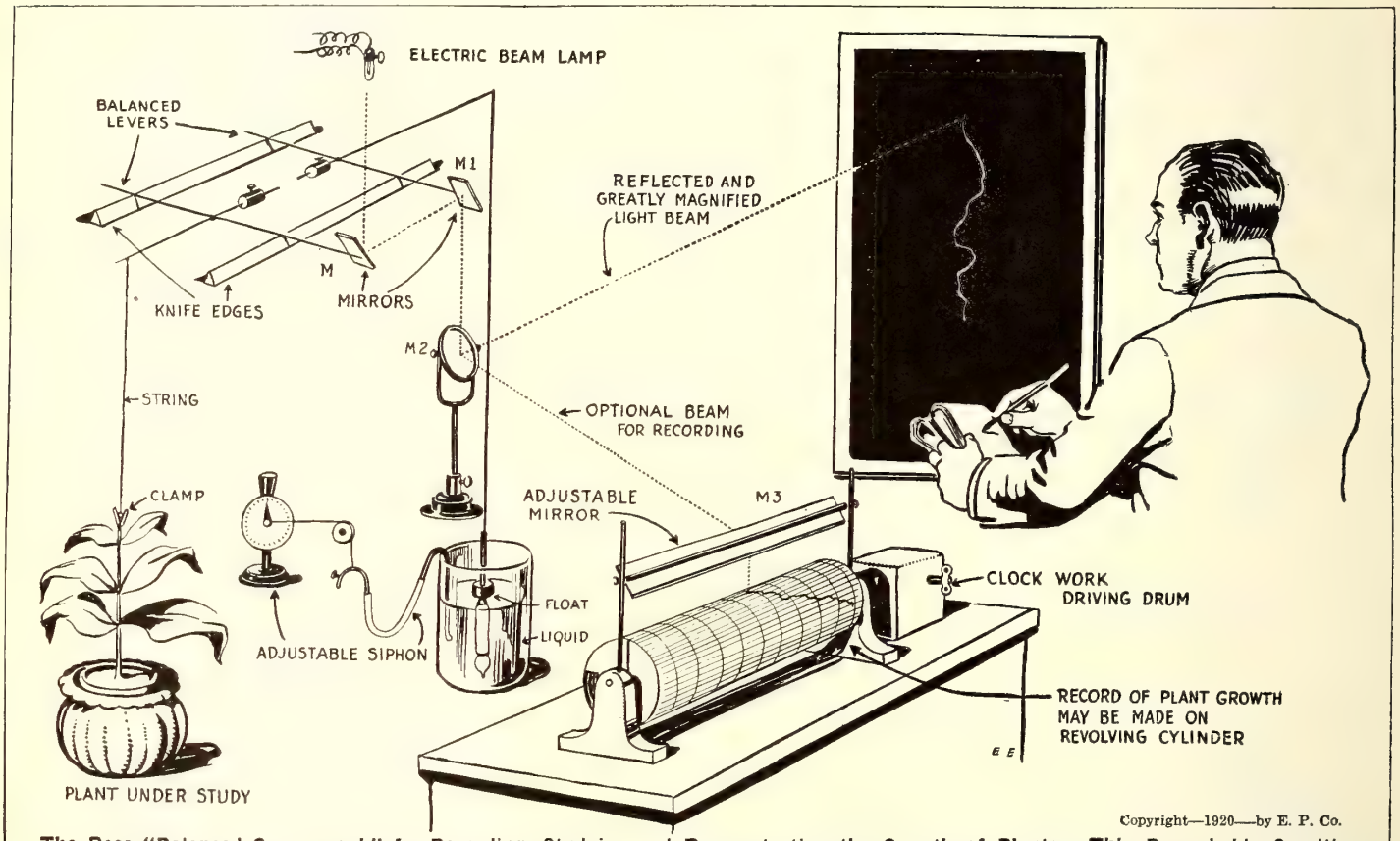
One of the chief features and applications of such an instrument as this, as pointed out by Prof. Bose, is the much shorter time that it would now require to obtain a definite knowledge of the growth of a certain plant under specific soil and climatic conditions. Instead of watching a whole season to learn if a certain plant will grow well in a given soil, and in a given climate, this test can now be carried out in a few days or weeks. The accompanying graphic curves show some of the effects of electric shocks and poisons on plant growth.

HOW FAST DO PLANTS GROW?

Altho you probably think a plant grows at a fairly rapid rate, even tho you cannot notice it in a period of, say, five minutes or even an hour, yet the plant really grows much more slowly than you perhaps imagine.

The little snail, whose slowness is proverbial, moves 6,000 times faster than the plant grows! Plants grow at an average rate of one one-hundred thousandth part of an inch per second, or, in other words, *plants add about one inch to their stature in eleven days.* A few years ago you would have thought it impossible to actually see the plant grow before your eyes, but now, thanks to Dr. Bose's remarkable researches, you can readily do this with the *crescograph.*

At a recent London lecture, Sir Jagadis Bose took a cyclamen leaf and attached it to the crescograph. The mirror at once reflected a spot of light on the wall screen, and this spot moved at the rate of ten feet in twelve seconds, notwithstanding the fact that the plant was growing only at the

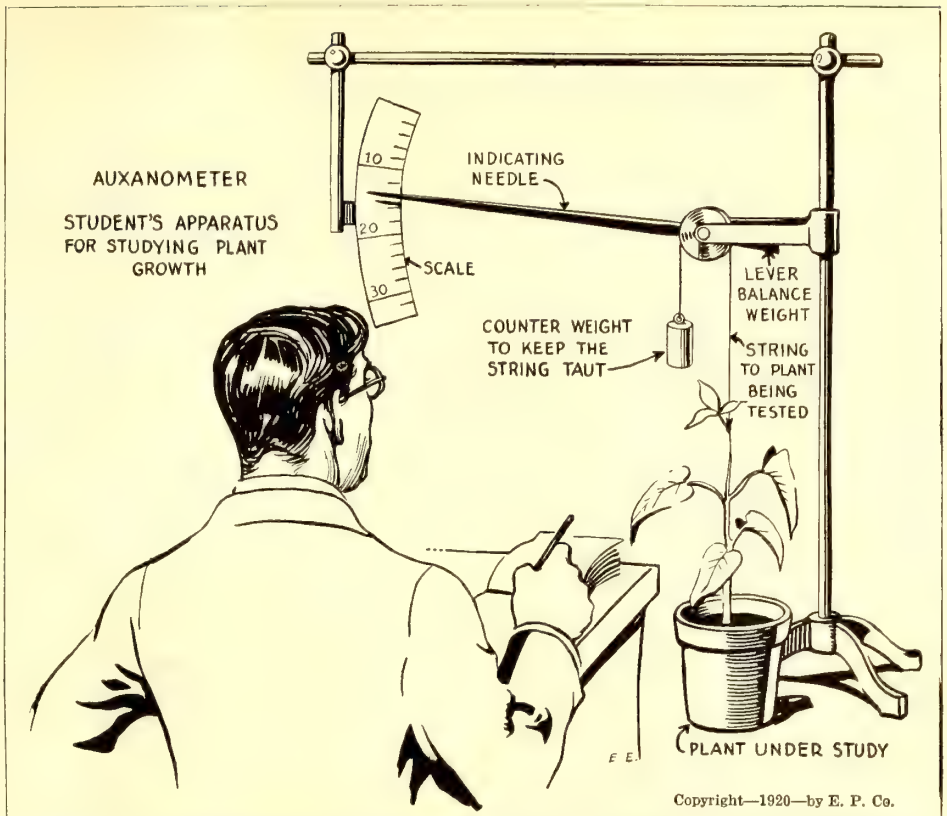


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The Bose "Balanced Crescograph" for Recording, Studying and Demonstrating the Growth of Plants. This Remarkably Sensitive Instrument Magnifies the Movement of a Plant While Growing, Up to 100 Million Times. In London, Recently, a Whole Audience Witnest the Action of Plants as Reflected on a Large Lecture Screen.

actual rate of 1/100,000th part of an inch per second.

Plants resemble animals very much in their daily lives, and Dr. Bose's researches have shown the presence of heart beats, death spasms, definite and positive reactions to various forms of stimuli, to anesthetics, poisons, etc. All of this work shows, according to Prof. Bose, that plants, like human beings, do have a nervous system. It is reported that this great savant of Indian culture and science has actually shown that plants can and do feel the effect of an etheric wave message, or a Marconigram, as they pass over the earth. This proves that the plant is more sensitive in its nervous response than the human body, which we usually are wont to think of as the most marvelous structure ever created. People have never yet, so far as we know, been able to "feel" a wireless signal or wave passing thru them, but by means of specially sensitive apparatus connected to a plant Prof. Bose has shown that the plant really feels the effect of the radio wave and will interpret this effect under the proper conditions.



Here's the "Auxanometer"—a Simple Instrument Well Adapted to Students' Requirements in Studying Plant Growth. The Slight Movements of the Plant Are Magnified by the Lever System Shown.

One of the interesting stories of Prof. Bose's interesting work relates how he studied a certain tree in India which had never been *transplanted* successfully. He reasoned that the tree died when transplanted because of the severe shock it received when it was dug from the ground, so he followed up this deduction by having a tree subjected to an *anesthetic*, in the same manner that the modern surgeon causes his patient to become unconscious in preparation for a surgical operation. Strange to relate, the tree manifested the same characteristics as a person under an anesthetic, and it was successfully transplanted while under the effect of the same. The tree continued to thrive.

HOW THE CRESCOGRAPH WORKS.

Several different forms of magnifying instruments for studying plant growth have been devised by Prof. Bose, and by other workers in this field of science. The standard form of Bose's crescograph is shown diagrammatically and in picture herewith. The student will find the simple form of plant growth measuring instrument, known as the *auxanometer*, illustrated herewith, quite within his mechanical possibilities, and it can be made up in many different ways. A smoked glass caused to travel slowly past the needle of such an instrument will record the changes taking place.

One principle, and in fact the underlying feature of all these instruments, appears to be the fact that a slight movement is magnified into a larger movement, by the well known law of levers—thus if you have a lever 100 inches long, and place a fulcrum at one inch from a given end, then any movement at the end of the shorter or one inch length of the lever will cause a corresponding and greatly magnified motion of this lever at the free end of the longer limb, which will be 99 times the initial movement.

The reader can readily devise a simple form of magnifying apparatus constructed from some pieces of aluminum wire and possibly a balance wheel, with its supporting pivots cut from an old alarm clock frame, whereby he can obtain some interesting results in watching the growth of plants.

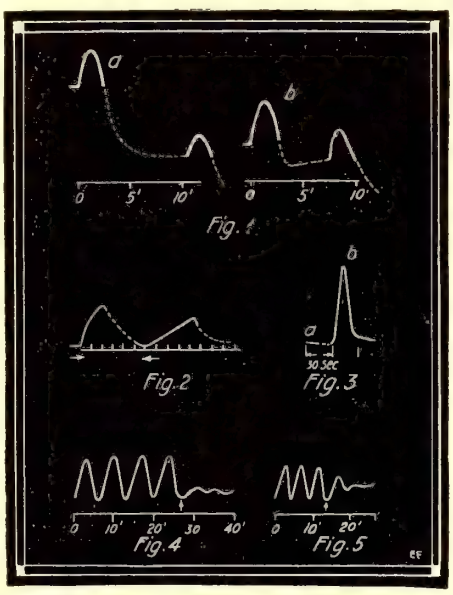


Fig. 1. Fatigue Under Long-Continued Stimulation in the Contracile Response of Plants. (a) Stimulation by Tetanizing Electric Shocks: (b) Stimulation by Rapidly Succeeding Thermal Shocks.

Fig. 2. Effect in Acceleration of Rate of Growth of Seedling of "Oryza Sativa" of Current Thru the Soil. The Continuous Line Shows Effect During Passage of Current Thru the Soil (1) from Left to Right (→), and (2) from Right to Left (←). Dotted Line Shows Effect of Cessation of Current. Fig. 3. Additive Effect in Electrical Response of Plants. (a) A Single Stimulus of 3 Degrees Vibration Produced Little or No Effect, but the Same Stimulus When Rapidly Superposed Thirty Times Produced the Large Effect (b). Leaf Stalk of "Turnip." Fig. 4. Death of Plant by Poison. Fig. 5. Death, and Arrest of Pulsation, in Leaflet of "Desmodium," by Electric Shock.

There are two forms of the crescograph, the *simple crescograph* and the *balanced* type. The larger illustration herewith shows the details of the balanced crescograph devised by Prof. Bose. The principle involved in the method of balance consists in making the spot of light, which is moving in response to growth, become stationary by subjecting it to a compensating movement.

Let us suppose the average rate of growth to be 1.2 mm. per hour. This will cause an excursion of the moving spot of light from, say, left to right, thru 1,200 mm. by the end of the hour; in that case the magnification is 1,000. Had the growth been uniform this would have meant a movement of 20 mm. per minute. But if not uniform the rate might sometimes have risen above, and at other times fallen below, this average. If we now subject the spot of light to a uniform compensating movement, such as by itself would have made it move from right to left of the recording surface to the extent of 1,200 mm. by the end of the hour, we shall find that, being acted on by these two opposite movements of growth and compensation, the spot will remain approximately on a single base line of compensation. The fluctuations, or variations, which have occurred in this average rate of growth will, however, be recorded as deviations to one side or other of this mean neutral line. Thus it will be seen that the slightest deviation from a uniform rate of growth will be found displayed by the record of the moving spot of light.

We are further enabled from our knowledge of the speed of the recording drum and the balancing rate, and from an inspection of the curve itself, to determine not only the periodicities, but also the absolute value of the rate of variation of growth at any given moment.

The compensating movement referred to is effected by means of a simple hydraulic device. The spot of light from the optical level falls upon a mirror attached to a second lever, or to a rotating wheel. The arm of the lever, or a thread which is past around the wheel, is attached to a float on the surface of a cylinder of water. Water is escaping from this cylinder, by means of a syphon arrangement, at a rate which can be adjusted with the greatest nicety. The float can be thus made to descend at any speed that is desired, this descent producing a rotation of the second lever or of the wheel.

We have then two mirrors, of which one is rotated in one direction, by the *growth-movement* of the plant, and the second in in the opposite direction, by the *descent of the float*. A spot of light reflected on the two mirrors will thus remain *stationary* when the precise balance is effected by proper regulation of the escape of water from the cylinder (see our figure herewith).

(*Continued on page* 1318)

Hello Mars!

By H. WINFIELD SECOR

Shall We Ever Be Able to Signal Mars Intelligently?

IN the past ten years, and particularly in the last twelvemonth, there has been evidenced a great deal of activity on the part of scientists in all parts of the world, on the subject of communicating with Mars, or possibly Venus. The present discussion has nothing to do with the astronomical facts of the case, for these are already well known,—at least so far as the distance between the Earth and Mars is concerned, and other heavenly bodies.

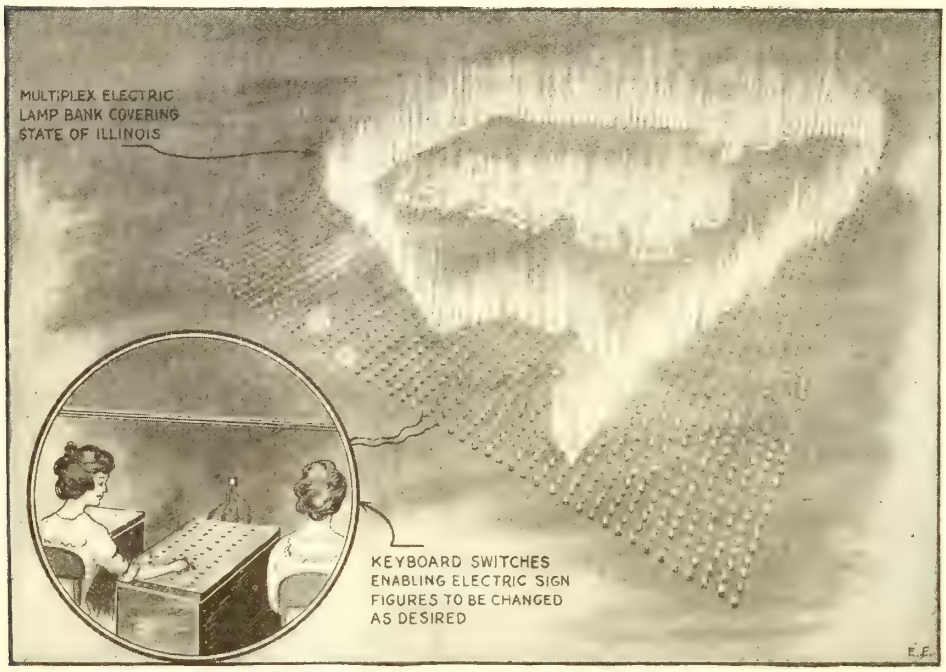


Fig. 7. One Writer on the Subject of Inter-Mars Communication Has Suggested That We Place Lamps, Thousands Upon Thousands of Them, Over a Large Territory—as Big as the State of Illinois—These Lamps To Be Fitted with Quick-Acting Shutters, Electrically Operated. The Lamps Are Also To Be Connected to Suitable Keyboards so That by Depressing a Given Pattern of Keys, Any Design Such as a "Map" of the United States, with the Letters "U-N-I-T-E-D S-T-A-T-E-S" Illuminated Can Be Flashed Out of the Entire Lamp Field as Here Shown, etc. Any Desired Letter or Picture Could Be Flashed on This Multiple Lamp Bank, as Becomes Evident.

The main thing that we do not know about Mars, is whether or not it is inhabited, but we will leave all of the vast and profound theories on the possibility of Mars' inhabitation, to the astronomers and others who are capable of investigating these facts.

So far as we are concerned in the present instance, we will assume that there is such a being as a "Martian". Next, the all-important and preponderant phase of the Mars' inhabitation theory is—how, and in what way could we start picking up conversation or communication with our distant neighbors, intelligently.

It seems quite evident, that once we have outlined and developed the proper method of procedure to start transmitting and possibly interpreting the Martian signals, as well as making sure that our method is correct, that the Martian may, with his supposedly far greater intellectual development, (owing to the greater age of Mars as compared with the Earth,) understand what we are trying to say to him.

It is nothing short of startling to read some of the newspaper details that come from all parts of the world, suggesting the "simple schemes" whereby we can open up communication with a people of whom we know absolutely nothing about. Think of it! Aside from the fact that we have to doubt their very existence, we do not have the slightest conception of what they look like, nor what their language may be!

One of the latest Martian communication converts is Dr. Charles Proteus Steinmetz, probably the world's greatest electrical engineer today, and one of our foremost mathematicians. If anyone should be able to conceive of a scheme for opening up conversation by wireless telephone or telegraph, or other means, with a strange neighbor so distant as the Martians, Dr. Steinmetz should certainly be fully qualified.

Dr. Steinmetz, in a recent statement, said that wireless communication with Mars is not at all improbable, and he suggested that signals might be transmitted by radio from a gigantic wireless plant on the Earth, which would be charged with all the electric power generated in the United States. This could be accomplished for the tidy little sum of about one billion dollars, according to Dr. Steinmetz, and would require steel towers at least 1,000 feet in height, in order to transmit radio messages or signals to the planet Mars,—which never comes any nearer the Earth than 35,000,000 miles, and at certain periods is 230,000,000 miles away. After mentioning the fact that we might accomplish the interpretation, after several years' recording, of the stray wireless signals mentioned by Marconi and Tesla as being picked up in their powerful radio stations, he goes on to say,—"If Mars was trying to communicate with this world, it is doubtful if it would ever be possible to decipher the code, but it would be some satisfaction to know that one planet could send messages to the other, and that intelligent beings were inhabiting the planet from which these messages came. We know enough about Mars to assume that there are inhabitants there," said Dr. Steinmetz, "and as it is a much older planet than ours, its inhabitants ought to be more advanced in scientific and educational investigations."

But—"*It is doubtful if it would ever be possible to decipher the code . . .* "—read that line over!—for it means a whole book-ful when you start to really think about it.

A SIMPLE EARTH-MARS CODE FOR NUMERICS.

There is, perhaps, no use of talking about communicating with Mars, or as we said before, with a people of whom we know absolutely nothing, but for the present we will consider that they are duly existing, and that they are, as some of our leading scientists and astronomers have argued,

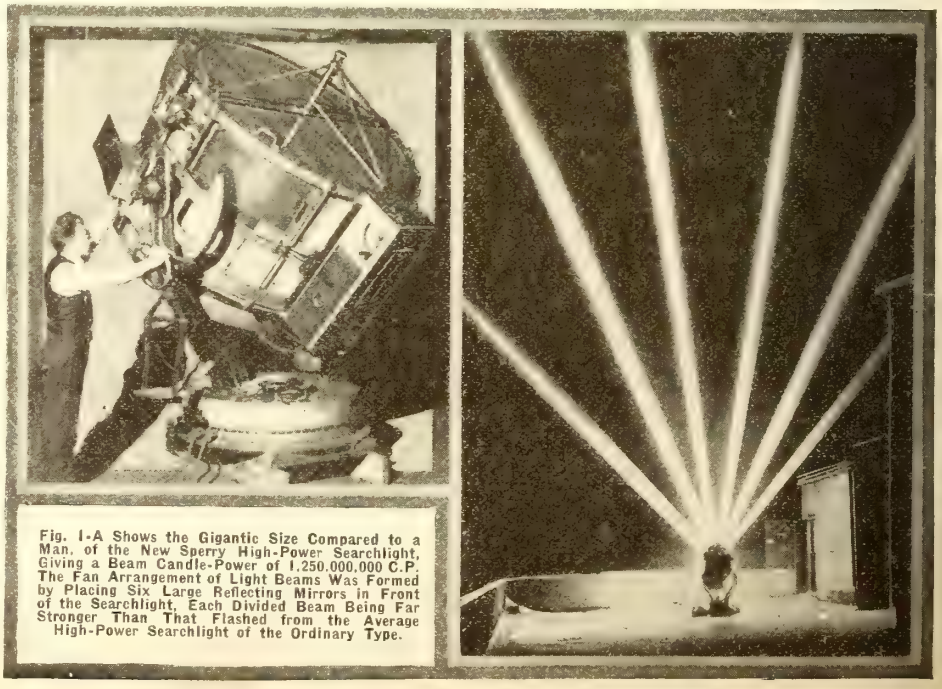


Fig. 1-A Shows the Gigantic Size Compared to a Man, of the New Sperry High-Power Searchlight, Giving a Beam Candle-Power of 1,250,000,000 C.P. The Fan Arrangement of Light Beams Was Formed by Placing Six Large Reflecting Mirrors in Front of the Searchlight, Each Divided Beam Being Far Stronger Than That Flashed from the Average High-Power Searchlight of the Ordinary Type.

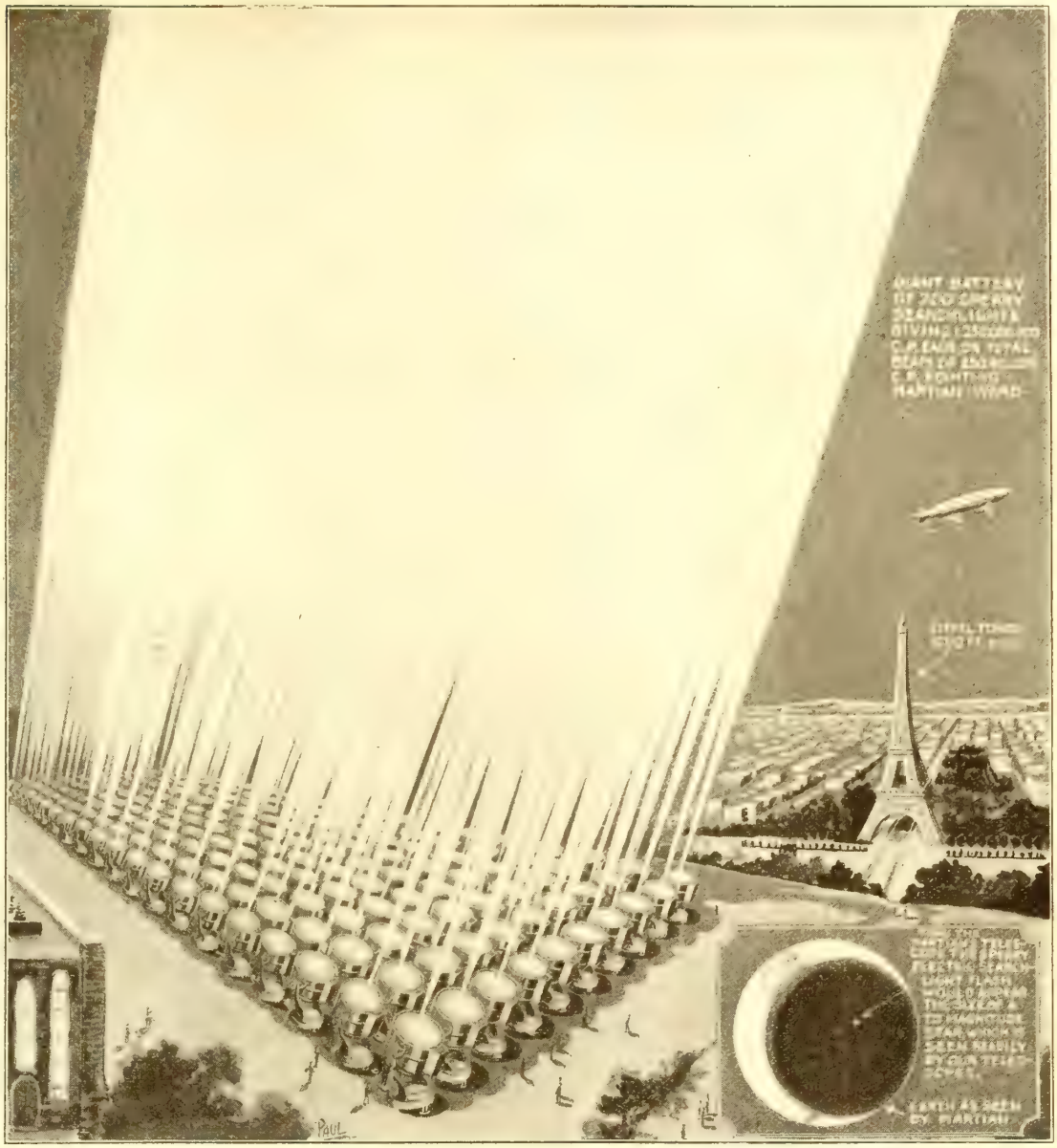


Fig. 1. The Latest Proposal as to How to Signal the Inhabitants of Mars Is That of Mr. Elmer G. Sperry, Inventor of the World's Most Powerful Electric Searchlight, Shown at Fig. 1-A. Mr. Sperry Proposes That We Employ a Battery of 200 of His 1,250,000,000 C.P. Searchlights in One Gigantic Bank, so as to Concentrate Their Rays in One Powerful Beam of Light. It Is Calculated That the Martians, if Such There Be, Cannot Miss This Blinding Flash of Light, Which Would Appear to Them as a Star of the 7th Magnitude, Which Is Easily Picked Up by Our Earthly Telescopes. This Beam of Light, Totaling 250,000,000,000 Candle-Power, Would Rival the Sun Itself.

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thousands of years in advance of us when it comes down to scientific matters including the languages. Probably they have but one language on the order of our rapidly growing universal language—*Esperanto*.

All well and good, but without wasting any more time conjecturing on the ways and means of interplanetary communication, let us start with the fundamentals of the understanding between any two Earthly human beings. To do this, as one professor of languages recently suggested to the writer, we certainly will have to step back to the period when we were little children. Go straight back to the days of the kindergarten, and then we are ready to start learning the real fundamentals of communication and understanding via the language route between humans. But before going further, we might take a glance at Fig. 2, which shows the simplest scheme for teaching or endeavoring to communicate to another person, the elements of numeric computation.

Fig. 2 shows that two dots, plus two dots, equal four dots. Little children are often taught in this way by several different schemes, how to count. Some of our ablest scientists and astronomers have suggested times beyond number, that this is a very good and plausible way to start communicating with the Martians, and not only this, but they often carry this idea to the point where it is claimed that eventually languages or codes explaining the languages may be transmitted and interpreted either by us or by the Martians.

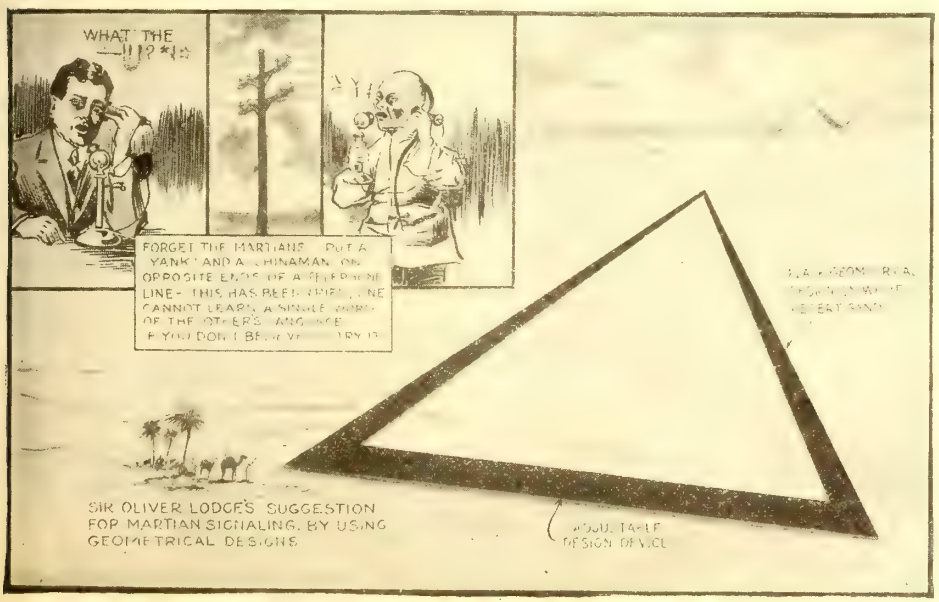
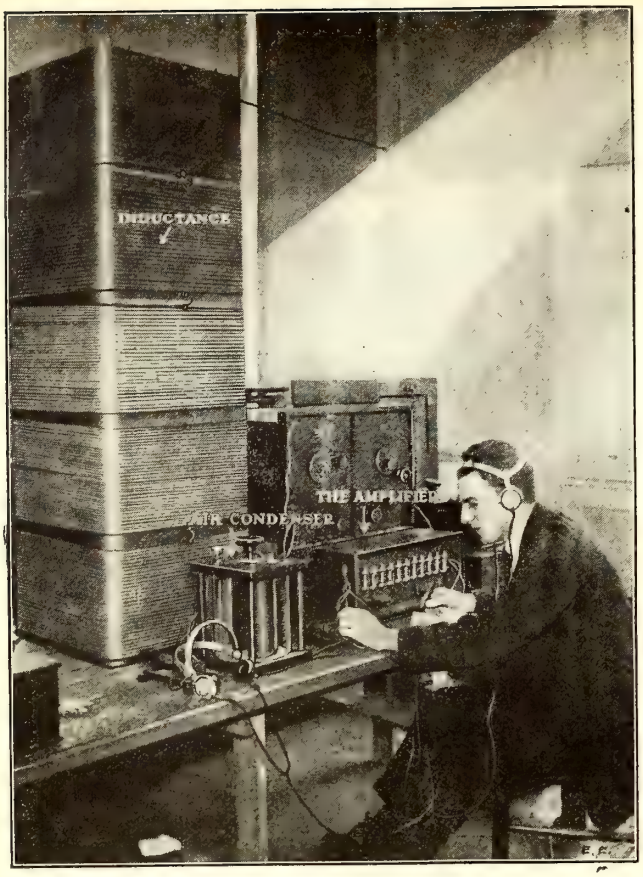


Fig. 5 (Inset). You Do Not Have to Endeavor to Open Up Wireless Telephone Communication with the "Martians" in Order to at Once Perceive That You Have "Started Something"—so Far as It Is Possible to "Talk," or for That Matter if It Would Ever Be Possible for You to Learn Even One Word of Martian. The Experiment of Placing a Chinaman and a Yankee on Opposite Ends of a Telephone Line Has Been Tried for a Considerable Time Period, and Neither One Could Assimilate or Interpret one Word of Each Other's Language, Altho They Talked Long and Often, Over the Telephone. Fig. 6. Sir Oliver Lodge Suggests That We Build Large Geometrical Figures in Black on the White Sands of the Sahara Desert, and He Believes That the Martians Will Understand It, as Geometry Is a Universal Study and Science.

It takes but a little reflection to see that, while presumably and with average intelligence no greater than ours, in a short time a person who doesn't know our language at all, should be able to perceive if shown a blackboard with this arrangement of dots, that we were trying to impress upon him the fact that two dots, plus two dots, equal four dots. Well and good, but when it comes to communicating letters or words of a language by this method, it would seem to be quite impossible, and altho the writer has discust this scheme with several experts on languages, they have not been able to think of a single method whereby it could be carried out.

So we go back once more to the little children in the kindergarten class. We will



And Wonder of Wonders!—Here Is the Very High-Powered Marconi Radio Station at Which the Mysterious Dots and Dashes Filtered in from the Ether—and Furthermore These Signals Are Believed by the Great Marconi Himself to Quite Possibly Be "Signals of Inter-Communication" Hurled at Us Thru Millions and Millions of Miles of Interstellar Space, via Wireless, by the Martians. At Left We See the 100,000-Meter Wave Inductance. At Right the Wonderful Eleven-Stage Audion Amplifier, Magnifying the Signals 10,000,000 Fold.

leave numbers out of the question, because we cannot carry on a conversation very well with a set of figures,—or at least we will presume that this is not the case with the Martians. How is a child taught the letters of the alphabet and their final correlation into words,—and again,—the meaning of these words?

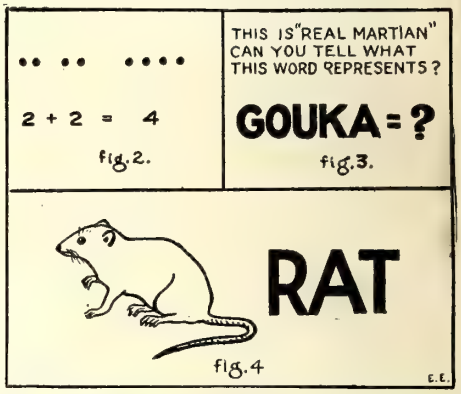
When you have thoroly philosiphized on this elemental detail of pedagogy, you at once become cognizant of the highly important fact that the little child who does not know anything about the language he is to be taught, cannot teil what such a simple word as "R-A-T" means. He can be taught the sounds of the letters of the alphabet so as to pronounce them—and also how to write them—but as soon as he has finished with this, think of asking him to define the word "rat"—a simple three-letter combination. Now, it is at once evident that the child has no more idea of what R-A-T means or stands for than the wood tie-post to which you hitch Old Dobbin—except for one potent and all-important consideration, and that is—that in the books from which he studies or else by means of the blackboard and the skilled artistry of the teacher, *he is shown a rat,* or possibly he might be shown a live one in a cage, or a dead one—but in any case he does two things when he first learns the meaning of any word, in this case "rat." He is first taught to pronounce and how to form the letters of the word in writing, and then he is shown simultaneously in some form the object which the word represents.

Some one may object at this point and say it is not so in every case that an object representing the word *is shown simultaneously* with the mastery of the word, but the answer is that if this is not done, then the teacher or the governess will have to launch forth on a lengthy *word-picture* explaining about the *rat,* let us say, and what it looks like.

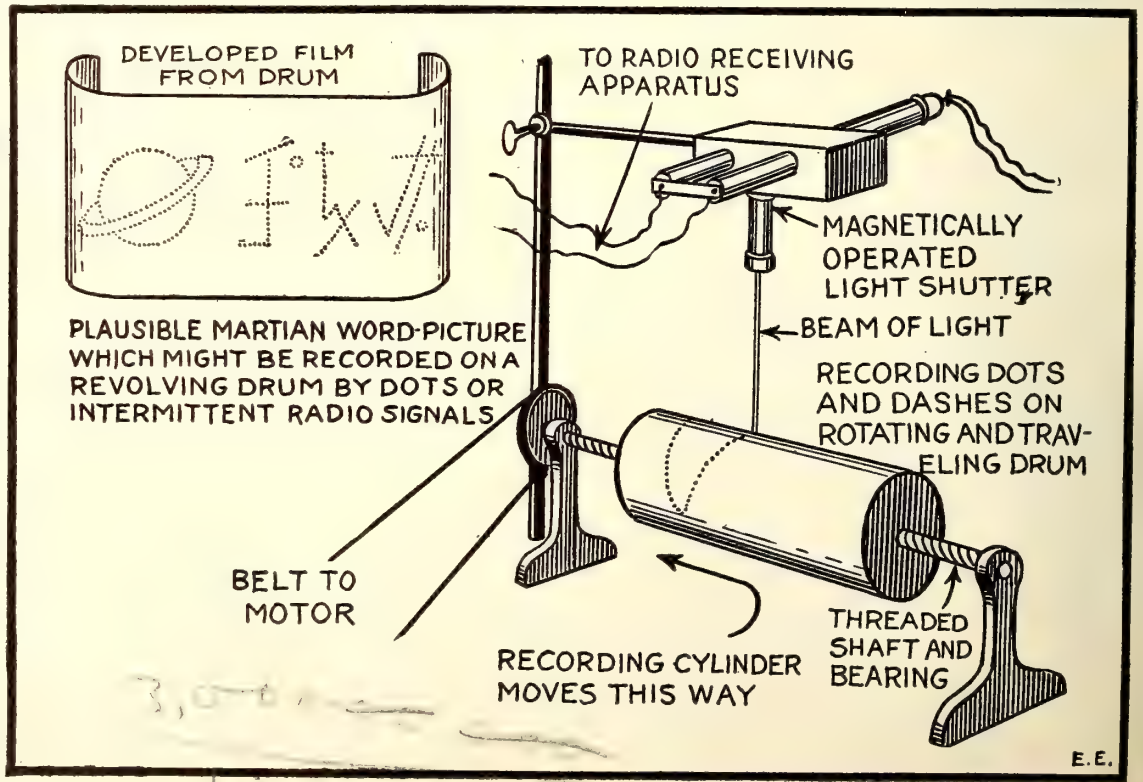
This basic element of learning any language is more forcefully shown at Fig. 3, where there is also shown what we shall call, for the sake of supposition, a real Martian word, G-O-U-K-A! Now just consider for one moment—no matter how familiar you may be with secret codes and ciphers—and try to think how you would look this *first Martian word* squarely in the face and endeavor to understand what object it represents! Does it represent a sea? Does it represent a house?—or a Martian horse?—or does it mean a declaration of war between two Martian nations—and so on and so forth.

Consider that the writer is a Martian and that thru your powerful earthly telescope some dark night you are confronted by a burst of light from Mars and upon directing your telescope more minutely and accurately towards this illuminated spot on the distant planet you read in outlines of fire this word. There is no use of taking any other words, for this one serves its purpose

(*Continued on page* 1302)



At Fig. 2 We Have the System—Commonly Advocated For Opening Up Communication Between the Earth and Mars by Means of Signals Sent by Light, Radio, etc. This Is to Give the Martian to Understand That We Earthians Count Two Dots Plus Two Dots as Four Dots. It Is Conjectured That in a Short Time We Can Thus Intercommunicate Very Nicely with Our Martian Neighbors. If You Think, However, That Such a System as This Will Eventually Lead to Inter-"Language" Communication and Understanding, Try and Dope Out What the (Assumed) Martian Word "G-O-U-K-A" Means. Fig. 3. In the Next Issue We Will Tell You. Fig. 4. The Most Logical Method of Establishing Any Inter-Language Communication with a Strange People, Such as the Martians, Surely Seems To Be by Means of "Word Pictures," Such as Shown Here, Flashed or Otherwise Transmitted Simultaneously, in Such a Manner That the Picture Can Be Built Up. Otherwise, If the Martian Received the Letters R-A-T by Radio and Could Understand Them, but Did not Know What Our Animal the "Rat" Looked Like—He Would Have Some Tall Difficulty in Trying to Find Out What R-A-T Meant, Granting, of Course, That He Knew Our Alphabet—For the Chances Are That Animal Life Is Different on Both Planets.



The Mysterious Stray Wireless Signals Which Have Been Recorded by the Marconi Trans-Atlantic Station, May Have Some Meaning Which We Do Not Understand as Yet. It Has Been Suggested by One Authority That Possibly if We Have the Proper Apparatus or Scientific Means For Interpreting These Apparently Meaningless Jumbles of Dots and Dashes, That We May Cause Them to Produce a "Picture." Suppose, For Example, That You Had a Revolving Drum Which Was Moved on Its Axis and Covered with a Photographic Paper or Film. If the Incoming Radio Dots and Dashes Were Recorded on This Drum, They Might Possibly Form a "Picture and a Word," Probably in Martian. If We Were Able to Obtain a Considerable Number of These Word Pictures We Could Eventually Figure Out What the Martian Alphabet Is. Fig. 8.

Electricity Foils German Seals

By FRED C. KELLY

HOW the Germans sealed up over a ton of official and secret papers in the safes of the Swiss Consulate at New York, only to be fooled by five American adventurers, who secretly opened the wax seals on the ropes and locks during the nights when the office was vacant proves highly interesting reading. The tale of these five doughty knights, whose names are unknown to the Government to this day, is told in this story. These unknown workers of Uncle Sam, who finally procured all the secret papers and handed them over to the Government, hired a suite of offices in the building where the papers were stored.

First they had their lock expert fashion a key to the outer door of the consular offices, and one night they went there to look the layout over. To all appearances the German papers were stored in two large safes, several sections of metal filing cases and a steel trunk.

Each safe and each filing case was bound around with rope and with red-white-and-black tape—in much the same manner that a shoe-box is tied with a piece of string at a store. The knots in the tape or rope were invariably covered with sealing wax of a special kind not easily imitated, and the wax was stamped with the official German seal.

Particular care had been given, apparently, to the sealing up of the larger safe. Pieces of sealing wax, bearing the official stamp, had been stuck at intervals all along the cracks at the edges of the safe doors. Official tape had been wound back and forth between the handles of the double doors of the safe, and the knots were sealed and stamped. The tape was also fastened against the flat surface of the safe doors with sealing wax and this, too, bore the official stamp.

Because the larger safe was the most carefully sealed up, the visitors assumed that it must contain the most valuable papers. They determined, therefore, to try to open that safe first of all. But even aside from the problem of working the combination, it looked like an impossibility to open the doors without disturbing the tape and seals.

In this way the seals could be removed one at a time, without disturbing the impression of the official stamp. Later the seals could be glued back to the same places from which they had been removed.

There was still the problem of getting the tape removed from the handles of the safe doors. But the callers hit on a plan for doing this that made the job simple.

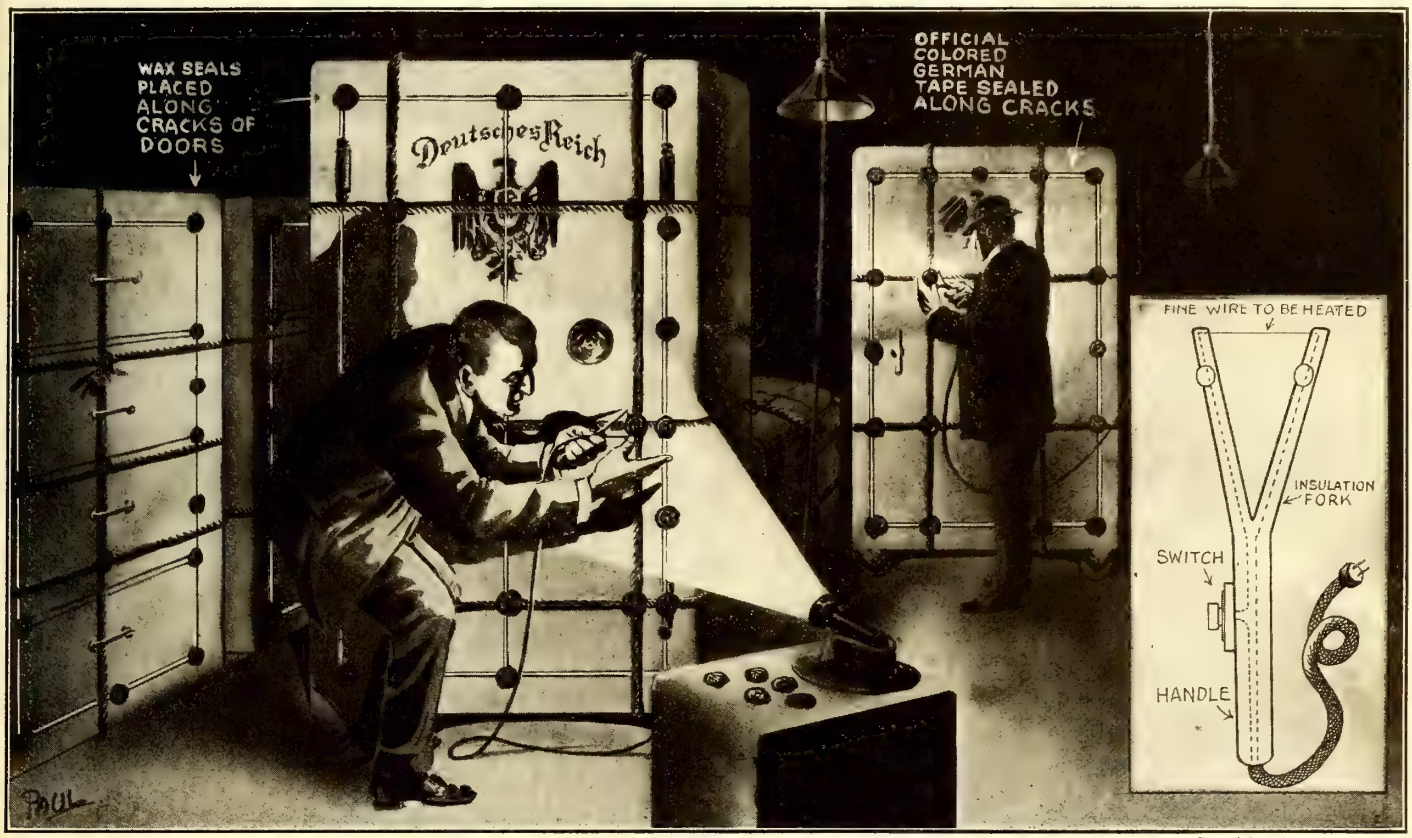
Instead of trying to remove the seals and unwind the tape, they removed the little invisible cotter-pin which held the grip part of each handle in place. Then the whole mass of tape could be slipt right over the knob of the handle. All very simple!

The handles showed slight blemishes where the pins had been removed, but this was quickly remedied simply by polishing the abrasion in the nickel-plating and applying a little nickel-plating solution.

The job of opening the safe, removing the contents and restoring the safe to its previous condition occupied the five men from about 11 o'clock at night until toward daylight. It was many days before they dared return to continue their search. While the nature of the papers in this safe was disappointing, the Germans, with typical German inefficiency, had left in the safe a great quantity of paper seals of exactly the same kind that they had used in sealing up the drawers of the metal filing cases. The possession of these seals greatly simplified the job of opening those drawers later on.

On a certain night while the Americans were at work on these files, a man, now supposed to have been the night watchman, came along and nearly stumbled upon them.

(*Continued on page* 1331)



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One of the Most Absorbing Chapters of "World War" History, Which Was Actually Enacted Not on the "Battle-Front"—But 4,000 Miles From It, in a Quiet Little Consulate Office Located in New York City, Is Here Told by the Author. The Germans, When They Left America, Placed Over a Ton of Valuable Papers in the Safes of the Swiss Consulate, and Plastered Up the Cracks of the Doors, and the Locks With Rope, Paper Tape, and Wax Seals Bearing the Imperial German Seal. Not to Excite Suspicion, Five Adventurous Americans Succeeded Finally, Thanks to the Clever Electric Heater Here Illustrated, in Removing the Seals Without Damaging Them—Procuring All the Secret and Valuable Papers—and Then Gluing the Seals Back Into Place.

HOW ELECTRICITY REMOVED GERMAN SEALS UNDAMAGED.

If these seals were noticeably marred it soon would be discovered that the safe had been tampered with. This would prevent later visits, and furthermore, if it became known that the papers were gone, part of the value they might have in tracing German agents might be lost.

The visitors saw that if they were to open the safe and not have their work afterward discovered they would need several ingenious tools. When they returned a few nights later they were equipt with such tools and devices as were required. The most noteworthy of these was an *electrical contrivance* which could be attached to one of the electric light sockets near the safe. The working part of this consisted of a Y-shaped instrument between the two prongs of which was stretched a fine wire. This wire, when heated by the electrical current, could be past underneath the seals where they adhered to the flat surface of the safe.

THE PHYSIOPHONE

Music For The Deaf

By H. GERNSBACK

WHEN I was sixteen I secured an old-fashioned Pathé phonograph of the cylindrical record type. You know the kind that was in vogue years ago. Being much interested in electricity in those days, the thought occurred to me, the same as it occurred to thousands of others, namely, why not transmit the music electrically by putting a sensitive microphone somewhere on the phonograph and thus get the music at a distance.

No sooner said than done. An old-fashioned Hughes microphone was constructed by means of three little carbon rods, and this miniature microphone was attached to the sound box. The microphone was in series with a battery and the primary of an ordinary telephone induction coil. The music transmission was excellent and phonograph music was transmitted over a distance of three hundred yards on my father's estate. These experiments created quite a sensation in those days, and my friends, all electrical "bugs," were much elated and pleased with the stunt.

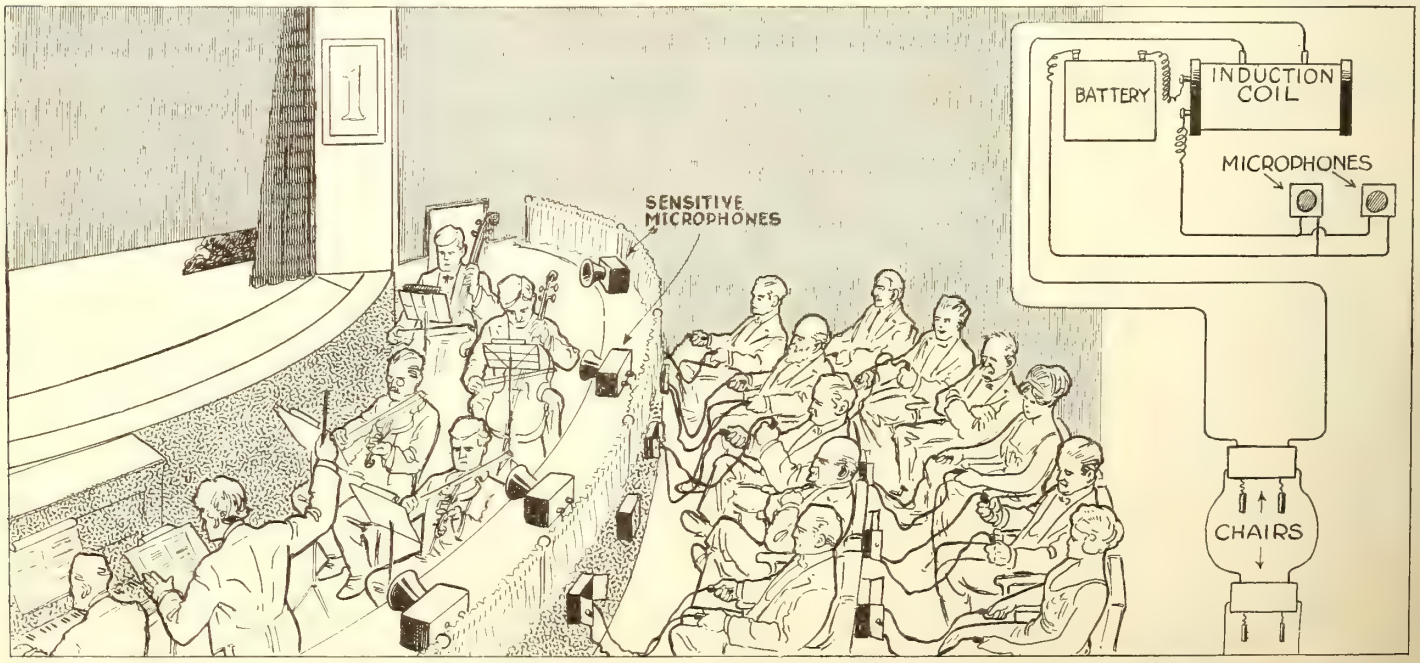
One evening I accidentally touched the two wires of the secondary terminals of the telephone coil and was quite surprised to get a smart and disagreeable shock. That was in 1900. The early experiments were soon forgotten, but in 1917, while editing an article in this magazine, where a young man had re-discovered the ancient experiment, I thought of that shock, and I understood immediately what that shock really was. I accordingly set to work and immediately built a new transmitter which was attached to a Victor phonograph sound box, and which is shown in Fig. 4. The connections are shown from which it will be seen that the microphone is in series with the 6-volt storage battery and the primary of an induction coil such as is used in telephone work.

The writer used a regulation sound box merely by making a microphone out of it and substituting a carbon diafram for the mica diafram. The space between the back carbon and the carbon diafram is filled out with polisht carbon grains. The mechanical suspension of the carbon diafram must be the same as the one for the mica-diafram. In other words, the vibrations of the phonograph needle must be faithfully past onto the carbon diafram, the same as is the case with the mica type. When the connections are correctly made and two handles are now attached to the secondary of the induction coil, and these grasp in your hands, the rhythm of the music will be felt faithfully and with astonishing fidelity. What we do feel is sound vibration translated into electrical impulses which in turn are felt physiologically by the human nerves. It is surprising how well this translated music is communicated to the nervous system of the human being, and with a little practise it becomes possible to recognize the different tunes merely by the variations of the little tingling shocks.



Mr. Gernsback Demonstrating the Physiophone. The Photograph Shows How the Instruments Are Connected. By Means of the Double Pole Switch, the Music Is Reproduced by a Loud Talker, Then the Switch Is Thrown, and Physiological Music Is Had.

Different records were tried in 1917, but just then the United States entered into the war, and the experiments came to a sudden end. Recently, however, they were taken up again with the following results. Improvements were made on the microphone and a great many new types were tried out, because the original type was not entirely satisfactory. Later experiments, however, proved to me that the 1917 type in principle was probably the best that could be produced. From some ten or twelve types which were evolved by me then, a few are shown here. Many different records were tried, and it seemed to be readily establisht that the different tunes, the different musical instruments, as well as voices, could be readily differentiated physiologically *without listening at all to the music*, or without hearing any sound whatsoever. Of course, it goes without saying that such experiments must



Double Barreled Music. Showing How an Audience Can Enjoy the Music Orally As Well As Physiologically. In Other Words You Hear the Music and You Feel It As Well. A Brand New Source of Enjoyment.



During Tests With Totally Deaf People, They All Expressed a Great Desire to Dance by Means of Physiological Music. Due to the Rhythm a Deaf Person Can Now Dance Without Any Trouble by Means of Physiological Music.

be made with the phonograph in a different part of the building with the handles so far away that the music from the phonograph cannot be heard at all. When using the microphone type as shown in Fig. 4, the sound near the phonograph is still audible, altho not anywhere near as loud as if the original mica-diafram were used.

For this reason the handles must be located in another room so that whatever music leaves the phonograph cannot be heard. I used a double-throw switch and a loud talker of the type commercially sold, and invited visitors to first listen to the phonograph record by means of the loud talker. Then the switch was thrown, and of course no sound was heard at all. By grasping the handles, the visitors could readily follow the rhythm of the record, and right here a curious thing happens.

Some people, altho musically inclined, have trouble in following the music, while others immediately recognize the different strains and have no trouble to sing or whistle with this physiological music. There seems to be a difference in the nervous system of individuals, and some people can more readily translate the rhythm than others, altho not necessarily more musically inclined. Other tests were made paralleling the idea *by using no phonograph at all,* but simply a microphone into which a person spoke. By having the experimenter count from one to a hundred, the other party at the far end could feel the voice impulses and after a while managed to "understand" the voice by physiological impulses.

In Fig. 1 is shown another type of transmitter attacht in front of the sound box in the phonograph. It consists simply of three transmitters connected in parallel, the connections being the same as usual. This, however, did not work as well, and very little could be felt at the secondary end.

In Fig. 2 is shown two transmitters, because the writer at one time when working with a single transmitter on a disc type phonograph did not receive all the impulses, that is to say, only one side of the lateral cut vibrated the diafram.

The same idea is shown in Fig. 3 where two transmitters were simply attached to the needle holder, the rubber band serving simply to feather the action, but the results in neither case were good, and the original 1917 type transmitter with certain refinements has been found to work best in all respects.

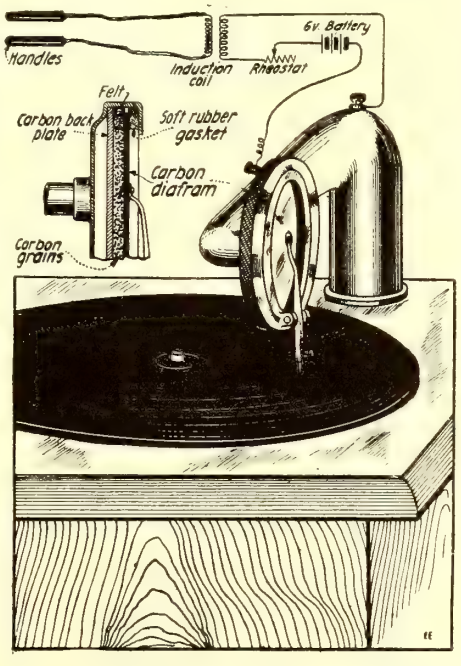


Fig. 4. Schematic Illustration of the Components of the Physiophone.

What purpose is accomplisht by these experiments? Ordinary human beings certainly do not require the translation of musical impulses into their nervous system, *but for the deaf a vast and important field has been opened.* Here we have a means of translating music into the nervous system of a deaf person who has not the slightest conception of music. Of course, it should be understood right here that I do not mean to convey the idea that a deaf person will actually "hear" the music. What he does get, however, is the rhythm, and he certainly gets this very definitely as has been actually demonstrated by tests with deaf persons upon which the writer experimented. It has been found that a deaf person can readily understand the different musical pieces, and can even recognize different musical instruments with very little practise.

Of course, the deaf person must learn the same as any other human being, for it is a well-known fact that if a person totally deaf were restored his hearing, he would not be able to understand what you said to him for some time to come. He would have to learn and judge the sound just the same as a child. The same is the case with a totally blind person who has never seen daylight. Experiments made with such people invariably prove that as soon as the eyesight is restored, they do not see in the sense that the normal person

(*Continued on page* 1320)

Electro-Medical Frauds

By JOSEPH H. KRAUS

FROM time immemorial, people of this and foreign countries have allowed a class of humbugs and fakers to foist upon them innumerable cure-all devices and medicines. Not alone have these quack doctors been charging exorbitant prices for worthless trash, but they have also caused various injuries and hardships to those attempting to manipulate or apply these worthless humbugs "as per directions."

In medicines, even today, the market is full of glaring advertisements of remedies which formerly were claimed to cure anything from a corn to a malignant tumor.

Some of these fakers and quack doctors have been enjoined from ever again manufacturing or offering for sale, *any* medicines of *any* kind and the harvests of five hundred thousand to several million dollars annually, is lost forever to them. Like all schemes of this nature, these individuals produce testimonial upon testimonial to *prove* (?) that their goods are as wonderful as they claim them to be and with the boldest effrontery, produce advertisements such as "Five Hundred Dollars will be paid to any one who can prove that these letters are not genuine, or have been solicited." This seems to pave the way to the enormous financial profits recorded by them in income tax reports and demonstrates to what an extent they have hoodwinked the Public.

It is only necessary for us to watch the continuous panorama of advertisements which bunko medicine houses use and view the daily death column in the paper to note the marked similarity of names of persons who have died of the same disease, which, two days later, the cure-all concern announces it had cured. "Dead men tell no tales" as the old adage goes, and hence, we will not stop to even question whether or not the individuals concerned in the treatment, ever had used it, but if so, the remarkable results are clearly indicated by the "slow procession."

One of the greatest frauds of all time and finally declared by the Government to be simply a scheme for obtaining money thru the mails by means of pretexts and fraudulent promises, and to which further use of the mails was denied, was the "great" and "wonderful" ACTINA humbug. Perhaps many of our readers remember this *Actina inhaler*, having probably seen advertisements of it thruout the country. This device sold at about ten dollars and later on, if the correspondents did not answer, a 50 per cent discount on any goods was offered.

Essentially, it consists of an outer casing about three inches long with a wide opening at one end, and a narrow opening at the other. An inner tube of perforated zinc about ¼ inch wide and fitting inside the first tube or casing (this made of copper). The American product, however, was entirely of steel. The space between the two walls shown in illustration (1) was filled with oil of mustard and oil of sassafras. The former smells like a decayed onion and great caution must be exercised when smelling this oil, hence the *Actina* advertisements stating that it was perfectly harmless were not only fraudulent, but also of great injurious content. This swindle "cured" *deafness, blindness, catarrh, and nervousness and a couple of other odds and ends thrown in.*

The American Medical Association, in their exposé propaganda, speaking of its effect in curing any eye or ear disease, state that the sufferer might just as well and with more safety, blow red pepper up his nose, and get his sneeze cheaper than by sniffing at a $10.00 evil smell.

This fraud claimed, in addition, to be an ozone battery, the electric action of which was due to the copper and zinc involved in its construction. We would refer the reader to several past descriptions of *real* ozone generators and recall to his mind that even the smallest of these generators was comparatively bulky and yet we find here, a company deciding that ozone can be generated by electric action (?) between the zinc and the copper, while held in the hand. Additional fakes made by the same concern were the Magneto Conservative Garment shown in Fig. 3. This garment, which was claimed to cure anything from indigestion to *locomotor ataxia*, looked like a suit of underwear with a large number of bar magnets, oodles and oodles of them, scattered thruout its interior.

Such magnetic devices never cured nor did they ever have even the slightest effect upon the individual. Such bunko devices as the magnetic hair brushes and combs, "cold feet" pads generating electricity due to the action between the copper and zinc plates, and electric belts, not only never cured, but also made themselves uncomfortable to the wearer.

Out of hundreds of claims for testimonials, not one cure could be authenticated by the use of the various devices here referred to.

In order to note the effect of magnetism on the human body, tests were made in France (see Fig. 2), which involved the use of gigantic electro-magnets capable of forming the most intense magnetic fields.

Persons placed under the effect of this ultra-powerful magnetic flux were carefully watched and every movement recorded with remarkable accuracy and precision. The pulse rate, heart beat, breathing, and reflex responses from the various nerve centers were noted and in no case was even the slightest change effected when the person was first under magnetic influence and again when the current was turned off.

This fact is well worth remembering. When once thoroly learned, people will not be bamboozled by *any* device which claims as its healing power, magnetism of any sort. Under this category, come also such ridiculous schemes and such flagrant misrepresentations as *Electro-magnetic Rings* which cure everything from nose bleed down to appendicitis, and varicose veins.

Another of the wonderful deafness cures which was perhaps more magical and mystical than the former was that of (Dr.) Branaman. This device would cure deafness or catarrh, head noises or asthma, so quickly that you would not even know it, regardless of what the deafness was due to. The poor afflicted victim was given a symptom blank which he filled out and whether he could add *yes* to every question or *no* to every question asked thereon, he was either pronounced deaf or suffering from catarrh.

The contrivance altho selling for $8.00, cost about $1.50 to make. Essentially, it is a leather belt strapt securely around the head, made in the form of a pocket. This houses the "battery." The battery is the same as employed in the audacious commercial frauds even now being advertised and manufactured in the form of belts.

These consist of a number of copper and zinc elements, the zinc being placed inside the copper. Around the zinc element is a tiny bit of felt so that when the battery is immersed in a vinegar solution an electric current is set up! These electric currents buzz thru the ears and stimulate in that way, the nerves of hearing, according to Dr. Branaman, America's *leading ear specialist* (at least he calls himself that); he even went so far as to publish advertisements in the newspapers showing the photograph of a man as being cured of deafness and blindness. This man had been deaf for years and was still deaf; and this Dr. Branaman knew. Still he persisted and continued to use the victim's name in his advertising slogans. Strange to say, a testimonial purported to have been written by the man, was printed altho the victim was so unfortunate as to be unable to write.

Even today, in some of our newspapers and magazines perhaps we find advertisements that start off with a big flare "Don't shout, use the *Morley* ear phone." This

(*Continued on page* 1312)

For "May" E. E.

Peace Time Uses for the Searchlight—A new scheme for outlining airplane field with one search'ight, by Edwin F. Linder, M. E., Specialist in Searchlight Design and Inventor of Bullet-proof Mirror.

The Automatic Telephone—Simple explanation in picture and in diagram by an expert in Automatic Telephony.

Flashlighting Birds and Animals, by Howard Taylor Middleton.

The "Loadstone" or Natural Magnet—Specially written by an expert on loadstones, with special illustrations.

A Day With the Weatherman—The rôle of electro-mechanics in foretelling your daily weather report, by H. Winfield Secor.

"Odd Photo" Prize Contest.

"House-hold Electrics" page, by Edna Purdy.

The Why and Wherefore of Magnetism, by Edward A. Keever.

How Glass Is Made—All about glass, the everyday substance about which we know so little, by Prof. Floyd L. Darrow.

Popular Astronomy, by Isabel M. Lewis, M.A.
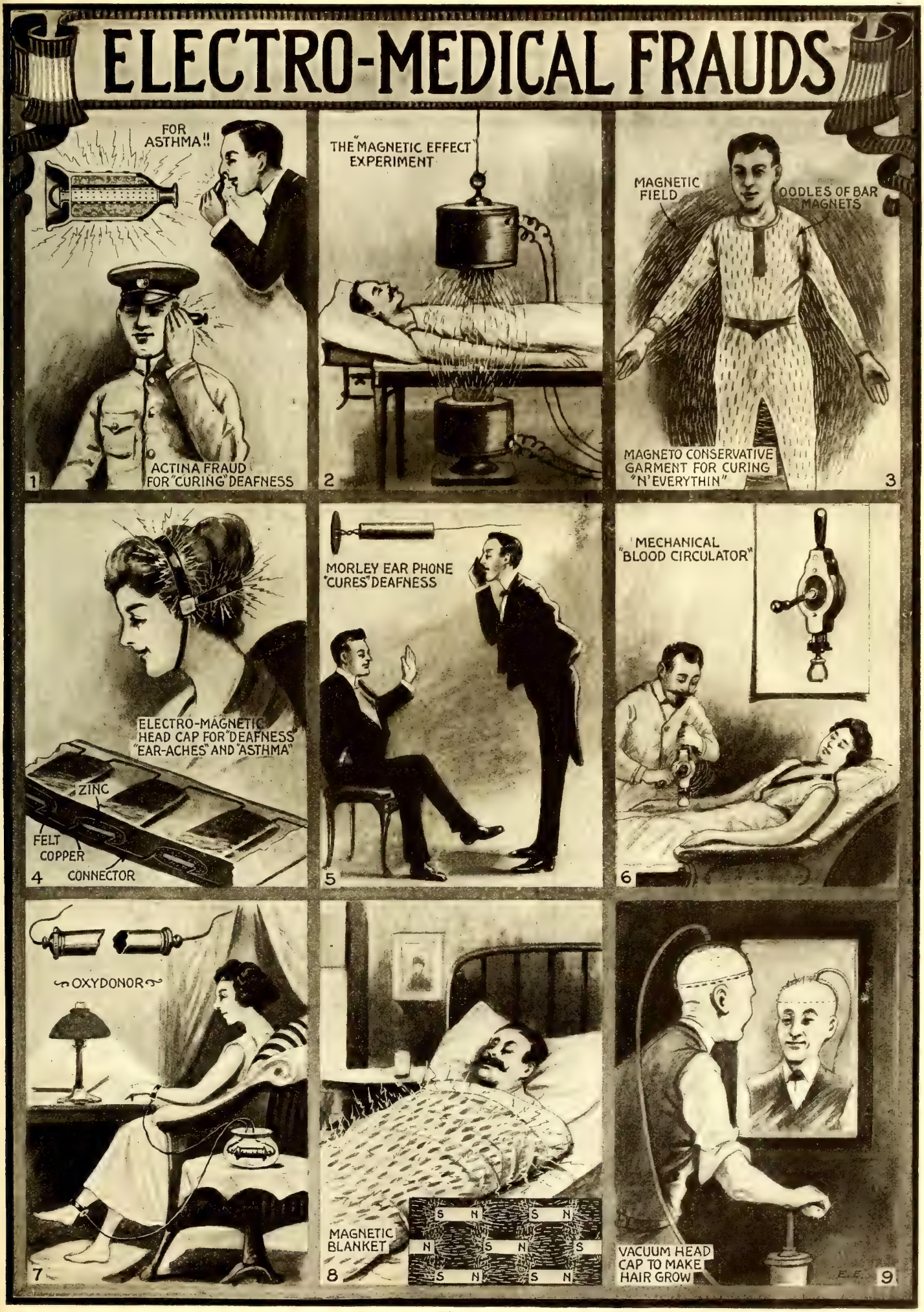
The Amateur Magician—The Mysterious "Rapping Hand" which foretells your fortune, by Joseph H. Kraus.

Long Waves and "Strays" on Rogers' Antennae, by Lieut.-Com. A. Hoyt Taylor, U.S.N.R.F.

Some Laboratory!!—An interesting story with excellent photographs of an American model worker's shop de luxe—Written as only he can write it, by Thomas Reed.

More Light for Microscopes, by Merrill M. Hunting.

ELECTRO-MEDICAL FRAUDS



FULL DESCRIPTION ON OPPOSITE PAGE.

"The Educated Harpoon"

By CHARLES S. WOLFE

THE Chief of Police gave me a hostile questioning stare. I'm not exceptionally quick witted, but I don't have to be hit with a club in order to grasp an idea. I rose instantly. "Something tells me I am *de trop*," I murmured.

My friend put out a protesting hand. "Sit down, you touchy ass," he said. "Chief, this man is a particular friend of mine. You can safely say anything in his presence. It will go no farther."

Undecided whether to go or stay, I hesitated. The Chief smiled sourly. "Oh, it's all right, Mister, if Joe here says so. But forget anything you hear, get me? We can't afford leaks."

Joe saw that I intended to go, and he crost and forced me back into my chair. "Don't mind the Chief, Bill," he said, laughingly. "He has an inherently suspicious disposition. Now then, Chief, what is troubling you?"

I gasped. I knew Joe Fenner as a fellow student, wireless telegraph enthusiast and scientific dabbler. A mighty likable, but not extraordinary, sort of a fellow. To find him on terms of intimacy—to say nothing of equality—with the Chief of our city's police force was astounding. Personally, I've always had a little fear of policemen, a relic of boyhood days and pranks. Apparently the king-bee of the whole clan had no terrorizing influence on Joe.

The Chief dropt wearily into the nearest chair. "You'll have to pardon me, friend," he growled at me, "I'm a little short on manners at the best of times, and this thing is getting on my nerves. Joe," turning to Fenner, "I want you to help us again."

I turned a mental summersault. The Chief of Police addressing my chum as Joe. Asking him to help them—again. Ye Gods! Was my seemingly commonplace chum a detective?

The Chief was speaking. "There was a man killed in the Atwood building an hour ago. I've just come from there."

My face must have reflected the varying emotions that this statement produced within me, but Joe's countenance remained passive. "Murdered," he asked, quietly. "How?"

"Stabbed in the back." The Chief might have been saying "Please pass the potatoes," for all the feeling exprest in his tones.

Joe shrugged his shoulders. "I don't think you want me, then," he said. "It's out of my line."

"Yes, you'd think so," agreed the Chief, "if it wasn't for the peculiar circumstances surrounding the crime."

"Peculiar circumstances? What's peculiar about them, anyway, Chief?" queried Joe.

"Well, for one thing, we can't find the knife, or whatever it was that he was stabbed with."

"Murderer took it away with him," suggested Fenner.

The Chief's face took on a pained look. "Maybe he did," he said, wearily, "only—there's no possible way he could get in to stab the man in the first place, and no way that he could get out after he had stabbed him in the second place. And in the third place the crime simply couldn't have been committed at all, but it was. And there you are."

"Chief, you're talking thru your hat," reproved the amazing Fenner with astounding disregard of the deference due one in the Chief's position. "There must be a perfectly simple way in which some one got into the place and away again."

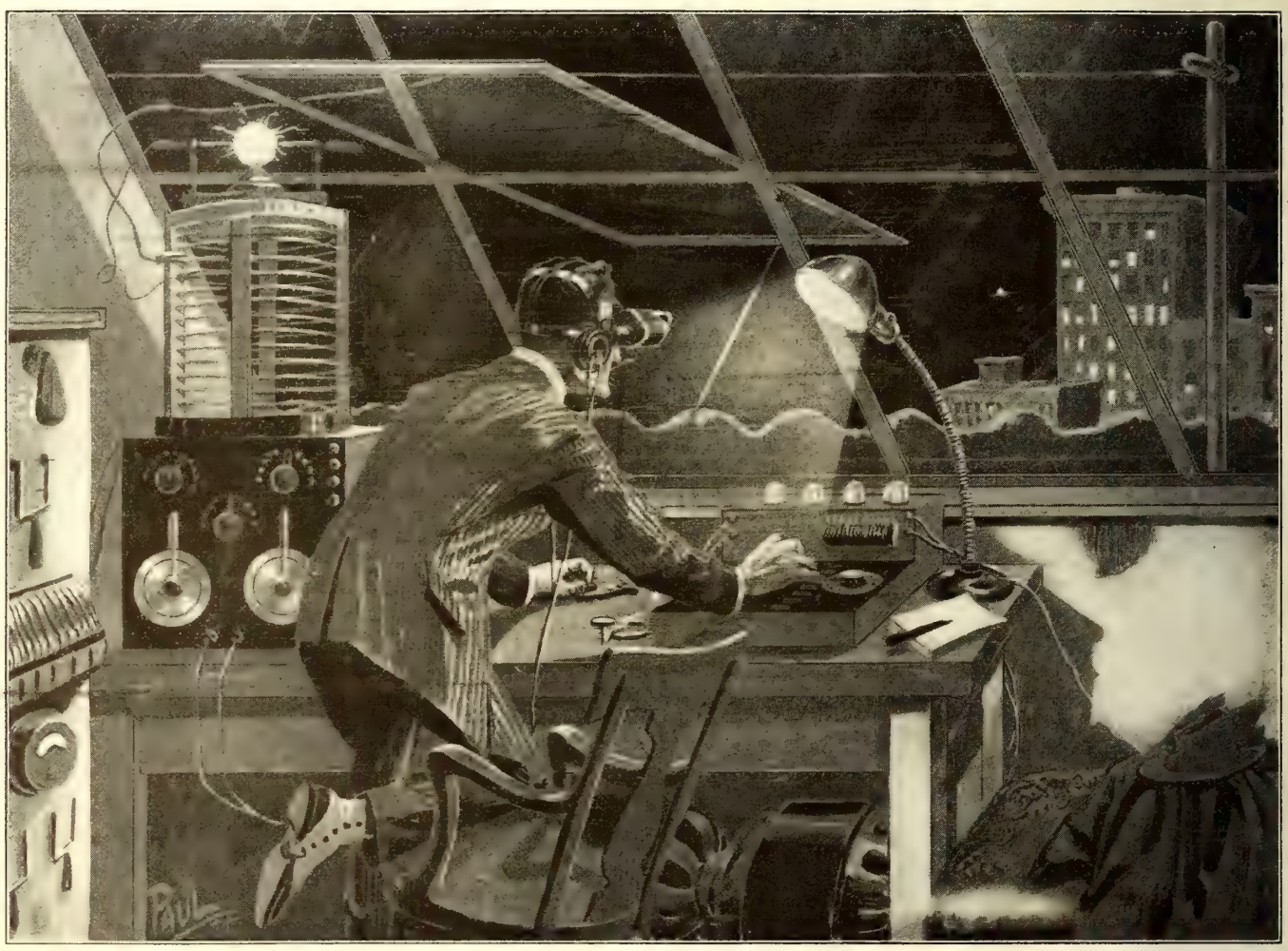
The Chief arose. "My car's outside," he said. "Come along down and have a look."

As Fenner hesitated I took my cue. "I'll ride along as far as my house if you don't mind," I said.

"You'll ride along and have a look with me," said Fenner, warmly. "I know you're just as curious as I am to get a look at the scene of this remarkable crime."

The Chief was almost friendly. "Yes,"

(*Continued on page* 1335)



This Is a Story of An "Educated Harpoon," and We Are Not Going to Tell You In a Few Words, Just What It Is or How It came About That a Great Business Man Was Murdered In His Private Office, Without Anyone Having Entered the Office, As the Facts of the Case Have Clearly Proven. However, If You Have a Fair Education In Electrical and Radio Matters, You May Be Able to Guess How the Man Was Killed. If Not, You Will Find This One of the Most Interesting Scientific Narrations Ever Written.

ELECTRIC BACHELOR MAID



The Electric Bachelor Maid Surprised Her Friends One Evening by Giving an "Electric Corn Popping" Party. A Stick to Which the Corn Popper Was Attached Waved Regularly Back and Forth When the Sewing Machine Motor Was Running.

Every Young Woman Likes Those Beautiful Blouses with Crimped Ruffles, but She Often Foregoes Buying Them Because She Has No Crimper. An Electric Curling Iron Is Not to Be Despised As a Crimper of Ruffles When One Has No Crimper.

The Electric Batchelor Maid. Does Not Confine the Motor to the Sewing Machine. She Cuts a Circular Felt Buffer and Fits It Onto the Shaft of the Motor for an Electric Manicure.

Making an Electric Cracker Jar. A Hy-Lo Red Bulb Is Inserted Thru the Top of the Cracker Tin, and the Heat Is Just Right When the Light Is On 1 Day a Week.

One of the Annoying Things About "Vacuuming" Is a Tangled Cord. A Coiled Spring May Now Be Purchased, or Made by the Handy Mechanic.

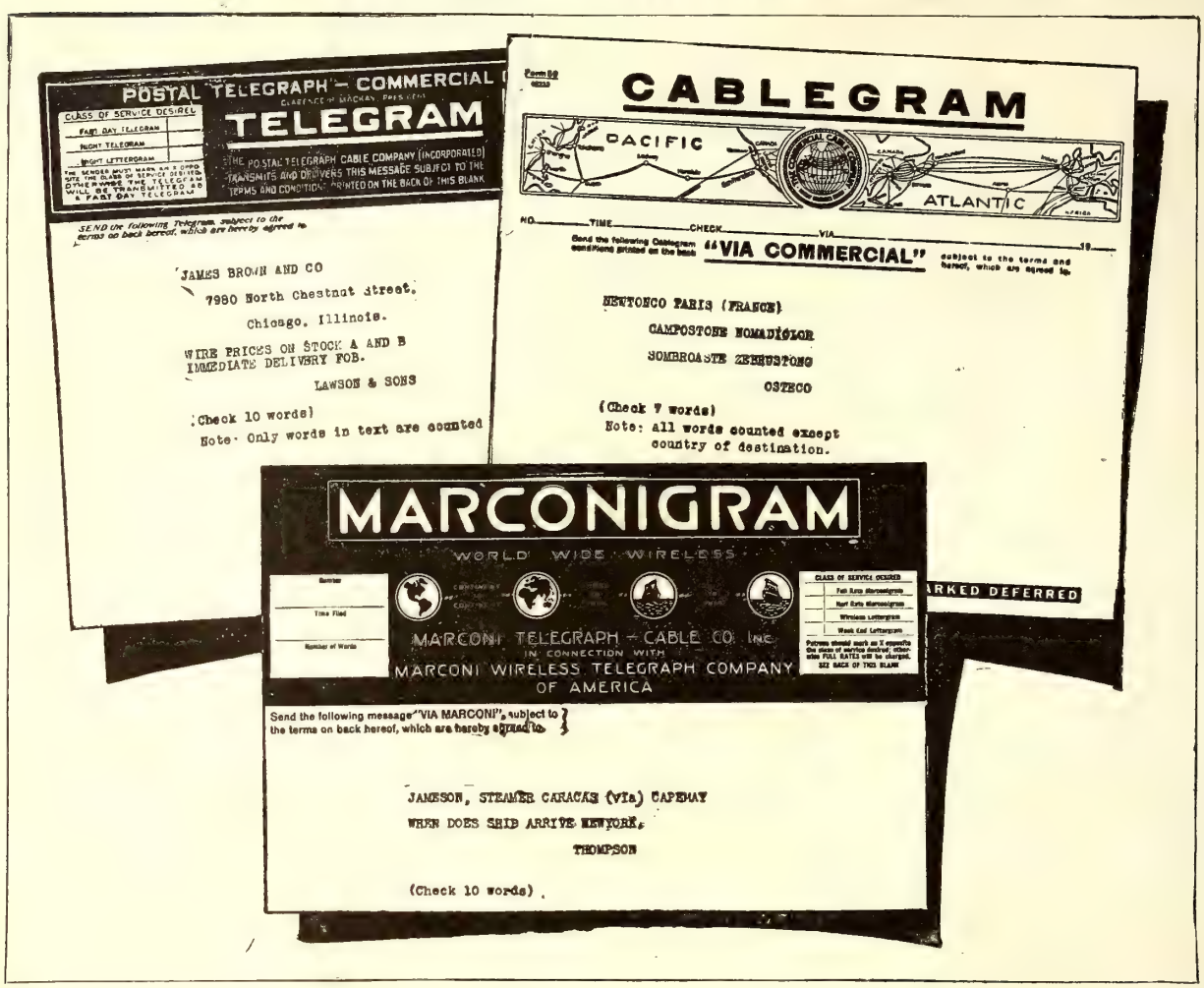
Efficient Brushing by Motor. The Brush Connected to the Shaft of the Motor Revolves, and Its Speed Is Regulated by the Foot Pedal of the Motor.

Here Is a New Combination in Electrical Devices. It Is a Curling Iron, the Center Rod of Which May Be Pulled Out from the Handle, and Screwed Into a Hot Water Bag to Keep the Water Hot as Long as Needed.

A Nitrogen Lamp Held or Clamped to a Tin Dipper for a Reflector, Gives a Surprising Amount of Heat, Which May Be Directed Over the Entire Head or Used to Dry a Section.

Telegraph, Cable and Radio Dispatches

By PIERRE H. BOUCHERON, Ensign U.S.N.R.F.



The Accompanying Illustration Shows the Three Principal Forms of Business Messages as Commonly Transmitted by TELEGRAM, CABLEGRAM and WIRELESS or MARCONIGRAM. The Underlying Key-Note, in Writing Out These Messages for Transmission, Is of Course Brevity, with a Capital "B." Many Useful and Practical Hints for the Correct Preparation of Such Messages Are Given by the Author in the Accompanying Text. Altho the Preferred Forms of These Messages Are Known Fairly Well to Everyone, Yet It Is a Fact That a Brief and Fully Complete Message Which Shall Not Be Misunderstood by the Recipient, is a Rarity

LARGE corporations of today do not waste and take up the valuable time of high-salaried executives by leaving it to them to prepare and properly route the dispatches of the firm in the most economical way. Instead a specially trained clerk, preferably one who has had experience in a telegraph or cable office, is assigned to this work, and all telegrams, cablegrams and radiograms must be routed thru him before forwarding. However, since it is not every organization whose business warrants the employment of such a clerk, nevertheless the smaller concerns may profit by some timely information on this subject. Particularly is this needed today, for in the mad scramble to "get the business" little details like economy in the use of words in telegrams and cablegrams are seldom taken seriously.

The writer, who during the war had an opportunity to study various systems of communications, both government and commercial, was surprised at the lack of common sense and knowledge displayed by some firms and individuals when sending dispatches. In some instances no efforts were made to economize in the use of words, and in a fifteen-word cablegram as many as five unnecessary words would be used, which in the case of messages destined to remote points, costing 42 cents per word, meant a loss of $2.10. On the other hand, there were those who were seeking economy by the wrong methods, and thru lack of proper knowledge of rules would attempt to combine words in an illegitimate manner in order to lower the cost of the message. In either case much money and time was lost in harangues and disputes between themselves and the cable clerks, which could have been avoided by securing the necessary information in very short order from competent telegraph clerks or from other experienced persons.

Besides the telephone there are three general means of rapid verbal communication with distant points as follows and in the order of their importance:

1. The telegraph.
2. The cables.
3. The wireless.

THE TELEGRAM.

The telegraph as a means of communication is usually resorted to in this country where the telephone is too expensive, or where the special delivery mail is too slow, and of the three mentioned above is the most commonly known and used.

CLASSES OF SERVICE.

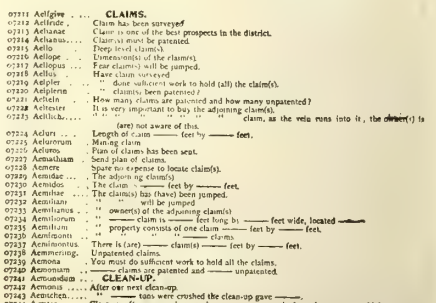
There are four classes of messages which may be sent by telegraph:

(1) The telegram, for which full rate is charged and which is given expedited transmission. It may contain ten or less words for the same charge, additional words being charged for according to rate per word.

(2) The night message, which is handled during the night only when traffic is small and for which reduced rates are charged. This message is usually delivered in the morning of the following business day.

(3) The day letter is transmitted during slack periods of the day and may contain fifty words or less. This form of message is charged for at one and one-half the charge of a regular ten-word day telegram, additional words being charged for at the rate of one-fifth of initial rates for each additional ten words or less.

(4) The night letter is handled in practi-


CLAIMS.

07311 Aelfgive . . . .
07312 Aelfrede . . .
07313 Aelhanae . . .
07314 Aelhanus . . . .
07315 Aello . . . .
07316 Aellope . . .
07317 Aellopus . . . .
07318 Aelloi . . .
07319 Aelpler . . .
07320 Aelplena . . .
07321 Aelteln . . .
07322 Aeltesti . . .
07323 Aeltilo, ...
07324 Aelurs . . . .
07325 Aeluroeum . . .
07326 Aeluros . . .
07327 Aemaliuam . . .
07328 Aemere . . .
07329 Aemidae . . .
07330 Aemidos . . .
07331 Aemihae . . . .
07332 Aemiliani . . .
07333 Aemilianus . . .
07334 Aemiliorum . . .
07335 Aemilium . . .
07336 Aemigonis . . .
07337 Aemimontius . . .
07338 Aemmerring. . . .
07339 Aemona . . .
07340 Aemonam . . .
07341 Aemondum . . .
07342 Aemonia . . . .
07343 Aemuchen. . . . .
07344 Aemier . . . . . .
07345 Aemulabare . . .
07346 Aemulabor . . .
07347 Aemulandae . . .
07348 Aemulans . . .
07349 Aemulantem. . .
07350 Aemulanti . . .
07351 Aemulapos . . .
07352 Aemularema . . .
07353 Aemularum . . .
07354 Aemulatur . . .
07355 Aemulor . . .
07356 Aemulorum . . .
07357 Aenuate . . .
07358 Aeniurtam . . .
07359 Aenatores . . .
07360 Aenatorum . . .
07361 Aenderbar . . .
07362 Aenderlich . . .
07363 Aenders . . .
07364 Aenderung . . .
07365 Aenesdae . . .
07366 Aenham . . . .
07367 Aenceaitent . . .
07368 Aeneanicus . . .
07369 Aeneanicum . . .
07370 Aeneatarum . . .
07371 Aeneatest . . . .
07372 Aeneatorem . . . .
07373 Aeneatoris . . . .
07374 Aeneatum. . . . .
07375 Aenelcolle. . . . .
07376 Aenelde. . . . .
07377 Aenedes . . . . .
07378 Aenestae . . . . .
07379 Aenrolarum. . .
07380 Aenebles . . . . .
07381 Aensolum. . . .
07382 Aeogtilgeu. . . .

Form
CLASS OF SERVICE DESIRED
FAST DAY TELEGRAM
NIGHT TELEGRAM
NIGHT LETTERGRAM
THE SENDER MUST MARK AN X OPPOSITE THE CLASS OF SERVICE DESIRED; OTHERWISE THE TELEGRAM WILL BE TRANSMITTED AS A FAST DAY TELEGRAM
THE POSTAL TELEGRAPH CABLE COMPANY (INCORPORATED) TRANSMITS AND DELIVERS THIS MESSAGE SUBJECT TO THE TERMS AND CONDITIONS PRINTED ON THE BACK OF THIS BLANK
SEND the following Telegram, subject to the terms on back hereof, which are hereby agreed to
NO. TIME CHECK VIA
Send the following Cablegram conditions printed on the back
subject to the terms and hereof, which are agreed to.
Time Filed
Number of Words
CLASS OF SERVICE ORDERED
Fast Rate Marconigram
Night Rate Marconigram
Wireless Lettergram
Week End Lettergram
Persons should mark an X opposite the class of service desired, otherwise FULL RATES will be charged.
SEE BACK OF THIS BLANK
ARKED DEFERRED

A Page from One of the Famous Telegraph and Cable "Code Books". (Lieber's Code). By the Use of a Single "Code Word" You Can Transmit a Whole Sentence, Thus Reducing the Cost Remarkably.

cally the same manner as the night message, but may contain fifty or less words, and is charged for at the same rate as a regular day telegram for fifty words. Additional words are charged for at the rate of one-fifth of the regular day message rate for every ten words or less.

Note: Day and night lettergrams must be written in plain English, foreign language, code or cipher not being accepted by telegraph companies.

The domestic telegraph message differs essentialy from the cable and wireless in that the text is the only part charged for; the address and signature being sent free of cost to the sender. Some essential and general rules regarding the transmission of telegraph messages may be briefly described as follows:

(1) The complete address as well as one signature are not counted nor charged for.

(2) Any dictionary word of a recognized language, that is, the English, German, French, Italian, Dutch, Portuguese or Latin, may be used and will be counted as one word, no matter how many letters the word contains.

(3) All numerals, decimal points, punctuation points, whether isolated or together, are counted and charged for as one word each.

(4) Names of places, states or countries, such as New York City, Havre de Grace, Camp Dix, District of Columbia, East St. Louis, South Orange, may be combined and counted as one word each, and in order to simplify counting, should be written thus: Newyorkcity, Havredegrace, etc.

(5) Mutilated dictionary words, written together contrary to accepted usage of the language, or combinations of several dictionary words will be counted and charged for according to the number of words they are composed of. For example, such words as "firstclass," "allright," "postoffice," etc., are counted as two words.

(6) Such words as "parcelpost," "percent," "carload," "O.K.," "A.M.," "P.M.," "C. O. D.," "F. O. B.," are counted and charged for as one word each, because these are recognized by custom to be single words.

(7) Code words and cipher words may be used. Code words not exceeding ten letters, and cipher words not exceeding five letters are counted and charged for as one word each.

(8) Only one address and one signature are allowed in one message, two or more signatures being charged for as so many extra words, whichever the case may be.

(9) Numerals in the body of a domestic message are counted and charged for as one word for each individual numeral.

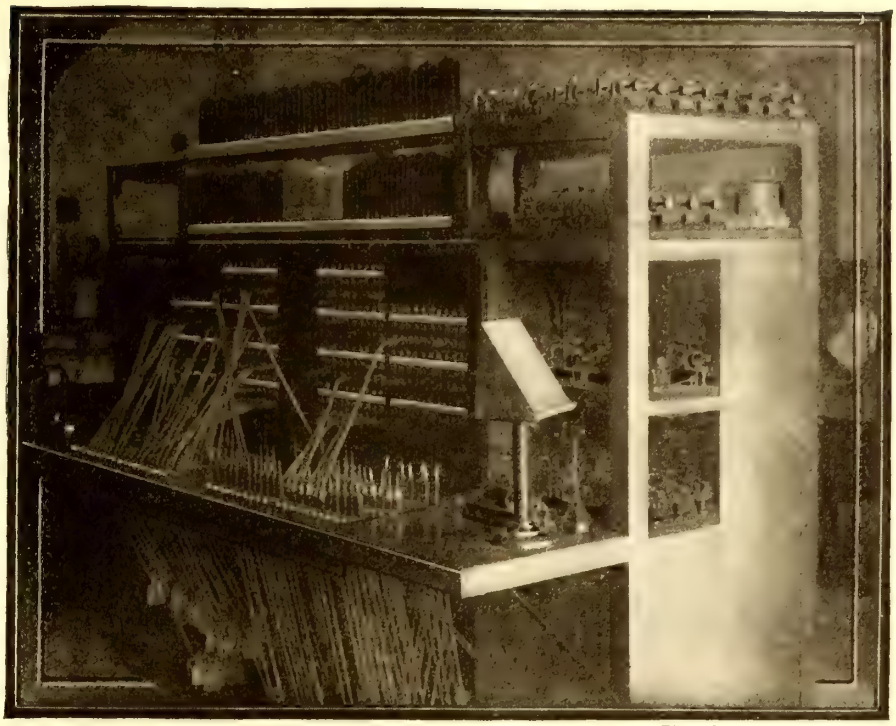


Photo Courtesy Donald McNicol.

And Speaking of the Dispatch of Telegraph Messages—Here Is the "Distribution Board" Which Links Our Local Telegraph Office, Manned by Two or Three Operators, with the Large Staff of Telegraphers in the Main Telegraph Exchange in New York City. Each Operator's Position on the Long Dispatch Tables Is Connected with a "Tell-Tale" Signal Lamp on the Front of the Switchboard. The Operator, who Sits in Front of this Board, Can Thus See at Any Instant Just Which Operators Are Idle. A Branch Exchange, Desiring to Transmit a Message, Signals Thru a Lamp on the Table of the Board, and All the Operator Has Then to Do Is to Take One of the Plugs Beside This Lamp and Connect It with a Jack Connecting with an Idle Operator. The Battery of Relays on the Right-Hand Side of the Frame Are Connected to the Various Branch Exchange Circuits and Cause the Signal Light in Each Case to Remain Lit Until Connection Is Properly Made by the Distribution Operator.

THE CABLEGRAM.

The cablegram is a more complex and detailed subject than the domestic telegram, and in order to avoid errors requires judgment and accuracy on the part of the sender. One reason for this is that it is usually sent to foreign lands, which entails handling by many hands, and the cost is considerably greater per word than the telegram. In the case of the cablegram, every part of the message is charged for with one exception —the name of the country to which it is destined, such as France, Italy, etc. In preparing the message these names are usually bracketed to avoid counting and charging for them. The manner of counting words is known and usually referred to as the "cable count,' which same is also employed in checking wireless messages or radiograms. Owing to the fact that cablegrams are expensive, commercial houses make extensive use of code and cipher in order to lessen the number of words and therefore reduce the cost.

Several well-known codes in commercial use today are:

ABC Codes, 4th and 5th Editions.
Lieber's Improved Code.
Western Union Code.
A. I. Code.
Bentley's Code.
Century Code.
Scott's Code, 10th Edition.
Riverside Code.
Imperial Code.
Bromley's Code.
Broomhall's Code.

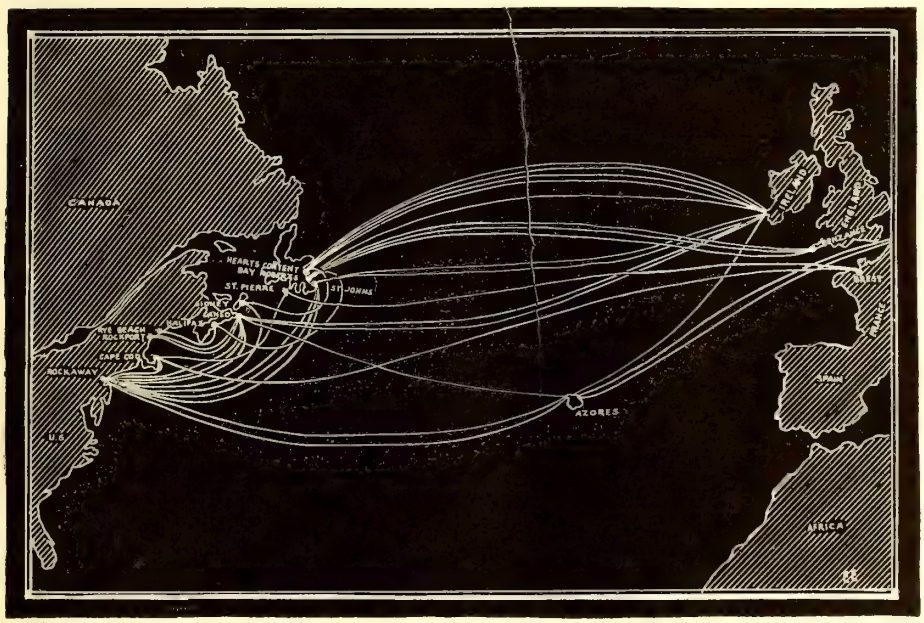
Typical code words: Codiac, Gopher, Staticallo, Nomadimice.

DIFFERENCE BETWEEN PLAIN LANGUAGE, CODE AND CIPHER.

Plain language, as referred to in cablegrams or radiograms, may be any language using the Latin alphabet and Arabic system of numerals. In using plain language in a cable or radiogram any legitimate word may be counted as one word up to and including fifteen letters; beyond that point and for each additional fifteen letters it is considered and charged for as two words, tho the word need not necessarily be disconnected. For instance, the word "unconstitutional," which contains sixteen letters, is *counted as two words.*

Code language consists of genuine or artificial words of a pronounceable nature, but which may have a different face meaning and are counted and charged for at the rate of ten letters to the word. When code words of an artificial nature exceed ten

(*Continued on page* 1298)



Many of Us No Doubt Entertain the Idea That There Are Two or Three Undersea Cables Spanning the Atlantic Ocean Between Europe and America, but a Glance at This Latest Cable Map of the Atlantic Ocean Tells a Different Story. There Are, in All, Seventeen Cables Linking the Old and the New Worlds.

Weighing The Earth

By LOUIS DERR

Professor of Physics, Massachusetts Institute of Technology.
Specially Written for the Electrical Experimenter

IF the earth could be weighed like a load of coal, how much would it weigh? Is it composed of light materials principally, or heavy ones? How can anything be learned about the matter? It is the purpose of this article to give a brief outline of some of the methods by which questions like these are answered.

Sir Isaac Newton's celebrated law of universal gravitation, publisht in 1687, states that every particle of matter attracts every other particle *with a force proportional to the product of their masses, and inversely proportional to the square of the distance between them.* As may readily be imagined, the law was deduced from astronomical facts, and finds its most important applications in astronomy, for by it the motions of the moon, the planets and other celestial bodies are determined.

There are, however, too many unknown factors in the formula to make it directly available for calculating the mass of the earth from astronomical data. Five quantities are involved, of which four must be known in order to calculate the fifth: the force between the two bodies, their respective masses, the distance separating them, and a numerical constant whose value depends on the units in which force, mass and distance are exprest. If we wish to know the mass of the earth in pounds or tons, *we must take some selected body on the earth's surface and compare the earth's attraction for it with the attraction of some other known body for it, at a known distance.* The working difficulty is that bodies of manageable size, separated by controllable distances, exert so feeble a gravitational pull upon each other that the measurement is a problem of considerable magnitude.

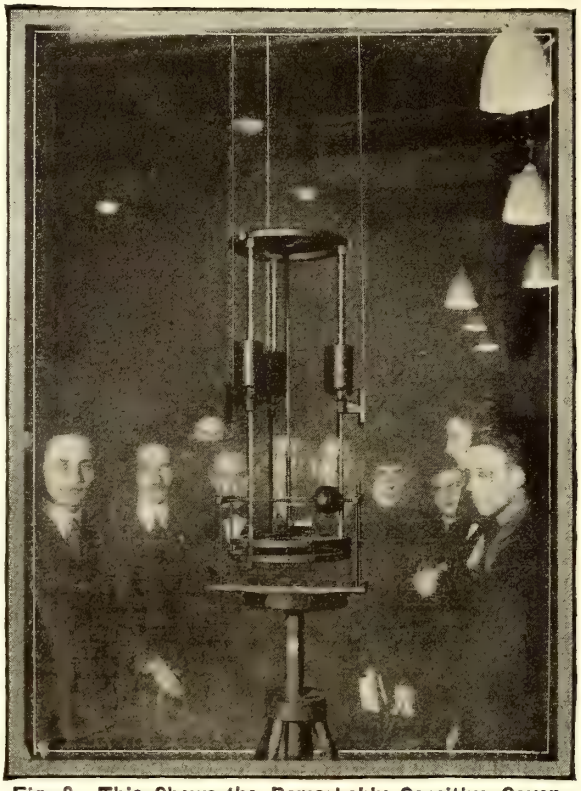


Fig. 8. This Shows the Remarkably Sensitive Cavendish Type Apparatus With the Small and Large Lead Balls, Reflecting Mirror, Etc., Actually Used in Determining the Weight and Density of the Earth, at the Present Date, by Professor Louis Derr and His Associates at the Massachusetts Institute of Technology, Cambridge, Mass.

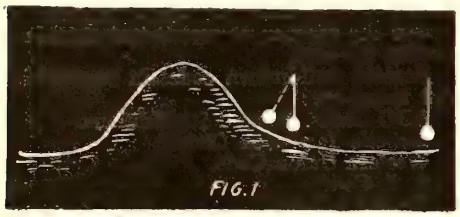


Fig. 1. Diagram Showing How the French Physicist, Bouguer, Attempted to Weigh the Earth by Noting the Pull of a Mountain Mass on a Suspended Bob, or Weight, in 1740. A Deflection of 16 Seconds of Arc Was Actually Observed, and From This Ratio, as Compared to the Pull of the Earth Upon the Bob, It Was Possible to Compute the Average Density of the Earth.

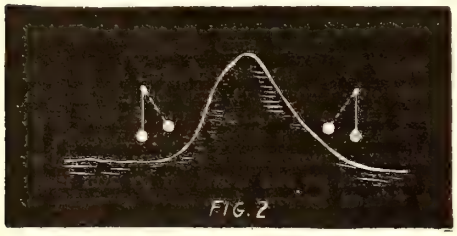


Fig. 2. This Shows the Arrangement Followed by Rev. Nevil Maskelyne in 1774, in Which Case He Chose a Mountain in Scotland for His Experiments. One Plumb Line Was Placed South of the Mountain, and Another North of It. The Ratio Between the Pull of the Earth and the Pull of the Mountain Was Readily Observed, and the Density of the Earth Then Computed.

The problem is an old one, and has been attacked many times and from many angles. The results obtained are usually given in figures representing the average density of the earth, a quantity of perhaps more scientific interest than the mere statement of its mass. Of course, if the mass and volume are known the average density is found simply by dividing one by the other.

Perhaps the earliest definite results are those obtained by the French physicist, Bouguer, about 1740. He hung up a plumb-line, ten miles east of the great mountain mass of the Cordilleras in Peru, and then moved it close to the mountain range. He reasoned that if the mountains exerted any attraction for the suspended bob, the line would no longer hang vertically, but would be tipt slightly. This is shown in Fig. 1.

The deflection was actually observed, and was found to be about sixteen seconds of arc. This gave a ratio between the *pull of the mountain on the hanging bob* and the *pull of the earth upon it* (its weight, of course) and from this ratio it was possible to compute the average density of the earth, which was figured out as about twelve times the density of water. The experiments were carried out with great difficulty, and the result is now known to be much too large, but Bouguer's work was of pioneer importance in that it showed that the earth is denser than water, that it could not be regarded as hollow, in view of the large average density, and that mountain masses do attract.

In 1774 the Rev. Nevil Maskelyne, Astronomer Royal of Great Britain, employed a somewhat different method, choosing a mountain in Scotland for his experiments. Fig. 2 shows his arrangements. One plumb-line was placed just *south* of the mountain, another just *north* of it. Now, from the known circumference of the earth and the measured distance between the plumb-lines, the difference of longitude between the two stations could easily be calculated, and the angle between the vertically hanging plumb-lines would have been 41 seconds of arc if the mountain were not there. Actually the angle was 53 seconds, *the mountain having pulled the plumb-line six seconds out of the vertical on each side.* This is indicated in the figure.

From this, as before, the relative pull of the mountain and the earth on the suspended bob could be determined, and when geologists had studied the mountain and estimated its mass the mass of the earth could be easily computed. Its average density came out 4.71 times that of water. Other trials, near Edinburgh, gave 5.32.

The weak point of the method is the difficulty of accurately estimating the mass of the attracting hill or mountain, and therefore the results obtained by methods involving the measurement of earth masses cannot be accepted as accurate. It is obviously necessary to have everything under complete control, and this has been accomplisht in several ways.

Poynting's method (1890) is as follows: Two metal balls were carefully counterpoised on a very delicate balance, and the position of the balance pointer noted by an observer looking through a telescope from another room. Then a huge ball of lead weighing 350 pounds was cautiously moved to a position just below one of the sus-

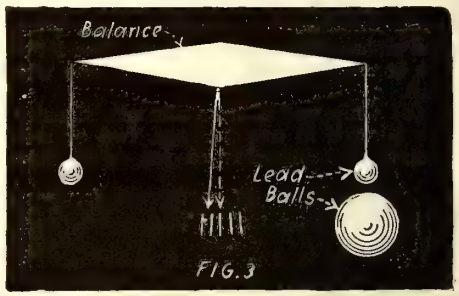


Fig. 3. This Shows Poynting's Method of Weighing the Earth. Two Metal Balls Were Carefully Counterpoised on a Delicate Balance or Scale. A Large Ball of Lead Was Then Moved to a Position Just Below One of the Suspended Balls and Its Direction Caused the Balance to Tip. The Pull of the Large Ball Could Thus Be Weighed Directly, Having Been About One Millionth of a Pound.

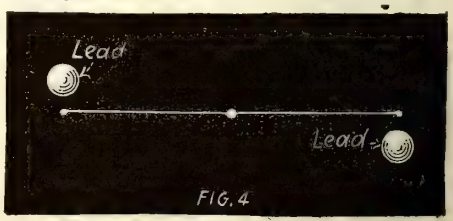


Fig. 4. This Illustrates a More Advanced Method of Weighing the Earth, Devised by Henry Cavendish, in London, in 1798. In This Case Two Small Metal Balls Are Suspended From a Fine Wire, and Two Larger Lead Balls Are Then Placed, One Behind and the Other in Front of the Suspended Balls. The Attraction of the Large Balls Thus Deflected the Rod Carrying the Small Masses, and This Deflection Could Be Recorded or Thrown on a Screen, by Means of a Mirror Mounted on the Suspension Wire and on Which a Beam of Light Was Focused.

pended balls, and its attraction caused the balance to tip slightly, as indicated in Fig. 3. The pull of the 350-pound ball was thus weighed directly; in the actual experiment it was about *one millionth of a pound.*

But the most accurate results of all have been obtained thru a method devised by Rev. John Mitchell. He did not live to carry out his project, and the experiments were first made by Henry Cavendish in London, in 1798. Cavendish took a slender rod seven feet long with a small metal ball at each end and suspended it horizontally by a very fine wire. A large ball of lead, twelve inches in diameter, was then brought up in front of one of the suspended balls, and a second lead ball of the same size placed behind the other suspended ball, as shown in plan in Fig. 4. The attraction of the large balls thus deflected the rod and the hanging balls, until the deflecting pull was just balanced by the twist in the wire. The force was then calculated from the deflection.

Within recent years the apparatus of Cavendish has been much improved and given vastly greater sensitiveness, especially by Prof. C. V. Boys, a noted British physicist. Fig. 5 shows one form of the apparatus.

The suspended balls weigh one-fortieth of an ounce each, and are about an inch and a half apart. The large attracting masses are of lead, about the size of a baseball, and weigh about six pounds each. The suspension is a fine thread of quartz, eighteen inches long and about one-twelfth the diameter of a human hair. Fig. 6 shows the quartz thread and a human hair equally magnified, and it must be admitted that the quartz thread is much the handsomer of the two. The fibers are made by melting the edges of two quartz crystals together and then quickly separating them, just as glass threads may be drawn by heating a glass rod in the middle and pulling the ends apart.

The deflection, which is very small, may be made visible to an audience in the following way. A tiny mirror is fastened to the little rod carrying the swinging balls, as shown in Fig. 7, and a narrow beam of light from an electric lamp is reflected from the mirror upon a scale on a distant wall. Any motion of the mirror is thus shown by a displacement of the spot of light on the wall, and the device practically amounts to putting a long pointer on the swinging arm, a pointer of any desired length, perfect stiffness and *no weight!*

The apparatus requires various accessories, an extremely steady support for the suspended balls being the most important. This steadiness is obtained by mounting the swinging system on a heavy iron frame or cage hung from a bracket on the wall of the room and provided with large adjustable weights at its extremities. These weights are set by trial at such points as to destroy accidental vibrations as completely as possible, and when properly adjusted they are very effective. Fig. 8 shows the arrangement worked out at the *Massachusetts Institute of Technology.*

The experiment, tho not spectacular, is nevertheless a striking one, and is occasionally shown at some of the larger colleges and technical schools. With the apparatus at rest, the spot of light on the wall is almost motionless, perhaps quivering a little when someone treads heavily on the floor above. But when the large lead balls are moved into position, altho nothing apparently happens for a minute or thereabouts, the spot of light then begins to creep slowly over the scale with a motion that very slowly but surely increases *until the displacement is a yard or more on a wall forty or fifty feet away.* No haste can be expected, for with the apparatus illustrated the force on the little balls is no greater than the weight of about one one-hundred-thousandth of an inch of human hair!

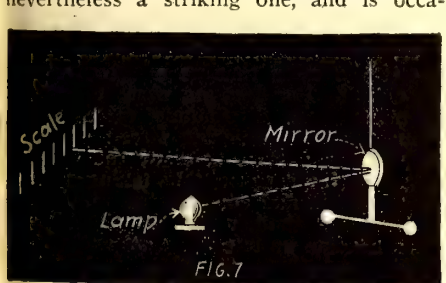


Fig. 7. This Diagram Shows How a Narrow Beam of Light Is Reflected From a Mirror on the Quartz Fiber, Suspending the Swinging Balls in the Cavendish Balance, Used in Determining the Density and Weight of the Earth.

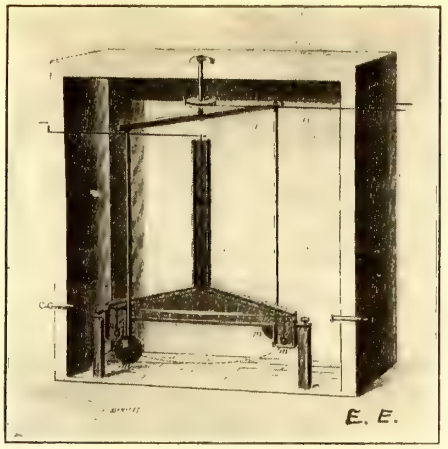


Fig. 5. The Early Cavendish Apparatus Is Shown at Left. A More Modern Type of Cavendish Balance Is Shown at the Right, and Which Was Much Improved and Gained Vastly Greater Sensitivity Under Development by Prof. C. V. Boys, a Noted British Physicist.

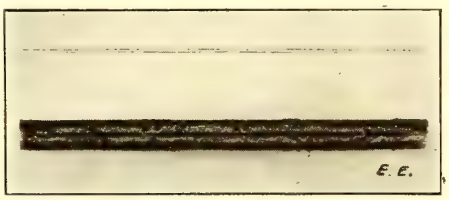
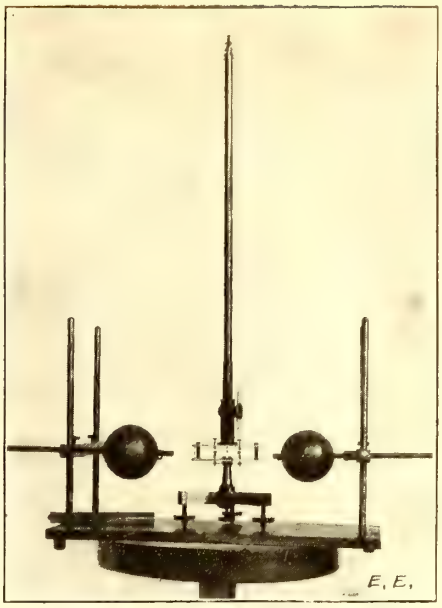


Fig. 6. This Photo Shows the Remarkable Smoothness and Even Diameter of a Quartz Thread Compared to a Human Hair, Both Equally Magnified. The Quartz Thread Is Used to Suspend the Two Small Balls in the Cavendish Balance.

The "conscientious objector" now rises to ask how it is possible to measure a force so absurdly small, and the answer is that the force is not measured directly, but obtained by calculation. By knowing the weights and the dimensions of the swinging parts of the apparatus, and the time required for a complete swing back and forth (just as the balance wheel of a watch swings), it is possible to calculate the force required to produce any given deflection, and in this way the pull of the lead balls on the suspended system may be figured. With the apparatus shown, one complete swing requires about three-quarters of an hour.

To sum up: The experiment determines the actual force between two known masses, at a known distance apart. If we consider a ten-pound ball lying on the ground we have a closely similar case. We know the pull of the earth on the ten-pound ball—obviously ten pounds' weight. We know the distance between the ball and the attracting center of the earth—four thousand miles. We know the mass of the ball—ten pounds. With the Cavendish apparatus we start by knowing the distance and both masses, and then determine the force; with the ten-pound ball on the ground we start with a knowledge of the force, the distance and one of the masses, and compute the other mass—*the mass of the earth.* A simple proportion, derived from the experiment just described, then gives the mass of the earth directly.



The resulting figure is so stupendous that it is utterly meaningless: the mass of the earth is 6,000,000,000,000,000,000,000 (six sextillon) tons. It may be added that its average density is 5.52 times that of water.

THE "UNIVERSE" ON A SMALL SCALE.

"Mars always challenges interest," says William Joseph Showalter in a recent communication to the National Geographic Society.

"It is quite generally believed that Mars has ice-capt poles. The telescope reveals white spots at the poles that have every appearance of being like our ocean Polar region. They advance toward the equator in winter and retreat in summer. In the summer of 1916, Pickering, who, with Lowell, has led the school of astronomers who believe they can see canals on Mars, said that he found the white caps stretching farther down toward the equator than he had ever seen them before.

"He said that if there was any connection between the weather of Mars and that of the earth the winter of 1916-17 would be the coldest in many years. It was true. May it yet be possible to do long-range weather forecasting on the earth by studying the waxing and waning of the ice-cap on the South Pole of Mars?

"Perhaps our most graphic picture of the solar system is given by Herschel. Imagine a circular field two and a half miles in diameter; place a library globe two feet in diameter in the very center; eighty-two feet away put a mustard seed. The globe will represent the sun and the mustard seed Mercury.

"At a distance of 142 feet place a pea, and another at 215 feet. These will represent Venus and the earth both as to size and distance. A rather large pinhead at a distance of 327 feet will speak for Mars, and a fair-sized tangerine a quarter of a mile distant will stand for Jupiter. A small lemon at two-fifths of a mile will play the rôle of Saturn, a large cherry three-fourths of a mile distant will answer for Uranus, and a fair-sized plum at the very edge of the field will proclaim Neptune.

"Eighty moons would be required to make one earth. A player there could throw a ball six times as far as it can be thrown on American diamonds. A man weighing 150 pounds there would weigh 900 on the earth."

Electrifying Canal Boats and Barges

By ROBERT G. SKERRETT

Marine Transportation by Electrified Trailers

THE towboat of to-day does not make the most of its store of mechanical energy. It fails for a variety of reasons, but primarily because its screw or screws are incapable of getting a full grip upon the water when drawing one or more powerless craft. A propeller to be efficient must actually advance thru the water proportionately to its speed of revolution, and the force of its drive is dependent upon the number of times it turns in the course of a minute. If it revolves rapidly without moving on it churns up the water, pumps down air, and, to a more or less pronounced extent, whirls around in a mixed or agitated medium which is hard to get hold of effectively.

Now this is pretty much the state of affairs when a tug heads the line of a string of barges or canal boats. Should the convoy be laden, then the tug struggles with all of its power to make headway, but the rate of advance is not in keeping with the speed at which the steamer would move if free and developing the same measure of energy. In short, its task is something akin to a freight locomotive, attached to a train, trying to mount a gradient on wet tracks, but with this difference—the tug must take the water as it finds it, but the locomotive can "sand the rails."

But the towboat is further hampered by the conditions under which it has to work. For instance, its churning propeller drives rearward a veritable mill race—directly against the bows of the oncoming convoy. As a consequence, this disturbance virtually adds to the load to be drawn by turning the steam vessel's own efforts against itself. In these days of high prices and general insistence upon operative efficiency there is a crying need for something better than the tug as a handy marine tractor. Fortunately, a line of improvement has been pointed out and convincingly demonstrated by Mr. William T. Donnelly of New York City.

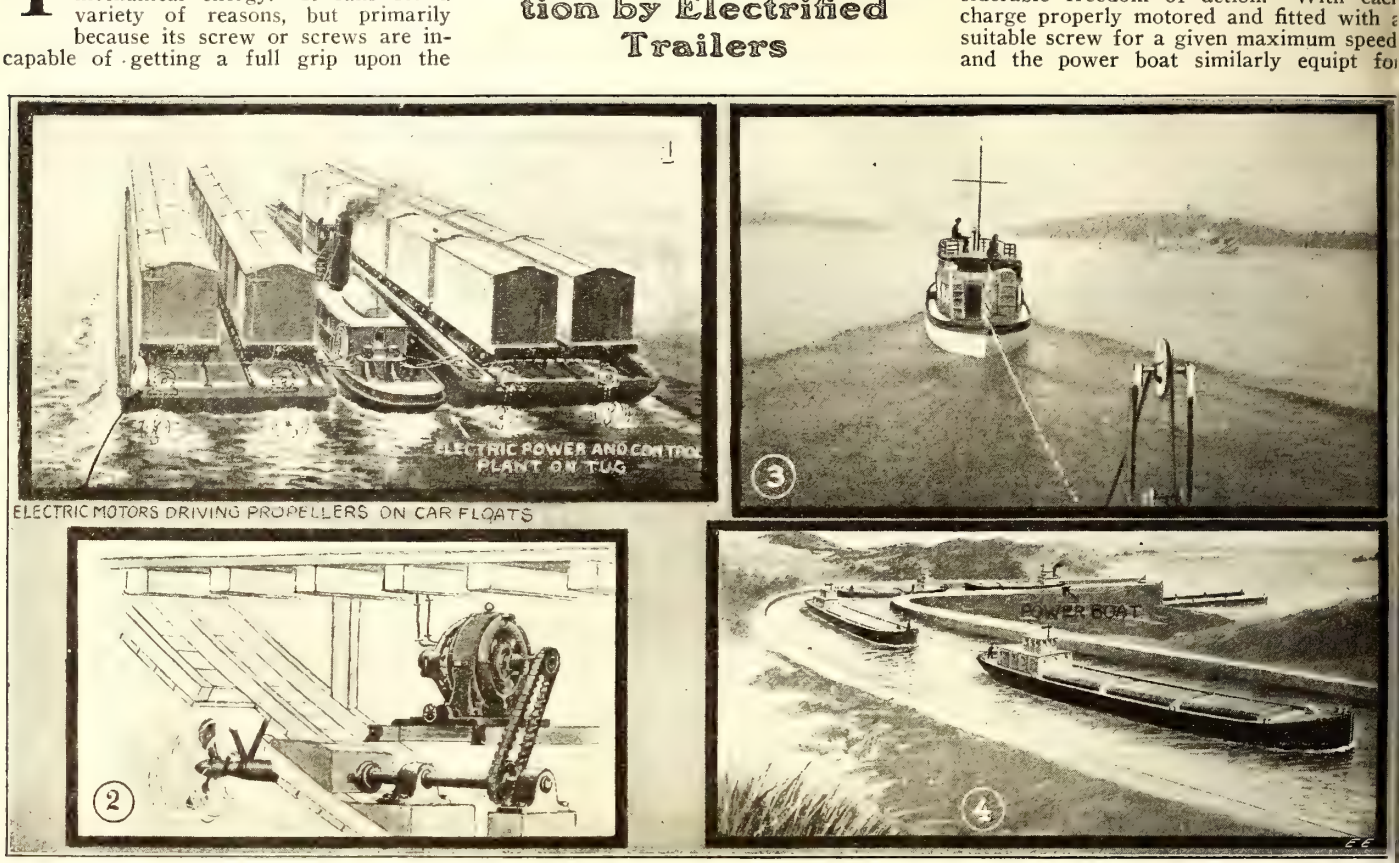
Mr. Donnelly proposes to turn the erstwhile tug into a navigable *power station*, generating electricity for its own drive and for the unit propulsion of its string of tows. The several vessels that would thus draw upon the floating central station would be equipt with electric motors for driving their respective screws. Making due allowances for the power losses between the generator and the motors dependent upon it, taking into account wastage incidental to transmission, et cetera, Mr. Donnelly has establisht the fact that a given initial power development can be thus apportioned and yield distinctly superior results in the common speed of a nautical train, so to speak. Further, the central station can, with equally good effect, either head or follow its charges or, if desirable, the tows can be secured on one or both sides of the master craft.

To begin with, an arrangement of this nature reasonably promises to add tremendously to the ease with which a number of boats so energized can thread a tortuous channel or a busy waterway, for each unit will be susceptible of independent guidance and, within the limits imposed by the linking electrical conductor, enjoy considerable freedom of action. With each charge properly motored and fitted with a suitable screw for a given maximum speed and the power boat similarly equipt for efficient operation at towing speeds, the whole string would be able to maintain a pace much faster than that possible if the same propulsive effort were exerted by a tug, as is now the case.

Mr. Donnelly has planned that his system be adapted to coastwise and ocean transportation. In the latter case, while the electric cable would not be expected to exert a pull, still he is satisfied, by reason of technical developments, that the conductor can be built strong enough to permit it to serve as a tow line in an emergency, involving motor breakdown on any of the convoy. For this purpose his cable would be patterned with a copper core suitably insulated, then wrapt with hemp and finally armored with steel wire, the latter giving the needful strength and serving at the same time as a "ground" for the circuit. For deep-sea work, the object in making the distributing cable strong enough to bear a linking stress would be to hold the various units of the tow together during a storm, thus taking care of "lame ducks" and enabling the whole fleet to help one another for the time being when heading up into the wind and waves.

As a substitute for river freight-and passenger steamers and kindred craft plying our Great Lakes and semi-protected coastal waters upon daily schedules, Mr. Donnelly would have recourse to specially designed navigable centra stations, capa

(*Continued on page* 1319)



1—In This Case the Flanking Car Floats are Each Equipt with Twin Screws Electrically Operated, and the Control of the Entire Group In the Hands of the Man in the Pilot House of the Central Vessel. By "Going Ahead" On One Barge and "Backing" with the Other, Would Be Entirely Feasible to Turn the Whole Tow Within a Small Circle. 2—This Diagram Illustrates One-half of the Propelling Equipment, An Electric Motor, of a Car Float. 3—A Photograph of the "New Era" Preceding the "DAWN" from Which She Obtained Her Energizing Current. Nearby is Seen the Pulley Over Which the Electrical Conductor Passes and Immediately Below is Visible a Part of the Re At the Bow of the "DAWN." 4—A Fleet of Electrically Propelled Barges Making Their Way Thru a Canal. It Will Be Observed Tha the Prime Mover, the Source of Energy, is a Freight-laden Craft At the Rear of the Line.

Talking Over a Sunbeam

By PROF. A. O. RANKINE

Professor of Physics, Imperial College of Science and Technology, London, England.
Written Especially for the Electrical Experimenter.

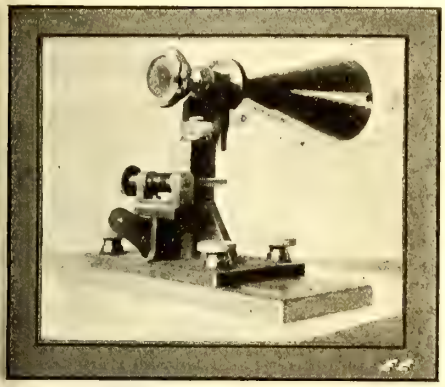


Fig. 3 Shows the Mount of the Vibrating Mirror On the Phonograph Sound Box. When the Voice Waves are Spoken Into the Trumpet They Cause the Diafram to Vibrate, and Also the Small Mirror Attached On An Arm, Secured to the Center of the Diafram.

FORTY years ago ordinary telephony was a novelty. Today the telephone is part of the equipment of most modern houses, and we use it without often thinking of the ingenuity which resulted in its invention. It comes as a surprise to find that telephony by means of light, the *Photophone*—which is still a great novelty—was invented almost as soon as the ordinary telephone. Appropriately enough, the inventor of both was one and the same person—Alexander Graham Bell. It was in 1880 that he succeeded in communicating speech, by means of a beam of sunlight, over a distance of about 200 yards. This was a very remarkable achievement, and it is difficult to understand why it has failed to be developt to any great extent until recently. Various experimenters have worked intermittently on the subject, with a view to improving Graham Bell's methods, but the fact remains that development has been extraordinarily slow in comparison with that of telephony over wires. The subject is, however, a very fascinating one, and it is the purpose of this article to explain the principles and methods involved.

In ordinary telephony we speak into the transmitter and thereby cause a diafram to vibrate in accordance with the vibrations constituting the speech sounds. The diafram in moving to and fro compresses to a varying degree the carbon granules contained in the microphone. Comprest carbon is a better conductor of electricity than carbon loosely packed, and therefore, if we connect an electric battery to the microphone, we obtain a current of electricity which fluctuates in magnitude in accordance with the vibrations of the diafram. These fluctuations of current are conveyed to a distance *by means of wires*, and, passing thru the electromagnet in the receiver, alter the amount of the attraction which the magnet exerts on an iron diafram, which is thus set in vibration, and the original sounds are reproduced.

Now, it will be clear that *any* means by which we can cause a current of electricity to fluctuate in accordance with the vibrations of speech will provide a method of telephony. And if this current can be operated by means of a beam of light projected from some distance away, it will be possible *to dispense with the wires* between sending and receiving stations. Graham Bell solved this problem by using the remarkable element called *selenium*. This substance is, ordinarily, a bad conductor of electricity, but if it is illuminated by a beam of light, its conductivity is increased. Thus if a thin layer of selenium is connected with an electric battery and kept in the dark, a small current flows thru it. If it is now placed near a bright light, the current is very much increased. Different colors have different effects. Red light is more effective than blue, but, generally speaking, the whole of the constituents of white light contribute to the increased conductivity. It is not within the scope of this article to describe the manufacture of a selenium cell. Suffice it to say that it has to be prepared in a thin layer, annealed at a special temperature, and mounted with two terminals

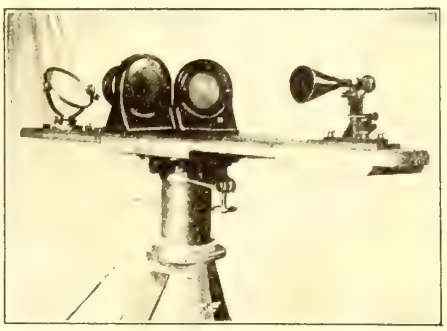
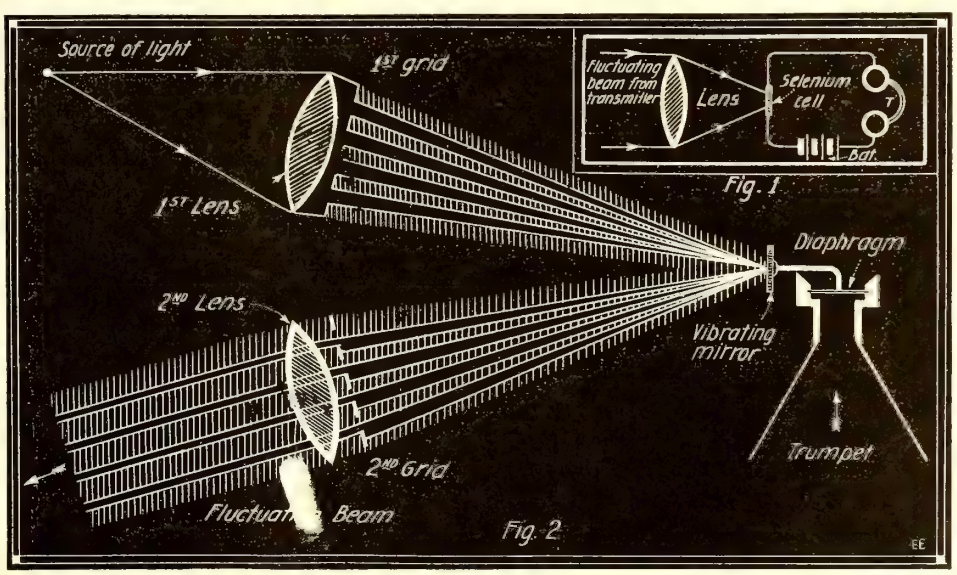


Fig. 4. This Shows the Latest Type Light-ray Transmitter Arranged for Use with Light from the Sun.

means of the lens on the selenium cell. What will happen? Every time the light gets bright the current in the receiver will increase. Every time it gets dim, there will be a reduction of current. Actually, of course, these fluctuations of light occur far too rapidly to be visible—perhaps 1,000 per second. But the selenium is affected by them, and the variations of light are copied by the variations of current, and one hears, as it were, *the light speaking*. Figure 1 then represents the arrangement of the *receiver* in "telephony by light."



1—Simple Form of Receiving Circuit for Use in Photophone, Comprising Light-sensitive Device, Such as a Selenium Cell, Connected in Series with a Battery and Telephone. 2—This Diagram Shows How Rays from Source of Light are Past Thru a Lens and Grid On to a Vibrating Mirror Mounted On an Arm Attached to a Phonograph Sound-box Diafram at the Right, and How This Beam is Reflected Thru a Second Lens and Grid On Its Way to the Receiving Set.

We have now to consider the problem of the transmitter, that is, the means whereby the vibrations of speech can be imprest upon a beam of light, so as to make it fluctuate accordingly. There are two possible methods of procedure. One may either endeavor to make speech vibrations control the brightness of a source of light itself, or use the vibrations for the purpose of interrupting the light proceeding from a steady source. The latter procedure was adopted by Graham Bell, and he describes two devices in this connection. It is unlikely that the first of these ever proved successful, but it is mentioned here because of its relation to the author's method, which will be described later. Bell proposed to construct two grids consisting of parallel strips alternately opaque and transparent. One of these grids was to be fixt, the other attached to a diafram at the end of a trumpet. The grids were to be placed parallel to one another, and originally so that the opaque strips of the one covered up the spaces of the other. A beam of light fell upon the grids, and the amount of light penetrating the pair would depend on their relative position. By speaking into the trumpet the diafram would be made to vibrate, and, consequently, the "shutter" formed by the grids

(*Continued on page* 1315)

Sawing Ice By "Motor"

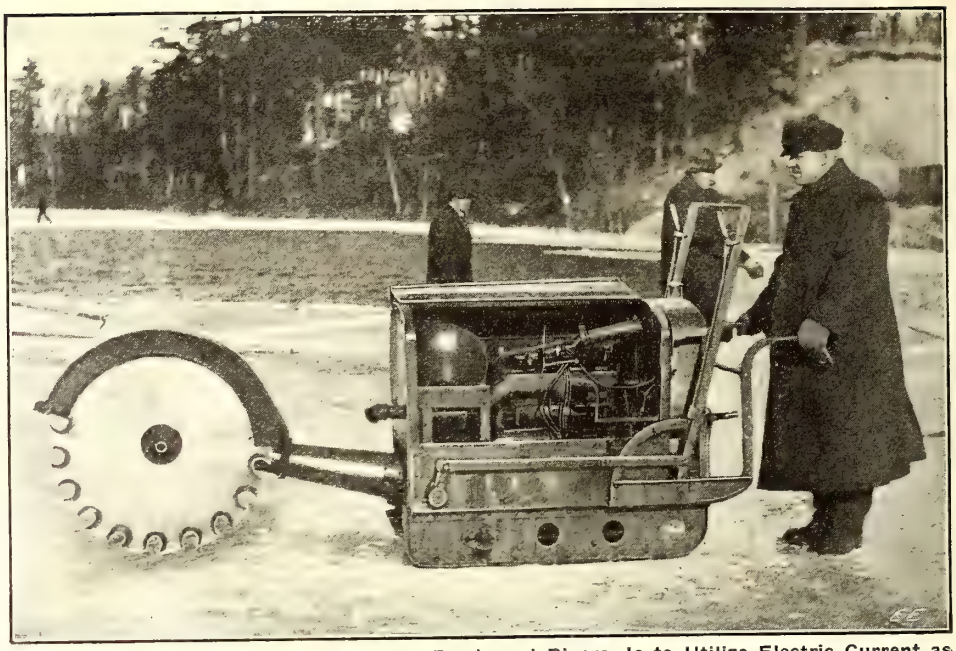
It takes a thief to catch a thief, they say, and so it has finally come to pass that the electric current steps in to really cut ice with anything like efficiency,—or what was once a *current* of water. In other words, this is a case of when current meets current—to paraphrase the old adage "when Greek meets Greek."

The twentieth century way of cutting ice on ponds and rivers, is to utilize electric current to operate a powerful motor, which in turn is connected thru gearing or directly to a large saw which tears thru the ice at prodigious speed.

With the aid of this powerful electric ice sawing machine, which obtains its current thru a flexible insulated cable, running to an electric power line near the pond, the work of putting 60,000 tons of ice in the ice-house of the Boston Ice Co., at Wellesley, Mass., was completed this winter in record-breaking time.

The ice reaches the machine in twenty-foot squares and the four cylinder saws cut them into the regulation size cakes.

Besides the electrically driven saws there are in use many gasoline engine driven saws for ice cutting. A Ford engine makes a good powerful prime mover for such a saw.



The 20th Century Way of Cutting Ice on Ponds and Rivers, Is to Utilize Electric Current as Shown Herewith. The Current Is Transmitted to the Motor Within the Saw Machinery, Thru Flexible Rubber-Covered Cable Running to the Shore. Gasoline Driven Saws Are Also Used.

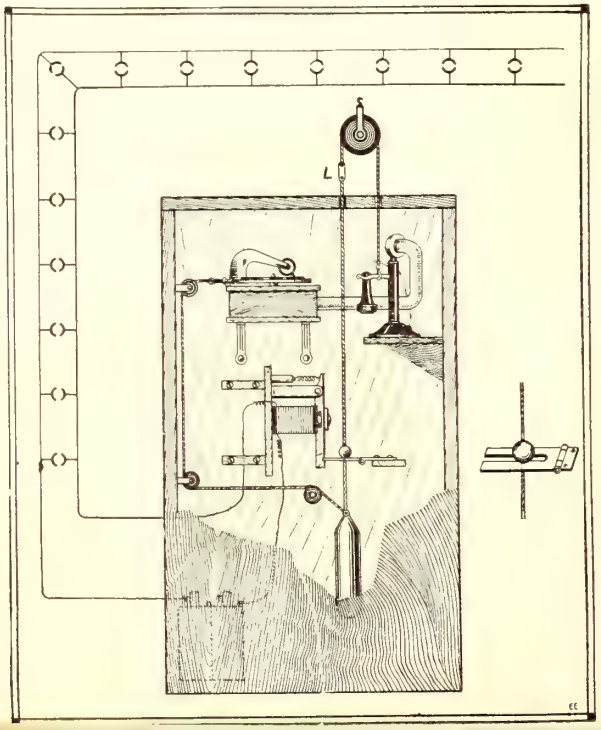
This Fire Alarm "Talks"

NOW that everything in the line of safety apparatus and fire announcers has been invented, a New York genius, a fireman, to be more specific, has perfected and patented a device which not only gives instant alarm in case of fire, but also notifies its precise and exact location, making the announcement when the heat in a room reaches about 130 degrees Fahrenheit, which is considerably lower than the temperature at which the sprinkler system would operate. In this way, announcement of the fire is made long before the automatic sprinklers flood the apartment or building with water, thus ruining by water a lot of material which could have been saved if the sprinkler had been promptly shut off. Knowing the difficulties and the faults of the methods used to-day, the inventor has developed mechanisms which are actuated by weights in which electric current plays but a very small part, and as long as gravity exists the mechanism is absolute and positive in its action.

Fuse links are another feature of this invention. These join together lengths of cord or very thin wire. This taut wire running thru a series of pulleys finally terminates in the fireproof box containing the phonograph apparatus. A weight is suspended to the cord which is also connected directly to the lever starting the phonographic mechanism. Another cord runs up thru the box and has another fusible link inserted in it, the latter outside of the box as illustrated. The cord now passes thru the box again and is connected to the Bell telephone receiver hook.

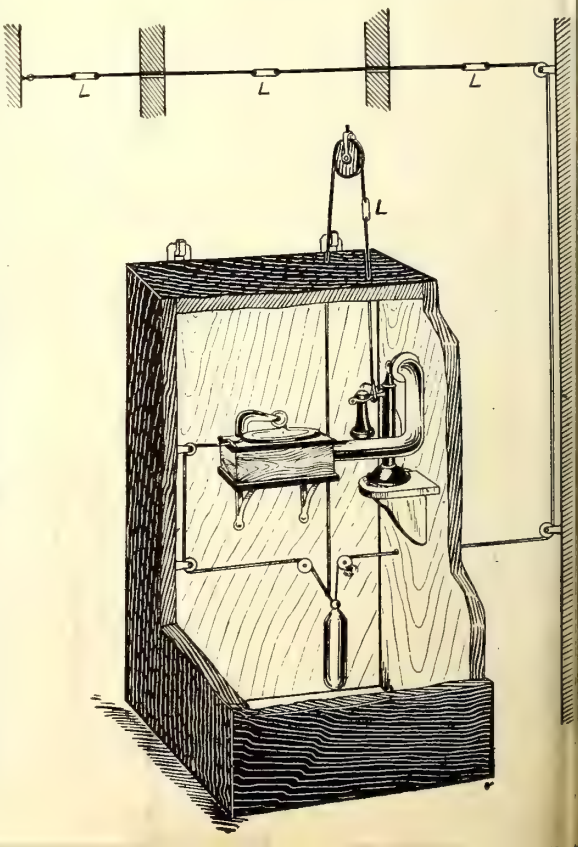
When a fire breaks out in any particular portion of the building, one of the fuse

(*Continued on page* 1317)



"Hello, Operator!—There Is a Fire at 188 Blank Street, In the Warehouse on the Second Floor, Front. Notify Fire Headquarters at York 1,000. Central, there is . . . Etc." This Is a Fire Alarm Call SPOKEN Over the Telephone by This Latest Fire Alarm Device. Diagram at Right Shows Fusible Links "L" Inserted in Taut Cord Which Releases Phonograph, As Soon As the Links Are Melted.

Diagram at Left Shows Electric Thermostats Which May Be Placed on the Ceiling About 10 Feet Apart, and Electric Relay or Tripping Device for Starting Phonograph In Case of Fire. When the Fusible Link Just Above the Cabinet Melts, the Phonograph Is Shut Off, and the Telephone Hook Is Restored to Normal Condition.



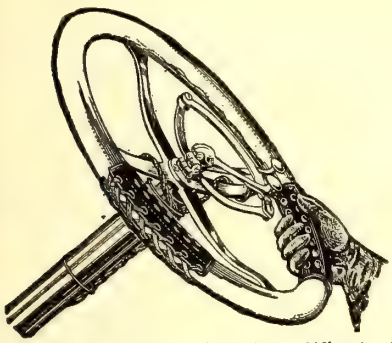
...Automobile News...

ELECTRIC STEERING WHEEL HEATER.

This newest electric winter driving comfort consists of two neat leather covered grips, one for each hand, which lace on to the steering wheel at any place convenient for driving. Special resistance wires are cleverly arranged between two copper plates in such a way that a very small current is sufficient to keep the grips warm. They operate on the same principle as an electric heating pad. After a certain heat is obtained the heaters will get no hotter, but retain an even temperature. They are simple, neat and efficient.

A type designed specially for the Ford car is heated by electricity from the magneto.

Safety demands a firm grip of the steering wheel which you cannot get with cold fingers. The new device keeps your fingers limber, with only a pair of light gauntlets on, which enables you to grip the wheel tight on the coldest winter days, giving you a safe feeling even while driving over pavements slippery with ice.

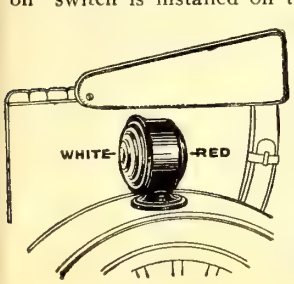


Electrically Heated Steering Wheel for Autos.

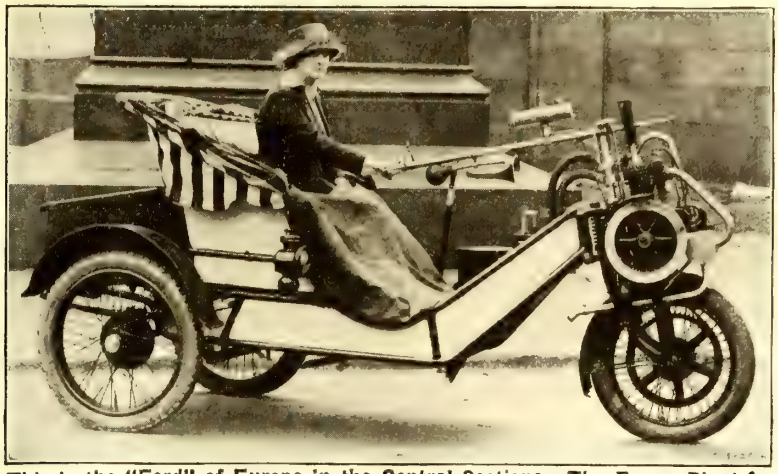
The heater coils use only half the current necessary for electric headlights. They are operated from the same storage battery or magneto that supplies the headlights and are easy to attach. They can be put on in ten minutes. There are no bolts or screws, or holes to bore; lace on—wire up—that's all.

AUTO PARKING LIGHT.

In order to save current while automobiles are standing idle on the streets, an enterprising concern has developed this auto parking light. This lamp is attached to the rear fender and takes the place of the regular head and tail lamps when the car is not being operated. The 2-candle-power bulb is said to consume only about a quarter of the current the regular lamps use. A 2½-inch white semaphore lens is furnished in front of the lamp and a red semaphore lens in the rear. An "off" and "on" switch is installed on the lamp itself.



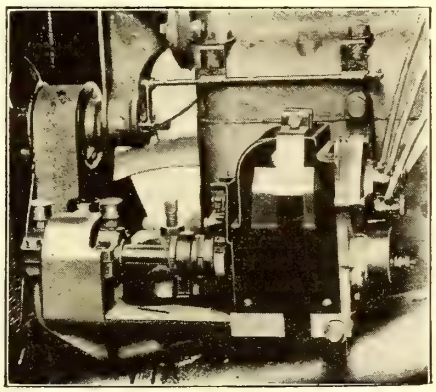
A Small Current - Saving Electric Parking Light for Autos. Lamp Is Attached to Rear Fender. Flashes White Ahead and Red to Rear.



This Is the "Ford" of Europe in the Central Sections. The Power Plant Is Entirely Mounted on the Front Above the Wheel. Photo—Edna Purdy.

NEW MAGNETO FOR FORDSON TRACTOR.

One of the neatest and most effective easy-starting ignition appliances yet produced for the Fordson is the new model magneto fitted with an impulse starter coupling. One slow turn of the crank of the engine gives ignition results ordinarily had at 500 revolutions per minute, due to the impulse starter giving a quick spin to the magneto rotor shaft. The new outfit is chain driven from the front end of the crankshaft, the unit being located on the left side of the engine, where it is away from exhaust heat, a most important advantage when the destructive effect of the heat is considered. The heat quickly destroys distributor blocks and reduces the magnetic life of the magnets. In this magneto all this has been eliminated. All that is needed for installation is a wrench. No holes need be drilled, or any parts removed or discarded. As shown in the accompanying illustration, the magneto rests on a support which itself is braced by brackets attached to the crankcase. The instrument is driven by a short shaft at one end of which is an adjustable coupling and at the other two bronze bearings mounted on either side of a 16-tooth sprocket. This sprocket is driven by a silent chain from another sprocket at the forward end of the camshaft. The silent chain is protected by a guard which is provided with an oil hole so that the chain may be given an occasional oiling. The chain is easily adjusted.



Showing New Magneto for Fordson Tractor Installed on Engine. It Has an Impulse Starter, Giving Full Spark on One Revolution.

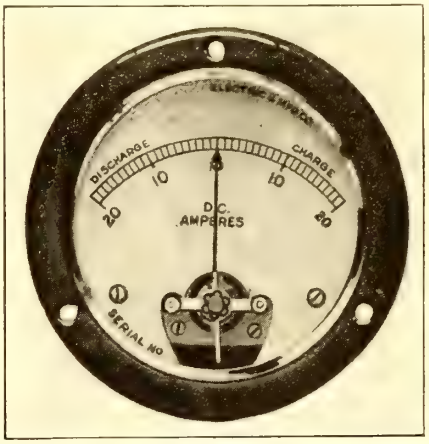
NEW AUTOMOTIVE AMMETERS.

Two new ammeters for automobiles, motor boats, airplanes and other automotives have recently been added to a well-known line of instruments.

The type of ammeter shown is an inexpensive instrument, but is rugged, reliable and amply accurate for the service for which it is intended. It operates on the polarized-vane principle, without springs or moving coils, is dead beat and can withstand momentary overloads of 500 amperes without injury.

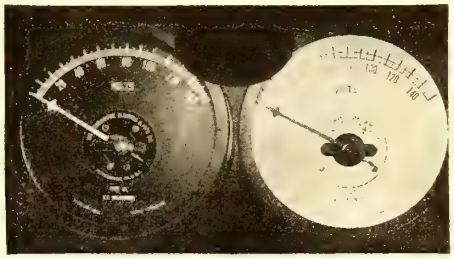
The dial is two inches in diameter, and the scale which indicates amperages of from 15 to 30, charge and discharge, is an inch and a half long. Either black dials with white figures and needles, or white dials with black figures and needles can be supplied. The meter is arranged for flush mounting in the dash or cowl.

The second type of ammeter was originally designed for government radio service, and is the smallest d'Arsonval instrument made. Tho but two inches in body diameter, this instrument possesses all of the delicacy of action, high sensibility, great accuracy and ruggedness of the standard switch-board type. It is supplied for flush as well as projection mounting. Voltmeters with scales ranging from 3 volts upward are also supplied in this style of instrument.



Latest Type of Auto Ammeter. White or Black Dials Are Available on These Meters.

Many electrical instruments can be furnished, when desired, with black dials, the figures, scale, and pointer being white. The comparative illumination on black and white dial instruments is vividly shown by the acompanying illustration, which shows a white and black dial instrument mounted side by side on a switchboard and illuminated by the same lamp.



Comparative Illumination on Black and White-Dial Instruments

Popular Astronomy

By ISABEL M. LEWIS, M. A.
Of the U. S. Naval Observatory

Observing The Heavenly Bodies

TO appreciate the beauties of a starlight night get as far away from the heart of the city as possible. No obobservations of the heavens can be made thru slit-like openings between rows of houses with the glare of street lights in one's face and the smoke, dust and haze of a busy city enveloping one on all sides. Even such celestial jewels as Sirius, Vega and Spica shine with a pale and sickly light for the city dwellers.

Get out in the open if you want to become acquainted with the stars and choose, moreover, a clear, *moonless* night, for bright moonlight blots out fully half of the stars that would otherwise be visible to the naked eye.

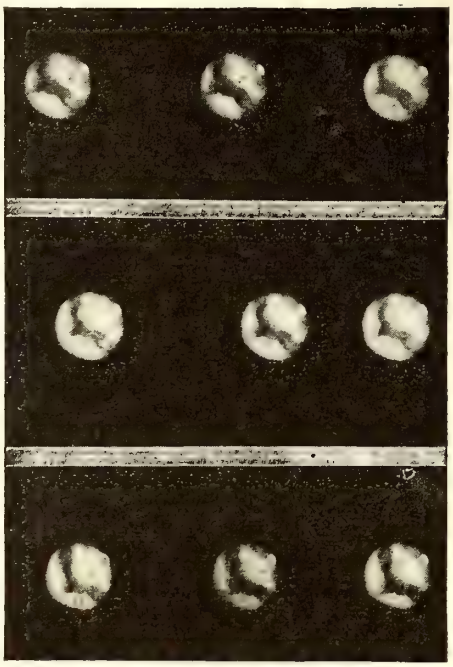
A good test of the "seeing" is the visibility of the Milky Way. If you always view the heavens from the outskirts of a great city the Milky Way really means nothing to you, but if you have the good fortune to be aboard ship on a clear, dark, moonless night or on the western prairies or near the summit of a mountain or at some farm or country home far removed from the city you will not fail to see at some hour of the night a portion of this magnificent girdle of the heavens, the groundwork of the universe, where suns are piled upon suns in riotous profusion and where the misty light of the luminous nebulae leads into the dark caves, rifts and lanes produced by the non-luminous nebulae, the whole giving us the impression of an elaborate and intricate structure that reveals the workings of a Master-mind and overwhelms us with feelings of awe.

In attempting to explore the wonders of the heavens with an opera-glass some amateurs have complained that they could not find Jupiter's four moons. This may be due either to poor observing conditions, as mentioned above, or to the use of a poor glass or to failure to recognize these minute points of light when visible. All four moons will probably not be visible at once, as one or more of the moons will usually be in transit across the planet or occulted behind the planet or eclipsed by its shadow. Continued observing from night to night will reveal the fact that these little bodies are actually revolving around the plant.

With a telescope that was in some respects inferior to a modern field glass Galileo determined the periods of revolution of all four satellites within a few nights of their discovery.



An Interesting Telescopic View of the Planet Neptune with Its Moon. The Little White Spot Near the Large One Is Neptune's Moon. An Unusual Photograph, as the Little Satellite Is a Very Difficult Object to View, Even Thru a Large Telescope.



Mars: Region of Syrtis Major. Photos Taken at Yerkes, September 28, 1909, Showing Changes Due to Rotation. Exposure 3 to 4 Seconds.

Some have complained also of the "dancing" of the stars when viewed thru a spyglass or small telescope of greater power than an ordinary field glass. It is useless to attempt to use any instrument more powerful than a field glass or opera glass without a tripod or rigid mounting of some form.

The more powerful the telescope the more carefully it must be mounted.

Buildings for housing powerful telescopes are built, if possible, far away from streetcar lines and railroads for the trembling of the ground caused by the passage of trains and cars affects the instruments. Telescopes of four inches or more in aperture are of little value unless mounted on a stone or cement pier and housed in such a way as to be entirely free of the floor, as even walking across the floor would otherwise cause the instruments to tremble. Temperature and atmospheric effects must also be considered, and to equalize the inside and outside temperature and overcome the "boiling" of the atmosphere due to unequal temperature the astronomer throws open the dome of the observing room for some time before he expects to begin his observations.

At most large observatories "visitors' nights" are a regular feature. Visitors to Mt. Wilson Observatory observe the great 100-inch reflector from a glass encased observing room that they may introduce no temperature effects upon the sensitiveness of this powerful instrument.

There are certain celestial objects that nearly every one desires to see thru a telescope.

We all want to see the Moon and Saturn's rings and some of our near neighbors in the solar system, as well as some of the most interesting objects that lie many light years away, the great nebulae and the globular star clusters and the double stars.

The best general view of the moon, as many are aware, is obtained a few days after the first quarter, but the best time to study any particular marking is when it lies near the terminator, the line separating the light from the dark portion of the moon's surface. The marking, crater or mountain or cleft, as the case may be, is then illuminated by a low sun and casts a long shadow, which indicates the height and form of the object. Lunar objects that stand forth beautifully when the sun is rising or setting upon them sometimes entirely disappear from view under a high sun. The poorest of all times to observe the moon is at the time of full moon, when there are no shadows and all detail of the lunar markings is lost in a flood of sunlight under vertical illumination.

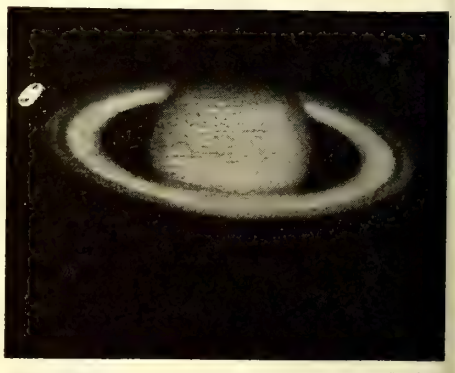
The most interesting views of the moon from a popular point of view are those obtained with a six- or eight-inch telescope showing the entire lunar disk in the field of view.

Highly magnified views taken with the great reflectors and refractors show the moon to us piece-meal, for, as the magnification increases, the angular width of the field decreases, and instead of a view of the entire lunar disk we get a "close-up" of a very limited portion of the surface showing great detail.

Venus in the telescope is a surprisingly beautiful little object if seen near its time of greatest brilliancy, halfway between inferior conjunction and elongation, when it appears as an exquisite little crescent moon. With a magnifying power of forty-five Venus appears exactly as the moon does to the unaided eye when it is four days old, tho, of course, it shows no distinctive markings such as appear on the lunar surface, for the surface of Venus is screened from our view by its dense atmosphere.

Astronomers prefer to make their observations of Venus and Mercury in the daytime, for they are then higher in the sky and the observations are not marred by the disturbing atmospheric effects of refraction, haze and "boiling" that are always greatest near the horizon.

Saturn is one celestial object that hardly ever disappoints us. His rings are a source of never-failing interest to everyone. To be sure, they disappear from view for a very brief period once every fifteen or seventeen years, when our line of vision



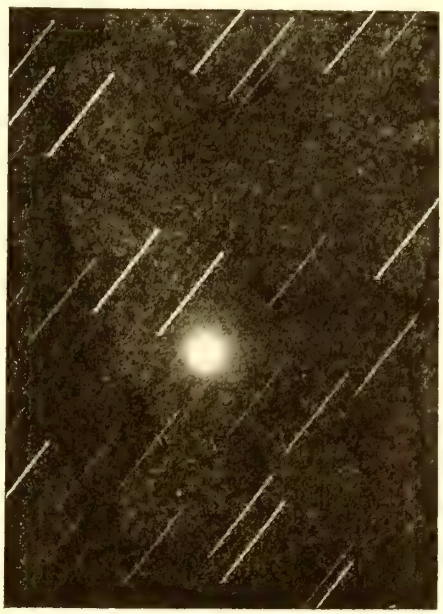
Remarkable Photograph of Saturn, Taken November 17, 1911, with the Sixty Inch Telescope of the Mt. Wilson Observatory. This Shows It as It Appears in a Powerful Reflecting Telescope.

lies directly in their plane, but such disappearances are comparatively rare and, even at such times, we cannot fail to be in-



At Left—Great Photographic Nebula Near Pi and Delta Scorpii. Photographed by Mr. Barnard with the Bruce Telescope. Exposure 8 Hours and 45 Minutes. One of the Most Beautiful Sights in the Heavens.

At Right—Encke's Comet, Taken at the Yerkes Observatory, October 29, 1914. Note the Great Lengths of the Star Trails, Which Indicate Rapid Motion of the Comet. This Comet Is Noted for Having the Shortest Period of All Known Periodic Comets, Three and Three-Tenths Years. At Its Brightest, It Is a Faint Telescopic Object, Showing no Trail.



erested in his belts and his moons and the ronounced flattening at the poles, which s then particularly noticeable.

Jupiter also delights us all with his contantly changing belts and varied coloring, nd the phenomena of his four historic ioons that show up so beautifully even in ie small telescopes.

Mars in the telescope is usually a disappointment to every one, and the astronomer ever presents him as a show object; in act, he prefers not to show him at all nless you are prepared beforehand. The lartian disk is small, for Mars is tiny world after all. Its surface s less than a third that of the earth, must be remembered. To glimpse ie Martian canals one needs a rained eye and the skill in observng that only comes after long conued practise, as well as exceponally fine atmospheric conditions, uch as are not usually to be found n visitors' nights at the observaories of our large cities.

It must be remembered that the iaps of the Martian canals that iost of us have seen are the results f years of painstaking observations iade under superlatively fine observng conditions, and that only a small roportion of the total number of anals have been seen at any one me. A canal may flash forth durng a moment of exceptional seeing nd then be dimmed by Martian iists or terrestrial haze. Even the hance observer will note the snow aps, however, and the most conpicuous surface markings.

The outer planets, Uranus and leptune, are so far away that they re of little interest even in the large elescopes.

In delving into space beyond the olar system, of greatest interest to ll are the star clusters and nebulae nd the double and multiple star ystems, as well as the many wonerful regions of the Milky Way.

Aside from the Great Nebula in rion, which is, indeed, a wonderul object in the telescope, the nebuie are, on the whole, disappointing hen observed directly. Here is one istance in which the photographic late, on account of the *cumulative ffect of light,* is vastly superior to the human eye. All the wonderful detail brought out in the photographs of the nebulae and star-clusters is the result of *several hours of photographic exposure.*

The Great Spiral Nebula in Andromeda, the Trifid Nebula and many of the wonderful double armed spirals with which we are familiar thru their photographs show up quite disappointingly in the telescope because they appear so extremely faint to the human eye.

Star clusters, as well as nebulae, appear at their best photographically. A few of the coarser globular clusters are wonderful objects in the larger telescopes. With small three-inch telescopes it is difficult to make out the stellar nature of even the coarsest of the star clusters.

Double and multiple star-systems can always be found even with as modest an instrument as an opera glass, for these systems abound in the heavens. At a conservative estimate at least one out of every four stars belongs to a physically connected system composed of two or more stars revolving around a common center of gravity. One of the tests of the power of a telescope is its ability to separate close double stars. A six-inch telescope will separate a double star into its two components that appears as a single star in a three- or four-inch telescope, while it will in turn show as a single star a close double that can be separated by a telescope of greater aperture.

Some double stars are so close that no existing telescope is powerful enough to separate them, tho the shifting of spectral lines will reveal that a companion star is present. Such double star systems are called *spectroscopic binaries.*

The wider doubles are frequently of beautifully contrasting colors, such as green and red or blue and gold. Many of these gems are visible in the smallest telescopes and they are among the wonders of the heavens that every one will want to see.

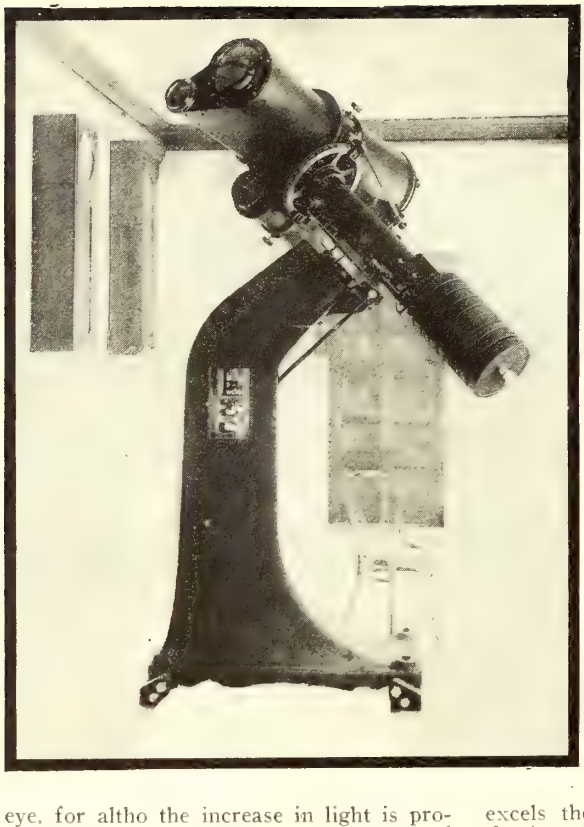
Often the faint companion of a brilliant star will be invisible in small telescopes because of the glare of light from its bright companion. Such is the case with the companions of Rigel and Antares.

Close satellites of the planets Jupiter, Saturn and Mars are also difficult to find, not only because they are small, but because they must always be so close to the planet that they are dimmed by its light. For the same reason our terrestrial planets are invisible at the distance of the outer planets.

Comets are not interesting objects to view telescopically, as they are extremely faint. No extended surface, such as the disk of a planet or a comet can appear brighter telescopically than it does to the naked



One of the Most Interesting of All Comets (Morehouse Comet) Because of the Sudden and Unexplainable Changes in Form and Brightness That Were Continually Taking Place. The Telescope Was Kept Pointed on the Comet While the Photograph Was Being Taken, Which Caused the Star Images to Trail Across the Plate. Taken at the Yerkes Observatory, October 15, 1908.



At Left—The Bruce Telescope of the Yerkes Observatory, Showing the Three Objectives by Means of Which Different Sized Photographs of the Same Regions May Be Photographed Simultaneously. Magnificent Photographs of the "Milky Way" Were Taken by Mr. Barnard with This Instrument, Temporarily Located on Mount Wilson, Cal. The Plate Holders Are Placed at the Eye-End of the Telescope.



At Right—A Universe of Suns: The Great Star Cluster in Hercules (Messier 13). Distance from the Earth Estimated To Be 37,000 Light Years. Photographed with the Sixty-foot Reflector of the Mt. Wilson Observatory. Exposure 11 Hours. This Is Visible to the Naked Eye as a Faint, Hazy Patch of Light. In a Three-Inch Telescope, Its Stellar Nature Can Hardly Be Distinguished.

eye, for altho the increase in light is proportional to the square of the diameter of the lens, the magnification of the object by the eyepiece spreads this light over a greater surface and the total amount of light received by the eye is less than when the object is gazed at directly.

The total amount of light received from the *stars*, however, is greatly increased as the diameter of the lens increases, because they appear as points of light. The bright stars can be seen in the daytime in the telescope and millions upon millions of stars invisible to the naked eye can be seen in the telescope. Many more millions that cannot be seen by the eye, even with telescopic aid, can be brought out by the cumulative action of light upon the photographic plate.

Photography is of little value in studying in detail surface markings of the planets on account of the rotation of the planets on their axes, which makes long photographic exposures impracticable.

The Martian canals have lately been photographed at the Lowell Observatory, and Dr. Slipher's wonderful photographs of Jupiter give unsurpassed general views of the Jovian markings, but all the more delicate changes in tint and shade of the markings of Jupiter, Saturn and Mars and, in fact, of the lunar markings as well, can be caught only by the human eye, which excels the photographic plate in catching *fleeting glimpses of fine detail* and in utilizing the rare instants of *perfect seeing* which occur from time to time in all localities.

Photography is far more valuable for cometary work than in delineating planetary features.

In spite of the fact that a comet is moving rapidly thru the solar system, valuable photographic exposures of even several hours' duration can be obtained by stopping the clockwork of the telescope, which keeps the stars immovable in the field, and allowing the stars to trail across the field while an observer keeps the telescope pointed on the comet thruout the time of exposure by means of the cross-wires in the finder of the telescope or by some similar means.

Wonderful photographs of comets have been obtained by such methods and these are of great scientific value in that they afford indisputable evidence of the changes in the form and general appearance of a comet that often take place with startling suddenness.

The speed with which the comet is moving can be judged from the length of the star trails produced during the exposure.

Photographs of comets are of great value to any one interested in researches into the causes of the remarkable and unaccountable changes in the behavior of comets that are continually occurring.

One of the most interesting of all come was Comet Morehouse (1908), which, t never bright, exhibited some very striki phenomena. Its brightness changed fre time to time in a most erratic manner, a the material that formed the tail at tim appeared to be swept aside by unseen forc or driven from the head with unaccountat rapidity. It may be considered one of t most mysterious comets that has ever a peared. Many excellent photographs of tl comet were taken which prove the pec liarity of its behavior.

Of special interest this spring will be t apposition of Mars, which will occur April 21. Mars' nearest approach to t earth will take place a few days later, April 27, when it will be about fifty-fo million miles from the earth. In 1922 a 1924 the distance will be even less.

Any one may find the ruddy-hued plan at that time very readily, as it will be t brightest red star in view in the evenir At the time of apposition Mars will almost as bright as Sirius, the brightest st in the sky, which will disappear below t western horizon very early in the eveni by the last of April. At the same tir Mars will appear in the eastern sky short after sunset and will be on the meridian midnight. Jupiter will also be seen ju west of the meridian at sunset and will n set until after midnight.

Sir Ernest Rutherford, On The Problems Of Radioactivity

In the first Silvanus Thompson Memorial Lecture, delivered before the Röntgen Society Sir Ernest Rutherford, F. R. S., reviewed the various lines of scientific investigation opened up as a result of the discovery of X-rays. In a tribute to the first president of the society, in whose honor the lectureship was instituted, he mentioned that on the morning that the late Silvanus Thompson read of Röntgen's discovery he set to work, and by nightfall had succeeded in producing what was probably the first X-ray photograph taken in England. The outbreak of war, Professor Rutherford said, had caused an almost complete stoppage in the great tide of advance in pure science, but the lull afforded a suitable opportunity for looking back with some degree of perspective over the ground covered during the last twenty years.

Undoubtedly the discovery of this new type of radiation marked the beginning of an epoch in physical science and had brought about a revolution in ideas of the nature of matter and electricity almost as marked as that produced in biology by the theory of evolution. The two decades from 1895 to 1915 had been a period of pioneer advance over a new and fertile territory, with the almost daily discovery of interesting facts and the gradual unfolding of fundamental ideas. The directions of advance which had been stimulated by the discovery of X-rays included investigation on the ionization of gases, electrons, tl diffraction of X-rays by crystals, and, mo important of all, the phenomena of radi activity, which was an even more dire consequence of the discovery of X-ra than the work on the electron. The s quence of changes in uranium, thorium, ar actinium had now been followed out, nc indeed completely, but in the main part. N doubt there would still be in the futu considerable developments as the result c investigations of the multiple transform tions of the atom, but as a whole, apa from a few outstanding difficulties, like th origin of actinium, the transformation c radioactive bodies was fairly well unde stood.

"Rabbit Contest" Awards

(CONTINUED FROM THE MARCH NUMBER)

SECOND HONORABLE MENTION.

I wish to say that the peculiar effect reproduced on the sample piece of film publisht in the December issue of the ELECTRICAL EXPERIMENTER was probably caused by the distorted curve of the primary alternating current which was probably operating at commercial frequency.

A distorted curve is considered as a resultant of a sine curve of the same frequency as the distorted curve, combined with a number of other sine curves of a higher frequency. The shape of the resultant curve depends on the features of design of the circuit. The sine wave of the same frequency as the distorted wave is called the *fundamental wave,* and the higher frequency components are called *harmonics.* Practically the resultant of the fundamental and a limited number of harmonics will represent any distorted wave with sufficient accuracy.

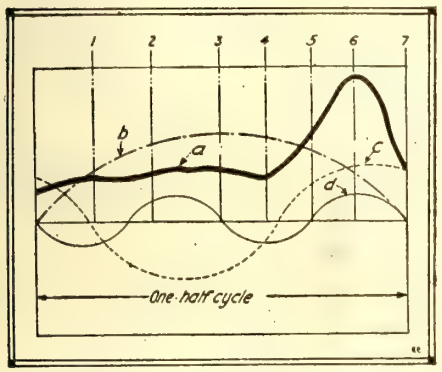


Diagram to Accompany Mr. Coffman's Explanation of the "Mysterious Rabbit."

The actual shape of curves is determined by means of an oscillograph or by some other method. In practice the problem is usually that of splitting up a given distorted curve into the fundamental and harmonics, and the ability to distinguish at a glance the presence of prominent harmonics in any distorted curve can be attained only by practice in drawing different fundamental waves and harmonics and adding these algebraically. In making such drawings the maximum value of the harmonics should be taken at less than the maximum value of the fundamental.

By referring to the photo of the film, we may draw a resultant curve which will be distorted as can be seen. The resultant curve is shown in the illustration. By beginning at the top of the film and going down it can be seen that the power of the primary inducing current gradually increased, and then suddenly flasht up to maximum power when view six was taken. The numerals in the accompanying illustration represent the time at which the respective views were taken. By analyzation of the resultant curves, it is proven that it consists of the fundamental wave *b* and the second and fourth harmonics *c* and *d,* respectively.

Altho the current in the high frequency secondary circuit was oscillating at an extremely high frequency, compared with that in the primary circuit, the power of the same at any instant was dependant upon the power of the current in the primary at that instant.

RAYMOND NOBLE COFFMAN.

105 Burt Ave.,
Newark, Ohio.

THIRD HONORABLE MENTION.

The effect obtained in making motion pictures of the rabbit undergoing the corona discharge from a high frequency apparatus is due to the fact that the exposures are made without reference to the intermittent appearance and disappearance of the corona discharge.

In a high frequency set the secondary voltage and current rises to maximum and drops to zero value in a rapidly succeeding train of high frequency waves for each discharge of the primary spark gap. That is, the frequency may be 200,000 cycles per second, but these wave trains are split into groups with a wave envelope of a shape determined by the frequency of sparking and the damping in the circuits.

A motion picture camera operating at a rate of sixteen exposures per second with each exposure lasting, say, .01 second, will snap the corona in the different stages of its changing values. The first five exposures on the length of film were made when the corona was at a value below its maximum, the sixth exposure occurring at the exact instant it had reached its maximum value in one of its recurring cycles. Were the rate of exposure and spark discharge kept at the same rate a perfect picture would be obtained at regular intervals.

THOS. W. BENSON.

3722 M St.,
Philadelphia, Pa.

FOURTH HONORABLE MENTION.

To explain this strange phenomenon, it is assumed that the spark-discharge used was of a highly dampt order, also the speed of the camera at the time happened to be running at a speed, synchronous to one of the many harmonics of a wavelength develop by the frequency of the spark discharge.

If this be true, then each picture, beginning at the top would not necessarily be taken of the next wave of the train, but the next in their order of the harmonic.

It must be understood that the harmonic is moving constantly with the frequency of the wavelength develop by the spark discharge.

In this case the camera shutter opens only when the harmonic is in evidence; that is, there is no picture taken except when the harmonic covers some one point of the discharge wave-train.

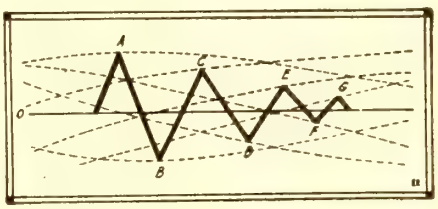
To illustrate this, the full lines in the drawing show the oscillations of only one spark discharge, and the broken lines show the harmonic position relative to the opening of the camera shutter on a spark discharge, that is, the first picture in the illustration would be taken when the harmonic was in a position as shown at C in the drawing, the second taken when the harmonic again crost a wave-train or at a point D, the third at a point E, the fourth at a point F, the fifth at a point G, the sixth picture would be taken from the first rush of current in discharging or at a point A, the seventh and eighth would be taken at a point G also or even later if the time-length of the wave-train was greater.

I have made many photographs of spark discharges, sometimes obtaining no picture at all, and never any two of the same strength or density.

By using a speed camera with a shutter speed of one, three or four hundredths of a second, pictures of this nature are easily obtained.

The movie camera gives the same effect, except that there are sixteen pictures per second in the standard machine, therefore the camera must have been running at a speed synchronous to a harmonic wavelength develop when the discharge took place.

HAROLD C. SIMONS,
Elec. (R. O.) U. S. N.,
Frankford, Mich.



Harmonics Enter Into the Solution of the "Rabbit Puzzle" by Mr. Simons.

FIFTH HONORABLE MENTION.

As everyone knows who is familiar with alternating current on open circuit (such as the poles and secondary windings of an high frequency induction coil constitute) the poles are electrified alternately with charges of positive and negative sign, one pole being positive while the other is negative. With a frequency of two hundred thousand the change in sign of the charge of either pole occurs so rapidly that the discharge seems to the unaided eye to be continuous.

The fact of the matter is that the discharge is not continuous, but approaches a maximum as the pole under observation is charged with electricity of one sign at its highest potential; dies down and disappears with the lowering of this potential, only to reappear when the pole is almost immediately charged with electricity of the opposite sign at a rising potential.

Thus it will be seen that if a camera with a fast working speed were trained upon the rabbit (in this case constituting part of one pole of the machine) and the film exposed at the time that the electric charge was changing signs (that is, when there is no discharge), the film when develop would be blank, while if exposed at the time of maximum discharge the result would be as shown in picture number six.

As the moving picture camera has a "frequency" of *approximately* sixteen, and the electrical discharge a frequency of two hundred thousand, the exposures would be made at times of different degrees of discharge.

Thus exposure number one was made when the discharge was approaching a minimum. Number two was made as the potential of the charge was still lower than the potential of the charge photographed in number one; numbers three and four are photographs of receding potential, while in number five the exposures of the camera and the frequency of the electrical machine again commence to be in synchronism, and the result is that the sixth exposure was made just as the discharge was at its maximum brilliancy, while numbers seven and eight again were made at times of discharge of lower potential.

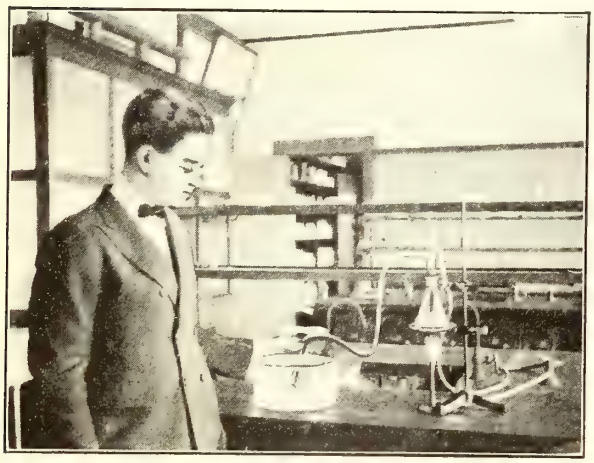
FRANK L. HEYDON.

Ponca, Neb.

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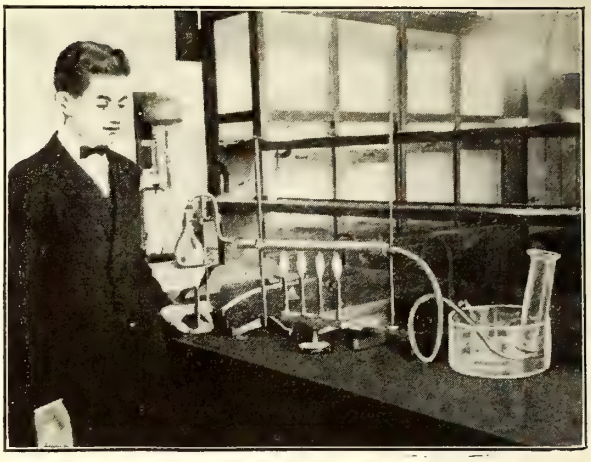
Practical Chemical Experiments

By PROF. FLOYD L. DARROW



Left — Making Phosphine Rings Is an Extremely Interesting "Chemical Stunt," Which Will Please All Those Who Have Even a Small Laboratory. The Gas Rings Arise in the Form of Beautiful Concentric Circles.

Right — Generation of Water Gas Is Here Readily Demonstrated, the Gas Being Collected by Downward Water Displacement. Note Bunsen Burner Quartet. The Set-Up of the Apparatus Is Clearly Depicted in Diagram, Figure 11.



FLAMES AND ILLUMINANTS.

THE object of experimentation in the home laboratory should not be amusement, merely. If that were the sole purpose, it would not be worth the time and effort required. But the skill in manipulation, the knowledge of chemistry, the training in observation and the interest in scientific work acquired in such practice are of inestimable value. It is well to remember, too, that a century and a half ago when chemistry was in its infancy most of the great chemical discoveries were made in *home laboratories*. Therefore, in all the work make it the best possible, be sure you understand the chemistry back of it and seek at every point to gain increased skill in manipulation.

In this article we shall consider the chemistry of *flames and illuminants*—a most important field of chemical investigation. Perhaps, we had better start off with the fact that to produce a flame requires the union of two gases or vapors. Red hot coals glow but there is no flame. Likewise the burning of iron in oxygen or the union of sulfur and zinc dust produces light but no flame.

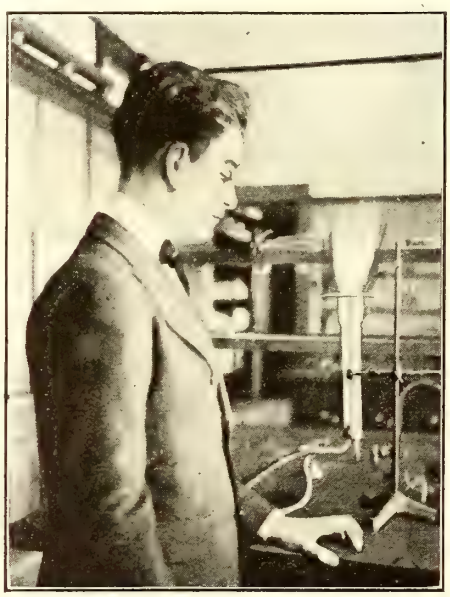


An Extremely Simple Acetylene Gas Lamp Whereby the Amateur Chemist Can Work at Night. The Light Emitted Is Very Constant and the Lamp May Be Turned Off by Simply Tightening the Pinch-Cock. The Embryo Chemist Is Here Seen Carrying on an Analysis Experiment by the Acetylene Lamp.

IGNITION OF GAS FROM AN EXTINGUISHED CANDLE.

Light a candle and when it is burning well blow out the flame. Immediately hold a lighted match in the rising smoke a half inch above the wick, when the vapor will catch fire and running back will communicate the flame to the wick.

To show this on a larger scale arrange a candle and Argand lamp chimney as shown in figure 1 allowing for good ventilation. On blowing out the flame and applying the lighted match to the top of the chimney, the candle will be relighted. The chimney may be 3 or 4 inches in height.



Here Is Something New to Try on the Gas Company. Instead of Burning Gas in Air—Do Both; Burn Air in Gas and Gas in Air Simultaneously, Thus Obtaining Two Lights at the Cost of One. The Trick Lies in the Lighting and Piping Arrangements of the Apparatus.

TO ILLUSTRATE THE TERM "SUPPORTER OF COMBUSTION."

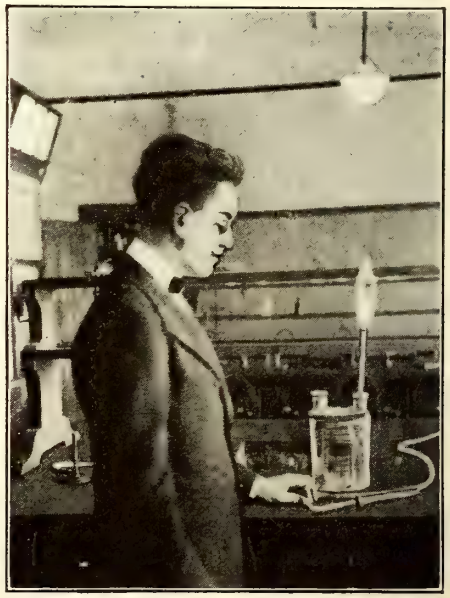
A gas may be combustible and yet not a supporter of combustion. This is well illustrated with hydrogen. Generate a cylinder of the gas in the usual way by the action of dilute sulfuric on zinc and collect the gas over water.

Now as shown in figure 2 hold the cylinder of hydrogen in the left hand, mouth downward and thrust upward into it a lighted candle attached to a wire. The hydrogen lights at the mouth of the cylinder with a small explosion, burning with an almost colorless flame, but the candle immediately goes out. Upon withdrawing the candle it is relighted at the mouth, showing that the hydrogen itself is burning. The operation may be repeated a number of times before the gas is exhausted. This shows clearly that while the hydrogen is combustible it does not support combustion. This is also true of many other gases.

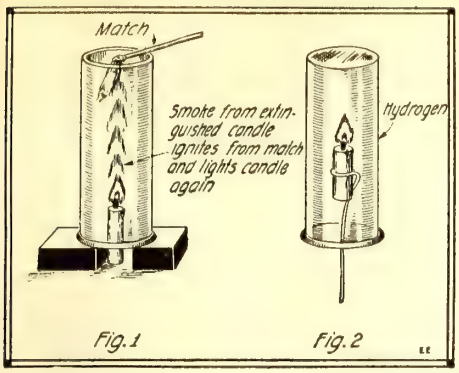
BURNING AIR.

That either illuminating gas or air may be regarded as the supporter of combustion is shown by the following experiment:

Fit a lamp chimney with a 2-holed rubber stopper carrying a glass elbow and a straight glass tube as shown in figure 3. The straight tube should be about 10 millimeters in diameter. On the top of the chimney place a piece of asbestos board with a small hole in the center. Now connect the glass elbow with the gas supply and closing the hole in the asbestos board with the palm of the hand turn on the



The Gas Flame Above Shown Coming From the Bottle Is Due to the Fact That Gas Had Been Introduced Primarily and Later Shut Off. Air Mixes With the Gas in the Bottle Until Finally the Mixture Therein Contained Is of a Sufficient Explosive Context to Go Off With a Loud Report.



Igniting the Gas From an Extinguished Candle, Thus Lighting the Candle Again.

Above, Diagram Showing That Even Those Gases Which Burn Can Act as Supporters of Combustion in Which Case They Need Not Burn.

gas. Then light the gas at the lower end of the straight tube, immediately remove your hand from the cardboard and also light the gas at the top of the chimney. Two flames will result, one at the top of the chimney, which is the excess of gas burning in air and the other at the top of the straight tube, which is air burning in an atmosphere of illuminating gas. Thus air is the combustible gas here and the illuminating gas is the supporter of combustion.

AN EXPLOSIVE MIXTURE.

Secure a 2-holed Woolf bottle of two or three liters capacity and fit the necks with stoppers carrying glass tubes as shown in Figure 4. The straight tube should be about 10 or 12 millimeters in diameter. Connect the glass elbow with a gas cock, and turning on the gas drive out the air from the bottle. Light the gas at the top of the straight tube and then withdraw the elbow with its stopper, at the same time turning off the gas. The flame will continue to burn at the top of the straight tube for a few minutes and then seem to disappear entirely. But do not conclude that nothing will happen. Wait, and suddenly a sharp report will occur and the bottle will be filled with a sheet of flame. In a *darkened room* the effect is much more impressive.

As the burning gas escapes, air enters thru the open neck until the bottle is full of an *explosive mixture* of gas and air, when the feeble flame strikes down into the mixture and ignites it. The "striking back" of a gas stove or Bunsen burner is due to the same cause.

THE SAFETY LAMP.

Multiply the above explosion a million times and you will have something like the effect produced by an explosion of "fire damp" in a coal mine. It will show you, too, the necessity for the miner's safety lamp invented by Sir Humphrey Davy a century ago.

The principle of this lamp is well shown by surrounding a candle with a cylinder of fine iron or copper gauze. Cut a sheet of gauze 6 by 8 inches and roll it into a cylinder and fasten it along the edges. At the bottom place a candle, securing it in position with wire supports.

Light the candle and hold the cylinder horizontally in jet of illuminating gas as shown in figure 5. The gas will be seen to burn inside the cylinder but the flame will not communicate outside and the burner will not light. This gauze may even become red hot without igniting the gas on the outside. So good a conductor of heat is the gauze that the gas does not reach its kindling temperature. A simple application of a physical principle, and yet it has saved thousands of lives.

A BUNSEN BURNER FLAME.

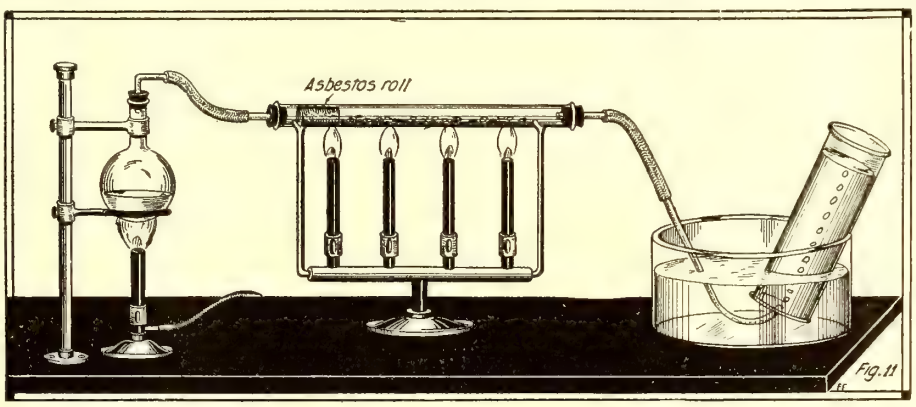
With the air holes open at the bottom of the tube a Bunsen burner flame shows two distinct cones—an outer cone of burning gas called the "oxidizing" flame and an inner cone of unburned gas called the "reducing" flame..

That the inner cone is not undergoing combustion is very strikingly shown in the following way: Thrust a pin thru a match stick about a half inch below the head. Mount this in the top of a Bunsen burner and turn on the gas. Now light the gas and observe that the match does not burn. To show that it has not burned turn off the gas and it will be found that the match is perfectly good and can be lighted in the usual way.

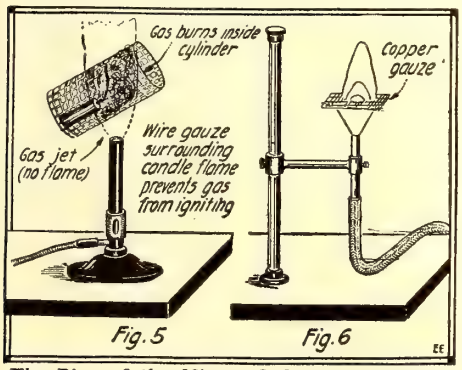
Another very striking experiment to demonstrate this fact is illustrated in figure 6. Make a burner of a small glass funnel and over the top place a piece of fine copper gauze. In the center of the gauze place a small heap of gunpowder or flashlight powder. Turn on the gas and light it by bringing a match down from above. The gas will burn but the powder will remain unignited. Slowly turn off the gas and as the flame diminishes in size the powder will ignite.

SPONTANEOUS IGNITION OF HYDROGEN.

Direct a stream of hydrogen from a generator on some platinized asbestos, when the asbestos will be seen to glow and presently the hydrogen will ignite.

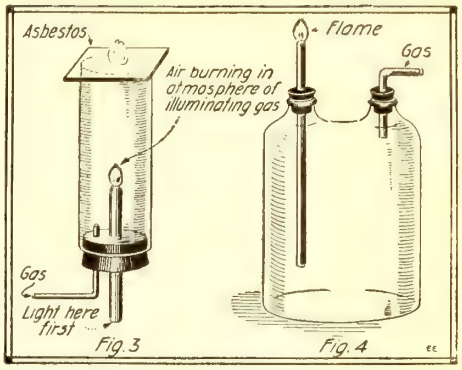


Your Own Gas Generator; Making "Water Gas." You Can Bottle It and Use It to Your Heart's Content.



The Plan of the Miners Safety Lamp Showing That an Explosive or Dangerous Gas Will Burn Inside the Wire Gauze Cage, Yet Not Ignite the Atmosphere of Gas Surrounding It.

Demonstrating That the Inner Cone of the Bunsen Flame Is Cool.



Burning Air in an Atmosphere of Illuminating Gas. Two Lights are Noticed, One at the Top of the Cylinder Burning in Air, the Other Inside the Cylinder Burning in an Atmosphere of Gas.

The Layout for the Explosive Mixture Experiment. The Gas Supply Pipe and Cork Is Removed; the Flame, However, Still Continues to Burn. Why?

The platinized asbestos may be prepared by moistening a small quantity of asbestos fibers with a few drops of platinum chlorid solution and igniting them in a Bunsen burner flame. The chlorid decomposes and finally divided platinum is left on the fibers.

PHOSPHINE SMOKE RINGS.

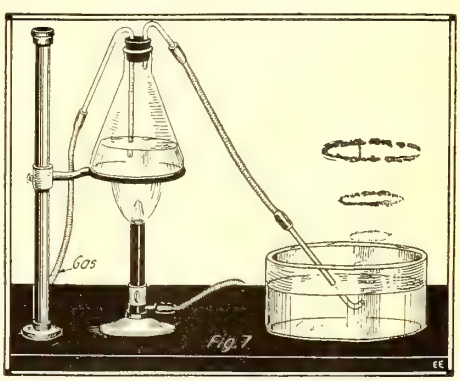
Arrange apparatus as shown in Figure 7. Fit a flask with a 2-holed stopper carrying two bent tubes, one of which reaches nearly to the bottom of the flask. In the flask place a *strong* solution of sodium or potassium hydroxid and a piece of yellow phosphorous, the size of a pea. Connect the tube leading to the bottom of the flask with a gas cock and drive out the air. To the other tube connect an 18-inch length of rubber tubing, in the end of which is inserted a glass delivery tube. Have the end of this tube bent up slightly and place it in a basin of water.

Now heat the contents of the flask and as the solution begins to boil a gas will be given off which spontaneously ignites on reaching the air.

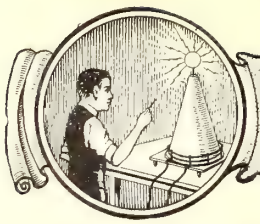
AN ACETYLENE LAMP.

Obtain a large mouthed bottle of one or two quarts capacity, a large lamp chimney, small disc of coarse wire gauze, one-holed rubber stopper, 6-inch length of glass tubing, rubber connection, acetylene gas tip and 18 inches of heavy aluminum wire.

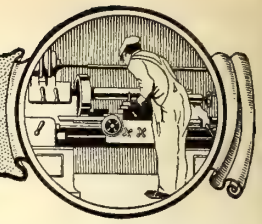
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The Very Pretty Prosphine Ring Trick. The Above Diagram Demonstrates a Stunt Which No Experimenter Should Refrain From Conducting.



THE CONSTRUCTOR



Home-made 110-Volt, 60-Cycle Induction Motor

By H. H. PARKER

MANY uses could be found for a small single-phase motor which would connect up to an ordinary 110-volt lamp socket, and while such motors are not high priced many Amateur Mechanics wish to build them themselves, but are deterred by the difficulty of making or obtaining field and rotor punchings, for, unlike the direct current variety, both the stator, or field magnet, and rotor cores must be built up of iron sheets or laminations.

No originality is claimed in the main design of the small motor to be described, but an attempt has been made to lay out a strong and substantial construction not too difficult to be built at home on a small screw-cutting lathe. The power of this little motor would depend to some extent upon the materials used and the workmanship and care in making the windings, but it should be serviceable for driving a fan, buffing wheel, rotary spark gap, or various types of light machinery. Having but one set of windings upon *rotor* and *stator*, it is not self-starting and will not start under a full load, this being characteristic of all such types of alternating current machinery. But by using a tight and loose pulley or a similar contrivance and giving the belt a sharp pull after throwing the switch, the motor will pick up speed without difficulty. Another crude but effective starting device is shown in the assembly drawing (Fig. 2); this consists of a spool shown on the left-hand end of the shaft around which a heavy cord is wound and the motor given a starting whirl by a quick pull of this cord.

In regard to the laminations: field and rotor are built up of sheets of "stove pipe" iron of about 22 gage, tho if regular transformer iron or silicon steel was obtainable a more efficient, as well as more expensive, machine could be produced. Even tho these sheets could be given a form simple enough to be cut out by hand, separately, with tinner's snips, this would be a formidable undertaking, and the method decided upon here is to cut out square sheets, pile them up, clamp together, drill out along the required outlines by means of a jig plate, then separate, break out the portions not needed and finish by filing and in the lathe. Even this means considerable work, when compared with the construction of a direct current machine, but to partly compensate for this the A.C. motor has no commutator, slip rings nor brush holders, the rotor windings being short-circuited. As seen in Figs. 1 and 2, the motor has four poles, with four stator coils, while the rotor has four wide slots and also four poles, with no electrical connection between stator and rotor. At a frequency of 60 cycles the speed will be a little under 1,800 r.p.m.

Fig. 3 shows the shape of the stator laminations and Fig. 4 of the rotor. By referring to Fig. 1 it will be seen that with the rotor in the position shown the spaces, or slots, in the rotor, lie opposite the stator pole faces, while the rotor faces lie next to the stator slots. By using care and with an accurate drill press or lathe drill pad, it might be possible to cut both a rotor and stator lamination from one sheet of iron, by making narrow separations at the corners where the rotor faces meet the corners of the stator poles. Otherwise separate square sheets must be used for stator and rotor laminations, requiring, of course, considerable more material. A saving could be effected by making each stator sheet in two parts, as per the dotted lines in Fig. 3, and "breaking joints" when assembling the pile, but this would introduce a little more reluctance into the magnetic circuit. Figs. 6 and 7 illustrate the method of making the drilling jigs out of a scrap plate of half or three-eighths inch cast iron or steel. Care should be taken in laying out these jigs that enough material will be left around the edges of the sheets, after drilling, to allow of a smooth finish. To use the jigs, the square sheets are piled up to make a depth of two inches, for both stator and rotor, when comprest; this would take about 68 sheets of 22-gage iron. After clamping or bolting, by the corners, to a hardwood board, the center hole is drilled and two lines scribed exactly at right angles thru the center; then the four 11/32-inch holes in the stator and 5/32-inch holes in the rotor are drilled, rotating the jig so as to use the same hole thru it each time and taking care that the holes were exactly ninety degrees apart. Then a pin is driven thru the half-inch hole of the jig and one of these holds the jig furthermore clampt to the pile, and one-quarter of the holes drilled; the jig is then shifted thru a right angle and the process repeated, and so on until all the holes are thru. With an accurate drill press the whole pile could be drilled thru at once, but in other cases it might be best to drill half of the plates, or a pile one inch high, at a time. The plates are now separated, the pieces broken out, reassembled and the edges finisht to size with a file. Previously to separating a shallow hacksaw cut should be made across the pile at some point, to insure getting them back in the same position, and before reassembling the outside corners are cut off to make less work for the lathe.

The stator plates are then assembled and bolted to the lathe face-plate, with a hardwood packing piece in between, centered up and bored out and the outside turned down to the given diameter. They must then be taken apart again and all burrs cleaned off the edges to prevent making electric contact between the laminations; before the final assembly each plate is given a thin coat of shellac on one side and allowed to dry. 5/16" bolts are used and each is wrapt in shellacked paper so that when dry it may be just driven into the 11/32" hole without tearing the wrapping. This bolt and rivet insulation is necessary for the insulation of the laminations. Similarly, ⅛" rivets are insulated and put thru the 5/32" holes. The plates should be clampt tightly together but not so tight as to spring them open where there are no bolts or rivets. The rotor core is similarly constructed, but the laminations are held on the shaft by two pairs of locknuts as well as ⅛" bolts, insulated with paper and fiber nuts, which also act as posts to hold the windings in place.

All the machine work must be completed before starting the winding. In regard to the bearings (Fig. 8-A), these are cast in brass or bronze; heavy bar brass with bearing bushings soldered or brazed in might also be used. The bearing yokes are separated from the stator core by cast iron, steel or brass posts, which also act as nuts to clamp the laminations together. There are several possible ways to drill out the bearings. One would be to put an 11/32" drill thru the bolt holes in the core, spot the bearing yokes and then drill and ream them 5/16". Then put in the 5/16" bolts (Fig. 7-A), insulated with shellacked paper and screw home the posts. Drill and ream to ⅜" a 2" length of steel shafting, drive it thru a hole in a 2" hardwood block, place between centers in the lathe and turn the block to a diameter that would just allow it to be pusht into the bore of the stator (3/16"). Then put in the short bearing studs (Fig. 8) and bolt one of the bearing yokes in place. Using the steel busht block as a jig, drill and ream the bearing yoke.

Two angle plates (Fig. 9) are cast in iron or brass for the motor base; these can be mounted on an angle plate on the face-plate and faced to take the stator core; one 5/16" bolt, also wrapt in paper, holds both in place.

The rotor laminations, as previously mentioned, are held to the shaft by two sets of locknuts, one set of which have 1" flanges. Or two 1" washers and four S. A. E. ½" nuts could be used. In any event, after screwing up these nuts and their lock nuts to clamp the laminations tightly, they are turned down to finish dimensions and the shaft also turned to finish size. If done previously to this, clamping the laminations might spring the shaft. Two grooves are turned, with sharp edges, to prevent oil working up into the rotor windings. A light cut is also taken to true up the surface of the rotor. Then the insulated ⅛" bolts are run thru and clampt by the fiber posts. Figs. 10, 11.)

THE WINDINGS.

Now for the windings. Procure a roll of "armature" tape, wrap some around the stator cores, tie it and cover with shellac. The construction of the stator precludes the use of *form wound* coils; so enough wire for one coil is wound on a spool small enough to pass thru the core, and the coil is wound by hand. A couple of split flanges of very thin fiber could be slipt on each end of the core and glued together, the splits opposite, to act as heads for the coil. No. 22 D.C.C. copper wire is used for the stator;

(*Continued on page* 1314)

Home-made A. C. Motor

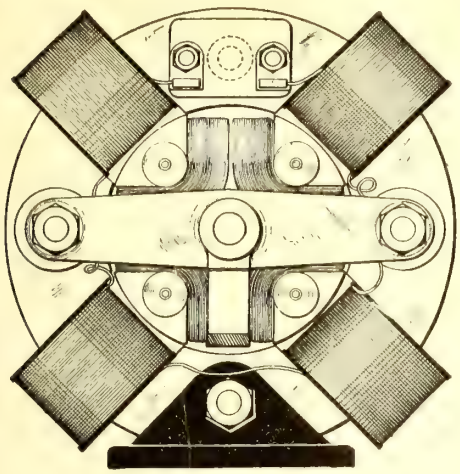


Fig. 1

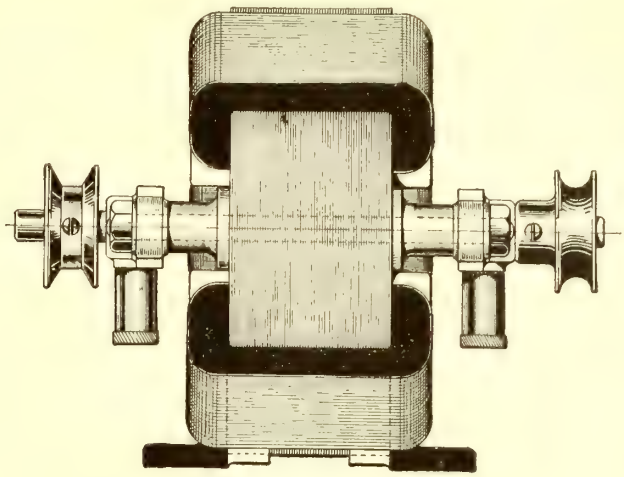


Fig. 2

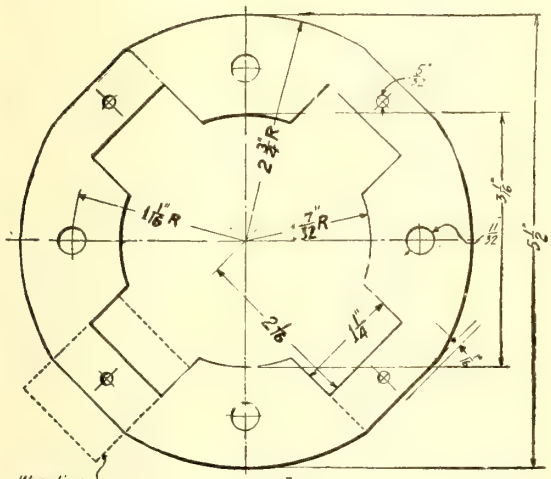


Fig. 3
#22 sheet iron 68 req'd

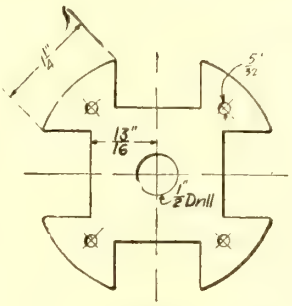


Fig. 4
#22 sheet iron 68 req'd

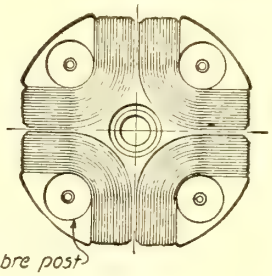


Fig. 5

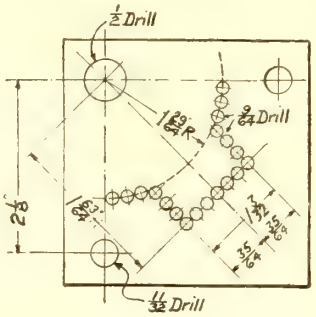


Fig. 6

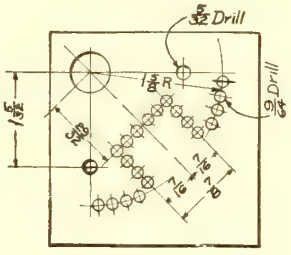


Fig. 7

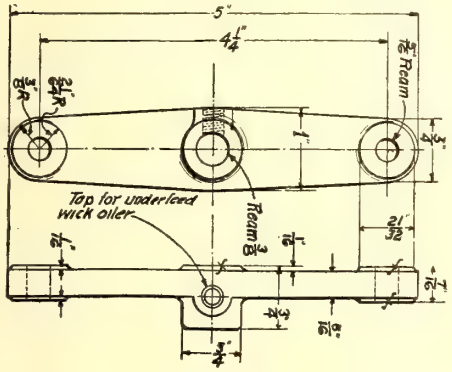


Fig. 8-A
2 req'd.

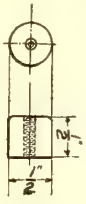
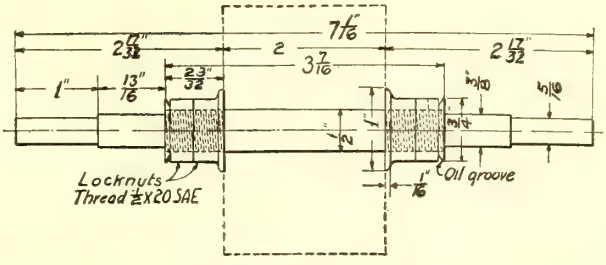


Fig. 11
8 req'd.
red fibre

Fig. 8
C.R. steel 4 req'd.



Motor shaft
C.R. steel 1 req'd

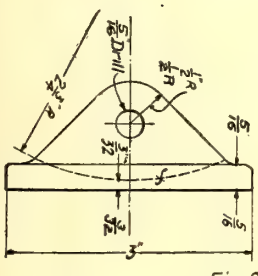
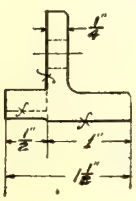


Fig. 9
2 req'd



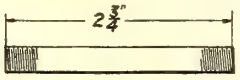


Fig. 7-A
C.R. steel 2 req'd

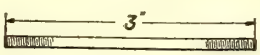


Fig. 10
C.R. steel 4 req'd

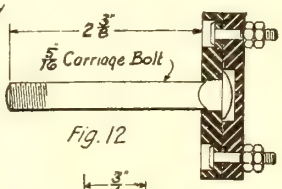


Fig. 12

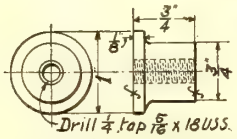


Fig. 6-A 4 req'd brass

EE.

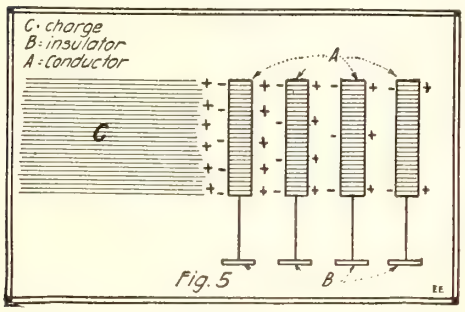
(Full Description Covering the Construction of This Alternating Current Motor on Opposite Page.)

The "Finer Workings" Of Static Electricity

By FREDERICK VON LICHTENOW

SECONT PAPER.

WHEN I had finished writing the (now) first part of "The Finer Workings" of Static Electricity, I felt that a limited treatise on the most vital phases of this particular form of electricity may not only help the beginner or uninitiated to gain a clearer



STATIC ELECTRICITY. Diagram Showing How a Series of Insulated Conductors May Be Charged by Super-Induction, the Individual Conductors Being Separated by Air Gaps as Shown. The Distribution of the Positive and Negative Static Charges Is Shown by the + and — Marks.

conception of what is demonstrated by the preceding experiments, but also considered it worthy the effort to lay down in an easily understandable manner the principal actions of this natural, electrical element, as I found them by experimentation.

Static Electricity has been my special Research-object, off and on during the past twenty odd years; and altho I had, during that time, observed many of its phenomena —both dim and pronounced in character— I venture to say, that numerous surprises are still waiting for those, who care to invade this wonderful region. The "Trail" has been carefully "Blazed" all the way to it long ago, has been kept open by ardent followers and added to, but a great portion of what lies on either side of it is well beyond; is as yet more or less engulfed by a tangle of doubts!

CHARGE AND CHARGING.

The various means by which a static charge is effected are found in any book on the subject and, consequently, need not be gone into any further here. The peculiar and unique action of this charge, in whichever way produced, however, embodies highly interesting phenomena, unclear if not wholly unknown to the beginner:

A static charge travels in any direction thru space; its natural trend being, of course, down and up, that is from the clouds to the earth or vice versa, forming its path by seeking whatever conducting body comes handy.

In order to retain such a charge for any length of time, *a supporting insulator is absolutely imperative.* Lightning, as it strikes a human being, an animal, a tree or a house does the damage during the instant while the charge is delivered, *but loses its force a moment after it reaches the earth* (a mammoth conductor). A probable exception from this is "ball lightning" and *only in so far,* that it has the peculiar trait of hovering over or moving along near the earth's surface for a fraction of time before its sphere of electric "fire" explodes. (All in all, a very rare occurrence!)

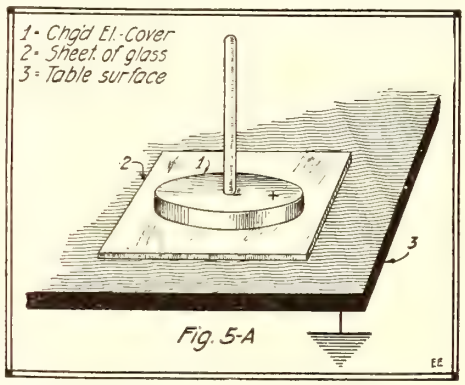
Any one of these electro-static charges is of a *Unipolar* character.

There are three ways of charging: *direct charging* (by contact); *indirect charging* (by induction, which is charging at a distance.) See Expts. No. 1-3-4, Part 1; and *circumstantial charging* (by superinduction), which embodies contact charging with an insulating body interposed between charge-source and conductor. See Expt. No. 2, Part 1.

But considering the peculiar nature of Static electricity there are *ever so many exceptions* from such fundamental, general rules, which (the exceptions) are some of the things that exemplify its "Finer Workings." And so it happens that contact charging at times becomes inductive charging (electrified insulator as charge-source!) and the same in reverse.

Likewise, charging by *superinduction* does *not always* include the *contact-element;* and a series of insulated conductors may be charged in this manner by having them separated by air-gaps. (See Fig. 5.)

As I have hinted at before: a conductor can only be charged, that is without losing its charge right away, as long as it is *supported by an insulator* of some kind: the



Experiment No. 5, In Which an Electrophorous Cover Is Statically Charged in the Usual Way and After Removing It From the Hard Rubber Sheet, It Is Placed on a Plate of Glass. The Charge Does Not Dissipate Instantly as Might Be Supposed, But Leaks Off Gradually.

air, silk thread, insulating stand, etc. (It so becomes a charge-source!)

It can be directly charged in this manner and will retain its charge for a certain, short time and also indirectly (Inductively) charged under the same conditions.

In the latter case, however, it will *not retain its charge any longer than it is kept under the influence of the waves emanating from the charge-source or removed from contact with the same,* which of necessity, has here to be an insulator. (Charged ebonite plate and electrophorus cover, for instance, if the latter is removed from the former without first grounding the repelled electrons!)

The only exception from this is furnished by "In-between-objects," like pith balls, which are neither good conductors nor good insulators.

Insulators cannot be charged directly by the application of a charged conductor, but may be "electrified" by the *friction method,* a thing impossible to accomplish with a conductor, *unless well insulated* (which applies also to the part with which it is in friction.)

They may so become charged on one end while the other one stays neutral, or charged evenly all over, as the case might be; and they will retain their charge for quite a little while.

However, they can be inductively charged (as well as by superinduction. Note: Glass plate in experiment No. 2, Part 1) but *only as long as they are in contact with the charge-source,* which here may be either an insulator or otherwise insulated charge-source.

True, inductive charging (distance charging) of insulating bodies, such as a sheet of glass, is also not so remote a possibility, as I found out, when such insulators are coated with a film of moisture (atmospherical dampness), which serves as a conductor. This is only one instance of the many circumstances which enter unbidden into static experiments and which, not seldom, overthrow time tested theories.

Proof, that an electro-static charge does not penetrate thru an insulator (sheet of glass, etc.) of a thickness, corresponding naturally with the value of the potential of such charge, is contained in the following experiment:

EXPERIMENT NO. 5.

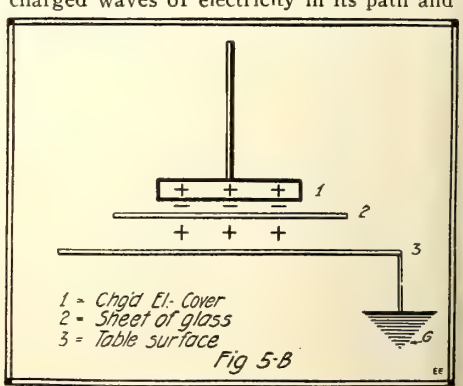
An electrophorus cover (tin box employed in the previous experiments) is charged in the usual way and, after removing it from the hard rubber sheet, placed on a plate of glass or other (neutral) insulating sheet. (Fig. 5-A.)

Altho this glass plate is grounded on the table and so should offer quite an inducement for the electrons residing on the cover to find a way thru, they can not accomplish this, but are retained on the cover. They gradually diminish, however, in value, which is the consequence of natural "leakage"; and this not more so than had the cover been suspended in space by a silk thread. In fact, its capability of holding a charge should now rather be increased, with the superinduced earth-force acting upon it, ("Bound" Charge!) Fig. 5-B.

SPARKS AND POLARITY.

It takes two opposite poles to produce a spark. A "unipolar" electro-static charge cannot do it.

When a lightning bolt cuts thru space, its blinding glare and tendency to branch out and to "Zigzag" are the consequences of its striking and reaching for oppositely charged waves of electricity in its path and



Continuing the Argument Set Forth at Fig. 5-A, the Electrophorus Can Hold the Charge More Efficiently, In View of the Superinduced Earth-Force Acting Upon It (Bound Charge).

s also the result of its tremendously high otential. For, these ether-waves need, of ecessity, not primarily be charged, may be eutral even, but will become *inductively lectrified*—and pretty high at that!—when his happens. There is nothing changed in he unipolar element contained in the bolt f lightning, except that it loses some of ts force; on the contrary, this only subtantiates the fact that a charge can only e of a "unipolar" character.

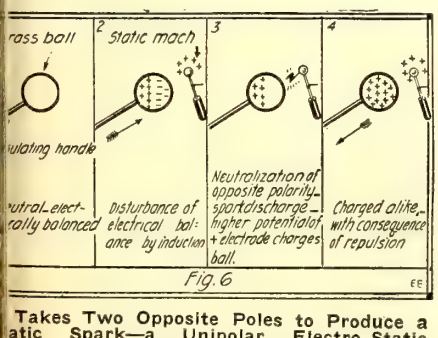
As such, when insulated and approached y another insulator it is as tame as a ove. Nothing happens. A somewhat ifferent aspect is offered, when—to give an xample—(serving as Expt. No. 6.) a metal bject, in neutral condition and held by an nsulating handle, is brought near one of the lectrodes of a static machine in action. parks will jump over, naturally, and they ill continue to do so as long as they find complement of electrons of *opposite* sign pon that object. These have partly existed nd are in addition induced there (on the bject being approached) and taking atmosherical conditions into consideration—are ourished to it more or less from the air a metal body is a first class conductor and ts like a sponge in respect of properties f attraction, *especially under pressure of duction!*) so that the sparking often connues for a long time. If everything was st right or as it should be, the sparking ould cease after a few moments; for, with e opposite electricity consumed by the eutralizing" spark, all further attraction n the part of the metal body stops. All at is left upon it is a charge, which it s acquired during the process, and which of the same sign as that of its erstwhile pelled electrons (but of a higher potial) as well as that of the charge-urce (see Fig. 6).

A pronounced effect is, quite naturally, ined when the unipolar charge is peritted to reach a grounded conductor, in hich it finds all the opposite electrical operties that it is longing for. It then—d only—really manifests all the "Ear-arks" of a charge and in proportion to potential becomes dangerous to a lesser higher degree. That is the basic prinple of the spark discharge, the *rushing gether* of *opposite* polarities;—that forms e spark!

The entirely opposite character of a posi-e (+) and negative (—) pole—the two gns of electricity—is in so far still further hanced, that the positive element is an *cess* of charge while the negative is a *ficit.*

According to the manner of charging an ject as well as according to the potential the charge-source and its own polarity, will the respective polarities, naturally ry in their arrangement upon such obcts.

The experiments and illustrations furned with Part 1 of this paper show this ite clearly, which eliminates a repetition re, while Fig. 6 demonstrates the polarstribution as nearly so as when direct arging is resorted to (not touched upon Part 1.) with the only difference, that actually direct (contact) charging, inction and neutralization follow one an-



Takes Two Opposite Poles to Produce a atic Spark—a Unipolar Electro-Static Charge Cannot Do It.

other *so rapidly,* that the induced, oppositely polarized element exemplifies another case of "Spurlos Versenkt"!—No evidence of it nor even time enough for such!

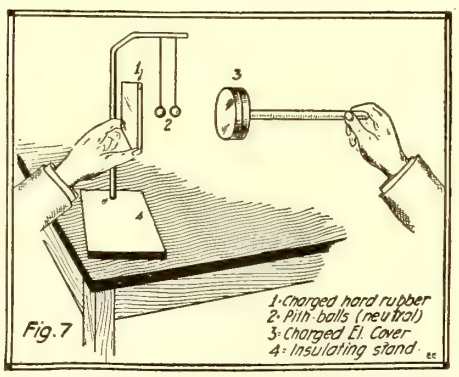
In any and whatever kind of charging of a neutral body, *induction* takes place first, followed by *attraction* and ended by *neutralization.*

NEUTRALIZATION.

Neutralization embraces everything in Static Electricity. It is there at the beginning and at the end; and the visible or otherwise perceivable action that lies between is nothing but the *evidence of its re-creation,* or the manifestation of the process in re-establishing the electrical balance.

Normally, everything on earth is static electrically balanced, that is positive and negative electrons are evenly distributed upon the things around us. Both polarities are conglomerated—so well mixed—that, as is self-evident, polarization cannot exist in such a case. The condition of such objects is then called "Zero," which means *neutral.*

As a natural consequence of the disturbance of this electrical balance under the effects of friction, heat, motion, etc., their potential becomes abnormally raised, which constitutes a charge or polarization. Some objects become positively polarized, others negatively, but only the *neutralizing action* furnishes *proof of the existence of a charge,* either directly or in a round-about way. For, it is well to remember that even like charged bodies, which ordinarily repel one another and plainly show this wherever possible, are such only *temporarily* and that they seek either a neutral or an oppositely electrified object by way of *compulsory attraction.* And attraction as such is *neutralization at a distance,* with the



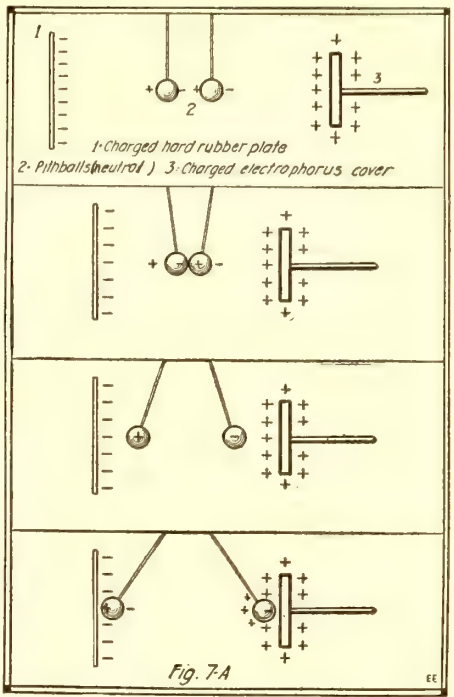
This Experiment Demonstrates the Process of Neutralization in as Near a Prolonged Manner as It Seems Possible to Accomplish With Such Simple Apparatus. The Static Neutralization Apparatus Required to Perform This Experiment, Including the Two Pith Balls, Are Easily Obtained and Cost Practically Nothing.

naturally "forerunning" induction. This shows, on the other hand, that they need not come in actual contact with a neutral or an oppositely charged body, but will become *neutralized thru the air in due time, if there is no way open for making contact.*

Neutralization is simply *the electrical law of the earth* and nothing can get around it.

While oppositely charged conductors neutralize their charges almost instantly on contact, or thru a spark at the proper distance, insulators do so unperceivably slow as well as only to a limited degree and, invariably, without the manifestation of a spark. This is partly due to the low potential to which only they can be raised, partly —and in the main—the result of their make-up, which *characterizes them as insulators.*

So it is possible, as I have already pointed out, that a hard rubber rod may become charged on one end and stay neutral on the other. But not only that; an electrified glass rod (+) may be rolled to and fro over a charged sheet of ebonite (—) and yet both will retain their respective polarities. No doubt, their charges lose some



The Disposition of the Static Electric Charges in the Pith Ball Experiment Illustrated at Fig. 7, Where the Electrified Electrophorus Cover and Electrified Hard Rubber Sheet Are Slowly and Simultaneously Projected Toward the Pith Balls From Either Side.

of their former strength, but unprovable little of it under this process. The insulating properties are so excellent, that by bringing a charged conductor and oppositely electrified insulator in contact there is *no noticeable evidence of neutralization*

All this becomes greatly changed, when atmospherical conditions (dampness) transform an otherwise good insulator suddenly into a fairly good conductor, which has also been hinted at in the foregoing. And under such circumstances neutralization works *overtime!*

EXPERIMENT NO. 7.

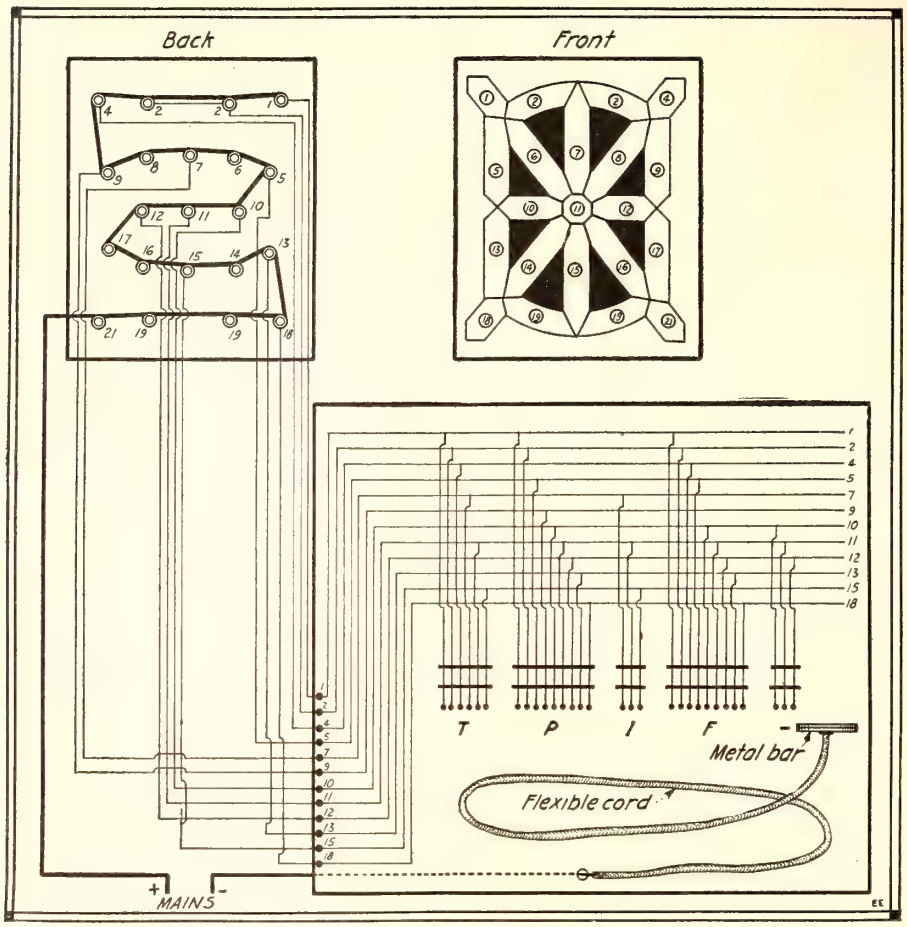
This experiment demonstrates the process of neutralization in as near a prolonged manner as it seems possible to accomplish with such simple apparatus. Fig. No. 7 refers to the instruments and their arrangement and shows the pith balls hanging very close together, *almost in contact,* as they should hang. This is important. Of further importance is that the charged El-cover and electrified hard rubber sheet are *slowly* and *simultaneously* approached from either side (each one facing only one side of each separate ball!) with the potentials of the two charge-sources given *individual* consideration. That means, the more strongly charged El-cover should at no stage of this experiment approach as near to its ball as the electrified ebonite plate be permitted to close in on its own.

Contrary to the expectation of the uninitiated or to the general law of attraction these light objects will not fly toward their respective charge-sources, but will join and cling together. When this happens their inductively repelled "inner" charges neutralize, and all action of the operator should stop here for the time being; for if he brought the charge-sources any closer he would simply accelerate the process and spoil the experiment.

In fact, the feeble element of attraction existing between the two balls overcomes the powerful attractive properties exerted upon them by the charge-sources only by reason of their—the balls—close proximity to one another and the greater distance that lies between them and the charge-sources.

(*Continued on page* 1324)

Electro-Monogram Sign for the Boys



Something of Interest to Every Young Electrician—an Electro-Monogram Sign Which Is Easily Constructed at Small Cost.

HERE, boys, is a signaling outfit that you may use at night, spelling out, one letter at a time, any message you desire to send to your "pal" across the street or over on the next avenue. No code is necessary. You merely place a metallic bar across groups of wires and the monogram, which contains electric lights, forms the desired letters.

You may construct the monogram any size you desire. A small one may be operated with batteries, or a large one may be connected with the 110-volt lighting circuit of your home.

A shallow box is used in the construction of the monogram. In case you make a small size, a cigar box of proper proportions is just right. It should be slightly longer than it is wide, but the proportions do not need to be exact.

The light portions of the monogram shown in the picture are troughs. Thin wood or metal may be used in making these troughs. They should be about as deep as the length of the lamps used in them, allowing a glass front to be placed on the monogram if desired. Each trough is furnished with a lamp, as indicated by the numbered circles. The troughs are painted white to form a reflector. Thus when lamp No. 8 is lighted, the wh trough indicated by No. 8 is lighted. Wh various combinations of these lamps lighted, different letters may be form The entire alphabet and all of the numer may be formed with this monogram.

The wiring diagram is shown on back of the monogram. The heavy l is a continuous wire which is attached one side of every lamp. This line g to one side of the battery or power l

Now one wire is run from the ot side of each lamp to the switch-board t minals shown on the left of the board the drawing. The lamps numbered 2 those numbered 19 may be connected one wire, as there is no letter that quires the use of one No. 2 lamp w out the other. The same holds true the No. 19 lamps. That means that have nineteen wires to connect to switch-board terminals. Only twelve w are shown in the drawing for the sake simplicity.

On the switch-board the nineteen w are run across loosely until the le groups such as T, P, I, F and the d have been tapt. They may then be for into a cable to give plenty of room the board for the letter groups.

By tracing out the wires in the T gr it will be found that the lamps to wh these wires are connected will form letter T when lighted. The same is of the P, I, F and dash groups. The w forming the letter groups are stretc across bridges about a quarter of an high and fastened at the ends. The bric should be made of wood or other conducting material. The portion of wires between the bridges should be ba

Now a wire is run from the source current to the center of the bottom of board and there a single-wire cord is tached. At the end of this cord a T-sha metal bar is placed. The handle shoul wrapt with tape or otherwise insulate strong current is used. The bar must h contact with the wire cord. When the is placed across the bare wires in any ter group, the lamps to which those w are connected will be lighted, illumina the desired letter.

The letter groups may be arranged rows in alphabetical order or after manner of a typewriter keyboard. W the operator gets accustomed to the p tions of the letter groups he will be to spell out messages with great rapi

Contributed by ALTON D. SPENC

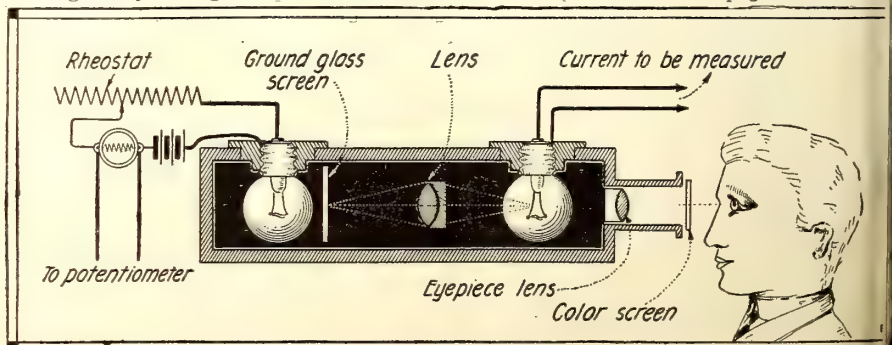
Measuring Electric Current With the Eye

By C. A. BRIGGS

A WASHINGTON scientist at the Bureau of Standards has devised an ingenious arrangement whereby it is possible to measure the amperes of electric current by means of a sort of photometer. In his scheme the brightness of a hot filament is matched against a bright background. This may have an application to alternating current work, and particularly to wireless work where it has been always necessary to get some means whereby the value of an alternating or high-frequency current can be reduced to its equivalent direct current.

The method can be understood by reference to the accompanying diagram. The electric bulb at the closed end illuminates a ground glass screen the image of which is thrown, by means of an achromatic lens, on the filament of the second bulb. The filament of the second bulb is viewed against the bright background thus formed by means of the eyepiece, which is provided with a color screen so that the observer is working always in light of one color. The first bulb is heated by an electric cur controlled by a rheostat. The value of current can be determined, as indicate

(*Continued on page* 1324)



Arrangement of Electric Lamp Apparatus for Measuring the Current Strength By Mat ing the Brightness of a Hot Filament Against a Bright Background.



1—Great Care Must Be Taken In Removing the Plates from a Storage Battery, So As Not to Damage the Lead Paste Filling. 2—See to It That the Insulators Between the Lead Plates are Perfect and Not Cracked Or Broken. 3—The Terminal Connections May Be Soldered Or Fused By Current Obtained from Another Storage Battery, Using a Pointed Electrode As Shown.

Storage Battery Repairing

By HENRY KLAUS

SINCE automobiles have become so popular many profitable occupations and side lines are afforded for rebuilding and adjusting their various parts. This is especially true of storage battery repairing and recharging. Most garages in small towns are not in a position or have not time to take them apart and bother with them, so they send them away to some larger place to have it done. Any one with a little experience can do this and make a handsome profit besides. It is the object of this paper to explain briefly the main points to be observed in the application of this work.

The equipment needed comprises a syringe hydrometer, voltammeter, welder (electric homemade), saw, blow-torch, test clips lead covered, pincers, sulfuric acid, solder, distilled water (can be made in the still shown), generator or rectifier and lamps for charging.

While battery repairing could be done without a charging apparatus, it would be very inconvenient to carry them to a garage or service station to be charged every time after they were finished. Many experimenters are equipt with D.C., or, a rectifier can be purchased from any electrical house. It will pay well to install this because the money expended is soon made back on it.

When a battery is brought in the first thing to do is test the voltage. If the cells show from 1 to 2 V. each they probably need only charging. Next draw enough electrolyte from each cell separately into the hydrometer syringe to float the hydrometer, take reading, and put it back again in the same cell. The table below shows the relative strength of the battery at the various readings:

1250	80%	strength of battery
1225	60%	" " "
1200	40%	" " "
1175	20%	" " "
1150	exhausted.	

A fully charged battery should have a Sp. Gr. of 1.275, or 1275 on the hydrometer, but it sometimes occurs that one shows a density of 1300 or even 1325.

The charging rate will be found on the lead name plate tacked to the case. Here is an example:

Start 13½ Amp. Finish 4½ Amp.

In this case a current of 13½ amperes (about 14-100 Watt lights in the lamp bank explained later) is allowed to flow until the cells gas freely, then continue the charge for 6 hours at the finish rate (in this case 4½ amperes with about 5 lamps connected). Never hold a match near the vent holes while charging as the products of electrolysis explode. If one of the cells has become short-circuited or for some other reason is below the rest, it should be charged separately until it is up with the others and then connect them all in. Some times a cell lags behind because the electrolyte leaks out of a cracked jar, and every time water is added the Sp. Gr. becomes less. This is taken up later. If the Sp. Gr. does not reach 1275 or over after 6 hours of charging at the finish rate continue at this rate until there is no increase. If a battery has been neglected for a long period it may take several days to bring it up to capacity. Never add acid to raise the density until the battery is fully charged. If it must be added it should have a Sp. Gr. of 1210.

A battery set away for the winter or standing idle for any length of time should first be fully charged and afterwards at intervals of one or two months to keep the Sp. Gr. up as long as it is not in use. A repair station should make a specialty of storing batteries for auto owners. If the batteries are neglected and allowed to freeze the active material of the plates becomes spongy and will fall off. The table gives the freezing points of various densities.

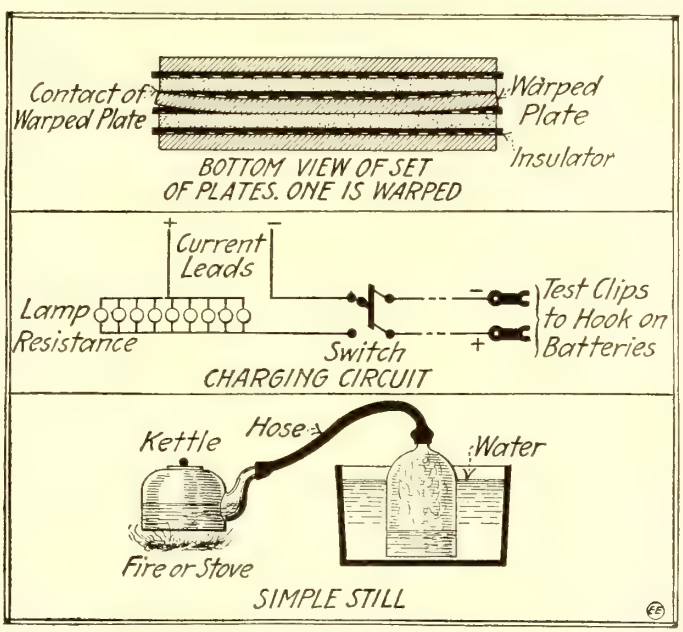
1150	Freezes	20° above Zero Fahr.
1180	"	0°
1215	"	20° below "
1250	"	60° " "

On a 110 Volt circuit a 100 Watt lamp draws nearly 1 Ampere and a 50 or 60 W. ½ Amp. When these size lamps are used for the charging resistance (110 V.) the current flow is easily calculated. The connections for this outfit are shown in the diagram. Don't forget to connect the positive side of the current supply to the positive terminal of the battery. Quite a number of batteries can be connected in series and charged at the same time. If you have test clips put them on the ends of the charging terminals, painting the positive red; also provide a few wires about a foot long with a test clip on each end. With these a connection is easily and instantly made.

Very commonly a battery comes in that has one or more cells which will not raise even after a day or two of continuous charging. This condition is usually caused by warped plates which have worn thru the insulators and touch each other. Such a cell, obviously, cannot be charged as the current goes thru the point of contact. The only remedy is to take out the plates and insulate the places where they come together. A whole new insulator can be put in, or, a strip an inch wide can be put in from top to bottom where the pressure comes. These insulators may be obtained from any house selling storage batteries. (Diagram shows putting in separators.)

As they increase in age storage cells deteriorate. In a storage battery the active material falls from the grids. This is hastened where they are used on an automobile, because of the jolts they get. The more material they lose the less charge they will hold. It is the positive element that almost always falls out first and a new set of these plates will often make a good

(*Continued on page* 1313)



Useful Hints On Storage Battery Repairing. Top—How Plates Become Short-circuited By Sulfating, Over-discharge Or Over-recharge. Center—Charging Circuit with Lamp Bank. The Lamps are of the Voltage Rating of the Line Potential. Positive Line Goes to Positive Terminal of Storage Battery. Bottom—Simple Still Made from Kettle and Large Bottle for Distilling Water for Storage Cells. Never Use Spigot Water—It Invariably Contains Sufficient Mineral Traces to Sulfate or Disintegrate Your Battery Plates.

The Electrical Machinist

By H. WINFIELD SECOR

No. 6—ERECTING MOTORS AND SHAFTING

THE erection of dynamos and motors is always a matter requiring extreme care, particularly when it comes to properly and exactly alining the pulleys on the motor and on the shaft which it is to drive. The leveling of the

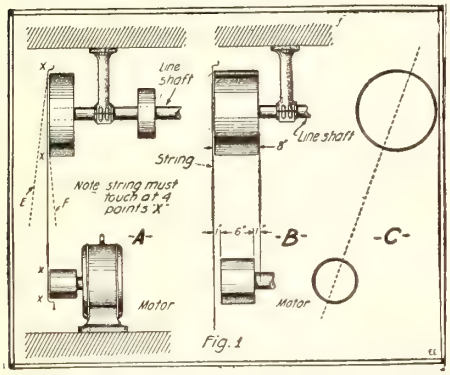


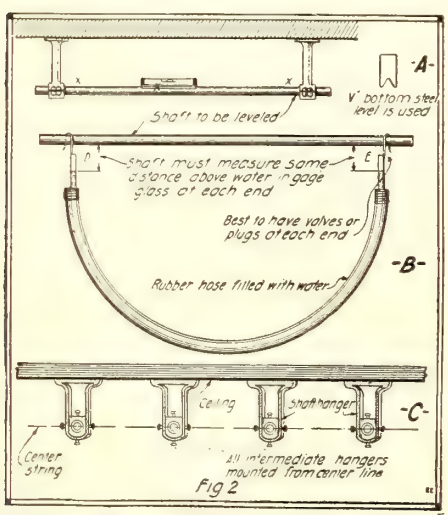
Diagram Showing How Motor and Shafting Pulleys Are Lined Up for Belt Drive by Means of a String or Chalk Line. If One Pulley Is Narrower Than the Other, Then It Is Centered as Shown at "B."

base of the machinery, as well as the leveling of the shaft are also very important matters which we shall here give our consideration.

Referring to Fig. 1, A, B and C represent different phases of the art of alining two pulleys, such as those on a motor and on a line shaft. At Fig. 1-A, the fundamental principle followed in lining up two pulleys of equal face width is illustrated. A strong cord or chalk line is held across the two faces of the pulleys so that the string shall touch at the four points marked "X." Usually two men do this, but if you have to do this alone, as will happen occasionally, then the string may be tightened around the pulley or otherwise secured at its highest point, when you can easily pull the string taut and bring it gradually into line with the lower base of the top pulley, and then move the motor to be mounted into position, so that its pulley face will be in perfect alinment with the cord.

Care must be taken to see that the cord is not allowed to assume an angular position such as shown, in a greatly exaggerated manner, by the dotted line E and F.

In some cases the two pulleys, that is the driver and the driven, are not of the same face width. In this case the string is applied as shown at B, in the usual manner, and by means of a rule the difference between the two pulley widths is divided up proportionately. For instance, if the larger pulley has an 8-inch face and the small pulley a 6-inch face, then if the two are to be alined, as is most always the case, then one inch space should be allowed on each side of the small pulley face when it is checked by a cord held on either side of the large pulley, as becomes clear upon examining the diagram.



Several Schemes Followed in Alining Shafting. The Stunt Employing the Rubber Hose Filled With Water and Fitted With a Gage Glass on Either End Proves Very Successful and Useful.

If the method of lining up pulleys with the cord is not quite clear, a glance at Fig. 1-C will make it so. Here it is seen how a cord is past, as nearly as possible, across the two diameters of the respective pulleys. Where the shaft projects thru a pulley, then the cord is simply pulled taut a little to one side of it, which gives exactly as good results as if there were no shaft projection, and the string past exactly over the diameters. The length of the belt, which is to connect the pulleys is usually measured by means of a strong, non-stretchable cord, past over the two pulleys or else by means of a tape measure.

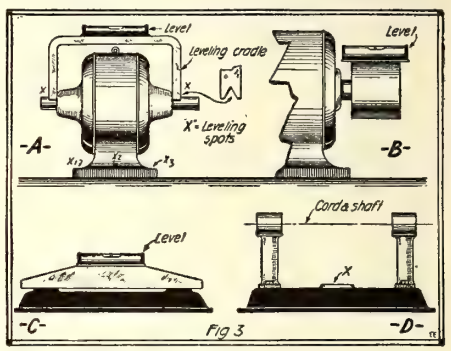
If the belt is to be a very exact fit, and of the endless variety, then the tape measure should be a steel one, so as to give a very exact reading. Most all motors, however, are fitted with belt-tightening screws on their base, so that quite a little variation is allowed for tightening up the belt, once it is put into place.

LEVELING SHAFTING.

The leveling of shafting, whether large or small, is an important affair, if the best efficiency and quietest running results are to be obtained. Figs. 2, A, B and C show some useful wrinkles in leveling shafts. The usual method for ordinary work is to employ a first-class steel level—preferably one having a V-shaped bottom—and the shafting should be turned into several different positions, so as to get a mean average on the level readings, and also the level should be placed on several points along the shaft while making the measurements, such as those indicated by X, X, X.

A unique suggestion to help in simplifying the leveling of long shafts, or, for that matter, short ones, is shown at Fig. 2-B. Two boiler gage glasses or other suitable glass tubes are hooked up with a length of rubber garden hose or rubber tubing; this is then filled with water, the water not quite reaching the tops of the gage glasses. The free ends of the gage glasses are fitted with hooks, which may pass over the shaft and hold it in position in the manner shown. This method is quite exact indeed, as it is well known that water or any other liquid will always seek its own level. In this case we at once perceive that the water level in the two gage glasses will be the *true level,* and if we then measure from these points indicated on the gage glasses to the surface of the shafting and keep changing the position of the shafting until these two distances, D and E, are equal, then we know that the shaft is perfectly level.

Where several shaft hangers have to be put in place before the shafting is available, the hangers are readily lined up and secured to the ceiling or side wall, whichever the case may be, by means of a center cord or string, as shown at Fig. 2-C. If more than two hangers are to be mounted by this method, then the two extreme end ones should be alined and put into place first. Intermediate hangers can then be readily lined up by means of the center string, which should be placed exactly thru the centers of the bearings in the end hangers, as becomes evident. Of course the string must be carefully checked up with a good spirit level, so that it is in a perfectly level plane. The shaft hangers are usually held on ceiling beams by means of lag bolts.



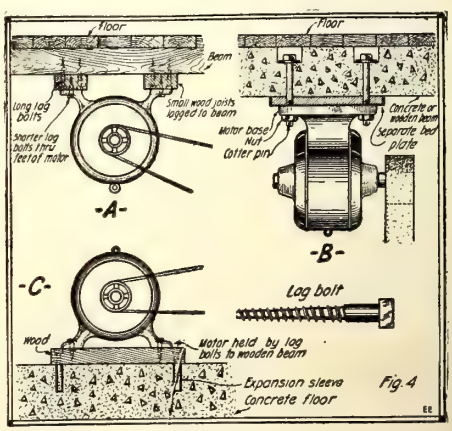
The Leveling of Motors and Dynamos Is Not Always the Easiest Proposition Imaginable. Several Ways of Leveling Up Electrical Machinery Are Here Shown.

LEVELING DYNAMOS AND MOTORS.

The leveling of dynamos and motor frames is not always the easiest task imaginable. This is particularly true in the case of small motors and dynamos having round or special housings, as shown at Fig. 3-A. An idea which can sometimes be brought into play, for such machines, is to have a leveling cradle of the form shown, and which may be adjustable for different sizes of machinery, which can be placed so as to rest on the shaft on both ends of the motor. The two lower feet of the leveling cradle should have V-shaped slots in them. The level is then placed on top of the cradle, as shown. In other cases there is often a sufficient amount of machined surface on the base of the motor so that it can be leveled in the necessary two directions, *i.e.,* at right angles to one another at the points marked X1, X2 and X3, or on both sides, and front and back of the base.

In some instances it is possible and permissible on a small motor or dynamo to level it close enough by placing the level proper on the face of the pulley, as shown

(*Continued on page* 1323)



Small and Medium Size Dynamos and Motors Are Here Illustrated, Mounted on Both Ceiling and Floor. Motors, Even Small Ones, Should Not Be Held to the Ceiling Beams by Lag Bolts Alone for a First Class Job, as Belting Strains Are Liable to Pull It From Its Moorings.

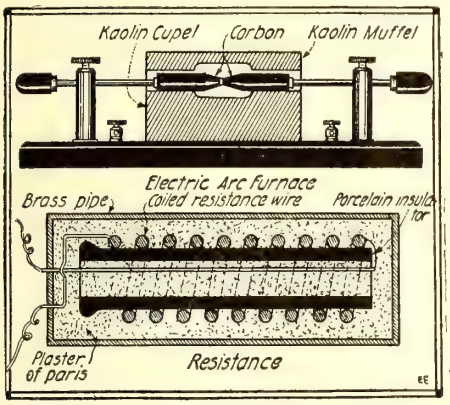
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

A "TESTED" ELECTRIC FURNACE.

I am a reader of your magazine and have been interested in some of the experiments publisht in it, and am therefore taking the liberty of sending you the diagrams of an electric arc furnace which I



An Electric Furnace That Works! A Rheostat Is Used in Series With It.

have used in my laboratory for some time with good success.

I believe the diagram to be self explanatory of the method of construction, and can be made from odds and ends to be found in any shop. I have used the above furnace to fuse brass, copper, silver, gold and platinum very satisfactorily as a high degree of heat can be obtained.

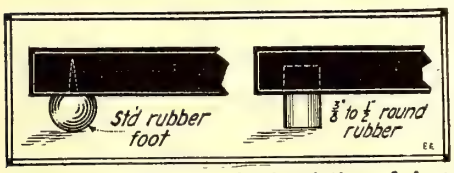
I also give a diagram of the resistance used in connection with the furnace. I used about thirty feet of No. 24 iron wire wound into a 3/16-inch coil which I then wound around a 4-inch porcelain tube. This was then suspended in a piece of brass pipe 6 inches long and poured full of plaster of Paris. It must be noted that before this can be used it must be placed over a very slow fire and thoroly dried out; else it would either burn out the coil or explode, due to the moisture being driven off too rapidly. I used this outfit on the regular 110-volt circuit.

Contributed by DR. A. T. FRIEDLINE.

UNIQUE RUBBER FEET FOR APPARATUS.

I had my wireless apparatus on a high polished table and as I did not wish to mar the table by fastening the apparatus to it, besides being bothered by having the instruments slide out of place and scratching the top, I cut up some rubber bands (about ¼" x 1") and glued them around the edge of the base, 8" or 10" apart.

Contributed by HERBERT M. MAUS.



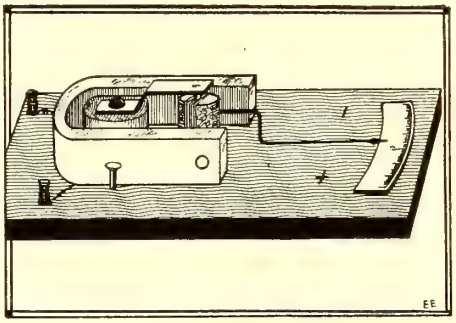
Rubber Feet Improve the Insulation of Any Electrical Instrument.

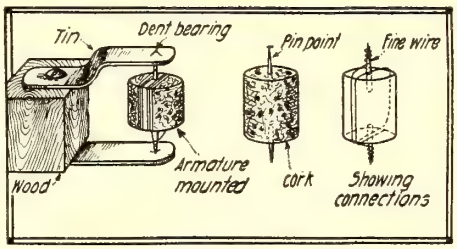
SECOND PRIZE, $2.00

MAKING A PERMANENT MAGNET METER.

I have experimented quite a bit on making various kinds of meters and have found great satisfaction in the ammeter here described. Procure a horseshoe type permanent steel magnet, about the size of a telephone magnet; a cork, some fine magnet wire, tin, cardboard and pins, etc. Cut the heads off the pins and insert one in each end of the cork, but be careful that they do not touch—and wind the wire around the cork, as in illustration, and connect each end of the fine magnet wire to the two pins so the pins act as bearings and the cork as an armature. Mount the armature between two pieces of brass strip to act as bearings and place the armature between the poles of the horseshoe magnet. Next bend a piece of copper or aluminum wire and insert one end into the cork. Mount the meter on a planed wood base and fix a cardboard dial under the wire. Calibrate it by means of a standard ammeter and batteries.

Contributed by LEE HOLMES.



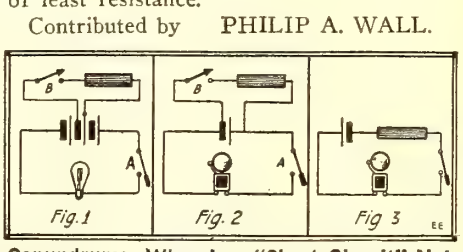


The Simplest Permanent Magnet—Moving Coil Meter. Nifty for Experimental Work.

A SHORT-CIRCUIT EXPERIMENT.

Practically everybody knows that if a battery connected to a bulb is short-circuited, the bulb will go out. But look at Fig. 1. The short-circuiting element is an ordinary battery carbon. Close switch A and the bulbs light brightly. Close switch B, and no change in bulb. Why shouldn't it dim? Oh, you think, you only "shorted" one battery. But look at Fig. 2. Here after A is closed and then B, the bell still continues to ring, despite the fact that *all* the current is short-circuited. Oh, you say, current does not pass thru carbon. But connect as in Fig. 3 and the bell will ring, indicating that it will. The owner of a Wheatstone bridge will easily ascertain the reason, however. It is a well-known fact that electricity will pass thru the conductor of least resistance.

Contributed by PHILIP A. WALL.

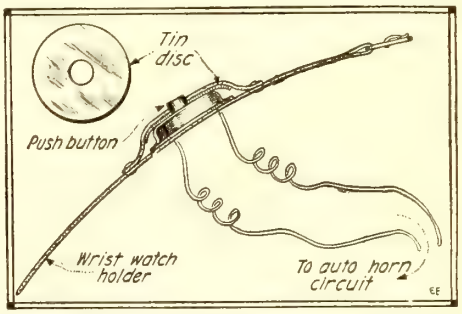


Conundrum: When Is a "Short-Circuit" Not a Short-Circuit?

THIRD PRIZE, $1.00

A CONVENIENT HORN DEVICE FOR AUTOMOBILES.

Purchase a wrist-watch case for about 50 cents and cut out a piece of tin large enough to admit a push-button, but leave the outside rim large enough to fit the watch case snugly. Procure a flexible lamp cord of sufficient length to permit the



Mount Your Auto Horn Button on a Wrist Watch Band and See How Convenient It Proves.

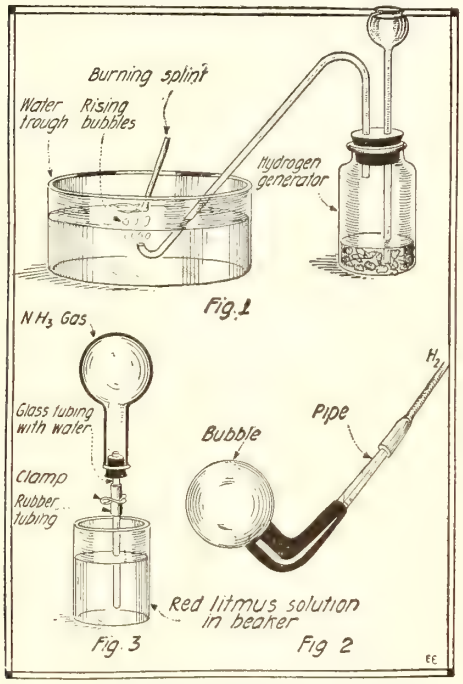
driver to hold one end with his arm outside the car, as when turning a corner. Now connect the wires to the button and to the electric horn circuit. Our circuit being complete, let us pass on to the uses of the push-button. You may strap the button to your index and second finger, so that the button may be in place for the fingers to be prest against the wheel without removing the hand. Now again, to blow the horn while turning a corner. Simply extend the hand and press the button with the thumb, and continue to steer the car with the other. By this arrangement you may blow the horn, signal to turn the corner by extending the arm, and guide the car—all at the same time. If the driver should not wish to use the button all the time, he may wind the wire around the steering rod and strap the button anywhere on the steering wheel. But pessimists may argue—"They will be easily stolen." I maintain that you can place a separable connector costing 15 cents in the circuit, so that the apparatus may be disconnected and placed under the seat or elsewhere. I find this a decided improvement over the present method, and think it will be worth a trial by all motorists.

Contributed by LYLE CASHION.



INTERESTING CHEMICAL EXPERIMENTS.

1. Heat a little sulfur with concentrated nitric acid until it has disappeared. Observe the red fumes. Insert a burning match into them and note that they support combustion. When the reaction is over,



Some Very Interesting Experiments in Chemistry are Here Illustrated and Described.

allow the tube and its contents to cool, then add barium chlorid solution and a white precipitate will be formed. This shows the presence of sulfuric acid. The sulfur has been oxidized by the nitric acid to sulfuric acid.

2. Burn a little sulfur in a bottle of oxygen and note the phenomenon. Do the same with phosforous. This time if the room is dark, the reaction will be more brilliant. Burn some charcoal also in oxygen and note the scintillation. Slip a small piece of cotton into melted sulfur, then attach it to a piece of picture wire. Ignite this and lower into a bottle of oxygen. Note how readily the wire burns and the globule of red hot iron that forms on the end.

3. Generate hydrogen and allow it to escape from under water. Hold a lighted splint over the escaping bubbles. (Fig. 1). As each one escapes it is ignited and explodes. This sounds like a miniature battle. Another way is to blow hydrogen bubbles and as they rise, set fire to each. (Fig. 2).

4. Dissolve some yellow phosforous in carbon disulfid and paint a sheet of paper with this solution. In a darkened room the phosforous will glow after the carbon disulfid has evaporated. Do not leave the solution or brush around. The bottle should always be tightly corked.

5. Dissolve 15-20 grams of lead acetate (sugar of lead) in 500 c.c. of water and place in a wide mouth bottle. Suspend in this liquid a piece of sheet zinc by a string. Allow it to stand for a day or so. By careful observation you will see the lead tree grow.

6. Alcohol from sugar. Dissolve 30 grams of table sugar (granulated) in 400 c.c. of water. Pour this into a flask provided with a stopper and delivery tube. Add ¼ cake of yeast and set aside in a warm place. It would be well to have the delivery tube dipt into lime water, so as to show that carbon dioxid is given off. Allow this to stand for a few days. You can then distill off the dilute alcohol. This is done by distilling about half of the liquid and discarding the remainder. It may be necessary to distill off half again before the alcohol is strong enough to burn.

7. Boil 10 grams of powdered nutgals in 80 c.c. of water. Filter after standing. There is now tannin in the solution. Add to this a solution of iron sulfate. Some inks are made in this manner.

8. Place a small piece of phosforous in a porcelain dish (free from water), and the same amount of iodine. The reaction proceeds by itself with the production of much light and heat.

9. Place a little powdered antimony into a jar of chlorin. It immediately catches fire and gives off a shower of sparks. Heat a piece of thin copper foil and plunge it into a jar of chlorin. Observe that it catches fire immediately, forming copper chlorid. Paint a piece of paper with turpentine and hold it in a flame until it begins to light. Quickly plunge it into a jar of chlorin. There will be a flash and great clouds of carbon are produced. Flowers, calico, etc., may be bleached by moistening and placing in a jar of chlorin.

10. Make an intimate mixture of equal parts of potassium chlorate and sugar. Set this in a pile and add a drop of sulfuric acid (concentrated). The mass catches fire at once and flares up.

11. A very striking experiment to illustrate the solubility of ammonia gas is to fill a flask completely with the gas and insert a stopper provided with a straight piece of tubing. (See Fig. 3). To this is added a piece of rubber tubing over which a clamp is placed. To this is attached another straight piece of glass tubing which dips into the bottom of a beaker of red litmus. When the clamp is opened, the water rises and the color changes to blue. This will take place sooner if water is put into the upper piece of tubing. (Fig. 3).

Contributed by
EDWARD MARENZANA.

LIQUEFYING A GAS.

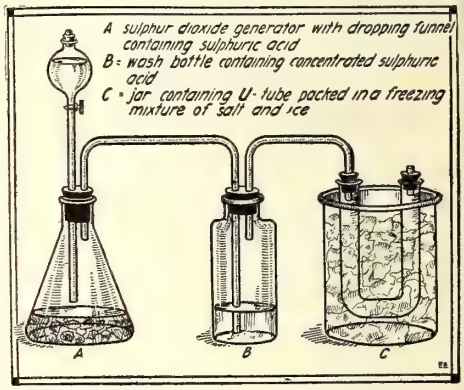
The actual liquefying of a gas is an experiment of great interest, and in the case of sulfur dioxid easy to carry out. The apparatus is set up as shown in the diagram. *A* is an Erlenmeyer flask carrying a dropping funnel and containing in the bottom a layer of sodium sulfite powder. The funnel contains a solution of sulfuric acid made by pouring the concentrated acid very slowly into an equal volume of water and allowing to cool. *B* is a gas-washing bottle containing concentrated sulfuric acid. *C* is a battery jar containing a U-tube packed in a freezing mixture of salt and ice.

After the set-up has been made allow the acid from the funnel to drop slowly upon the sulfite. A rapid evolution of sulfur dioxid gas will at once begin, and in passing thru the U-tube the gas will be condensed to a clear colorless liquid.

Freezing Action of the Gas—Pour a little of the liquid gas into 10 cc. of water in a small beaker. The mixture, upon stirring, will immediately crystallize to a solid mass.

Place a little water on a block of wood and upon it set a small beaker containing a little of the liquid gas. The rapid evaporation of the liquid will produce intense cold and freeze the beaker to the block.

Contributed by FLOYD L. DARROW.



Apparatus Set Up for Experiment in Liquefying a Gas.

TO GIVE PLASTER FIGURES APPEARANCE OF MARBLE.

Put one ounce of grated pure curd-soap into four pounds of clear water. Dissolve in a well-glazed earthen vessel. Then add one ounce of white bees-wax cut into thin slices. As soon as the whole is incorporated it is ready for use. Having well dried the plaster figure before the fire, suspend it by a piece of twine, and dip it once into the above varnish. Upon taking it out the moisture will appear to have been absorbed. In about two minutes stir the solution and give the figure another dip. Two dips are usually sufficient.

Allow the figure, carefully covered to protect it from all dust, to stand for a week, then with a soft muslin rag, or cotton wool, rub the figure gently, when a most brilliant gloss will be produced.

Contributed by
WALTER CHAS. MICHEL.

METHOD OF TESTING WOOLEN AND COTTON THREADS.

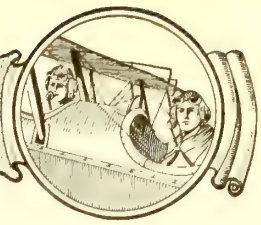
Take a few threads of the material to be tested and place in a test tube with enough nitric acid to cover them. Bring just to the boiling point over a flame and allow to cool. Pour a small quantity of ammonium hydroxide in the tube and note the change. If the liquid is not changed in color the material is cotton, but if the liquid assumes an amber color the material is woolen. In either case dense white fumes of ammonium nitrate will be evolved from the tube.

Wool contains much nitrogenious matter while cotton contains none. This accounts for the change. The above is a sure test. I have used it repeatedly.

Contributed by
JOHN ELIOT CHRYSTAL.



RADIO DEPARTMENT



Some Long Distance Radio Telephone Tests

By ROBERT F. GOWEN*

A SERIES of radio telephone tests and experiments by the writer performed during the months of December and January have produced some results which may be interesting to the readers of the ELECTRICAL EXPERIMENTER. The results are interesting, not only because of the records made, but of the peculiar conditions under which the experiments were performed.

The transmitting equipment consisted of a standard one kilowatt deForest Oscillion panel transmitter which is designed to work on large ship type aerials on wave-lengths between 500 and 1000 meters. This transmitter uses two ½ kilowatt power tubes for the generation of the high frequency currents. The plate current of these tubes is supplied from a motor-generator set which delivers a voltage of 1500. The tubes are of a new type made of Pyrex glass and the plates are of Tungsten so that external cooling is not required. The tuning is done by means of a variable sectional series condenser and by varying contact clips on a helix in the rear of the panel. The circuit employed was of the standard deForest single tuned type with capacity coupling between the grid and plate circuits.

A special new type of modulating circuit developed by Mr. C. V. Logwood was installed, the novelty being in that both the grid and plate circuits of both tubes are modulated by the voice currents at the same time. Continuous wave telegraphy is accomplished by making and breaking the grid leak circuit and a modulated wave was added by substituting with a switch, a buzzer and key in place of the microphone.

The transmitter was installed at the home of the writer in Ossining, N. Y., and connected to a comparatively small aerial, four wires 170 ft. in length with a spacing of 30 inches and with an average height of 55 feet. A 60-foot lead-in was tapped off the end nearest the station and brought to the transmitter through a hole in a window pane. This aerial has a capacitance of approximately .0007 mirco-farad and a fundamental wave-length of about 355 meters.

The ground system consisted of 84 square feet of copper sheet buried beneath the foundations of the operating room about 8 feet below the transmitting apparatus. There were also additional grounds to the water pipes, gas pipes, heating apparatus, etc., of the house.

Upon installation, no difficulty was experienced in making the transmitter operate successfully on 750 meters for tests and demonstrations with the deForest laboratories at High Bridge, but when later, experiments were made to cause the set to oscillate at 200 meters in order to work with the amateurs, it was found that the constants of the circuit were such as to make it decidedly unstable at this high frequency. After a good deal of experimentation and adjustment, however, fairly good results were obtained at a wave-length of 330 meters which, it will be noted, was below the fundamental of the aerial.



Photo Above Shows the Author, Mr. Robert F. Gowen, the Radio Engineer Who Talked 1,500 Miles on Less Than 300 Watts, or About One-Fifth of a Watt per Mile. He Is Shown Holding a New De Forest 1 K.W. Transmitting Bulb or "Oscillion." Photo Below Shows Amateur Radio Station of Mr. Trump at Topeka, Kansas. He Received the 1,500 Mile Radiophone Speech Sent Out by Mr. Gowen at Ossining, New York

Using this wave-length during December the writer attempted to communicate with amateurs in the vicinity of New York and found great difficulty in making the telegraph signals heard because of the extremely sharp tuning of the emitted wave and also because very few amateurs listen on wave-lengths over 250 meters.

On the 330 meter wave-length the transmitter would put but 2.4 amperes into the aerial with an imput of 300 watts, tho a maximum of 2.6 amperes could be obtained with an imput of approximately ½ kilowatt. Owing to the unstable conditions caused by the circuit constants the oscillator had very poor efficiency and about January 1 the writer was surprised to have a report that the signals were being heard at Utica about 175 miles away. Mr. Benas at Utica reported by radio telegraph and by letter that the music sent out at the Ossining station could be heard 100 feet away from his telephone receivers when using a two step amplifier, so that in two instances, his friends there had used it as a dance orchestra.

It was apparent from this report that, altho it was difficult to get amateurs to listen and answer the calls on 330 meters, when the signals were once tuned in, they were very loud. This incentive prompted the idea of working later at night when the amateur interference was less, and shortly thereafter Radio Station 8ER answered a call and reported that they were at St. Mary's, Ohio, more than 600 miles away.

Continued efforts in adjustment of the circuit and methods of calling them brought in reports from many stations thruout Ohio, and Indiana. Reports of successful reception of the speech were received also from Wakefield, Massachusetts, Gaffney, South Carolina, Napanee, Ontario, about this time, increasing the distance to about 750 miles. Subsequently a letter was received from the operator on a yacht 300 miles south of Jacksonville, Florida.

(*Cont. on page 1326*)



Photo from Underwood & Underwood

Robert K. Trump, 21, a Former Sailor Living in Topeka, Kansas, Overheard Phonograph Music and Conversation Between Robert F. Gowen, Engineer of the DeForest Radio Telephone and Telegraph Co. and R. H. G. Matthews of Chicago

Music 400 Miles by Radio

If you haven't your favorite jazz melody and if there isn't one within 400 or 500 miles, don't let that worry you. Just send a radio to the nearest wireless station, and have them put the desired record on the instrument, put your receiver in operation, and you have it. Everyone knows the wireless has proven a successful invention, but very few know all the uses it may be put to. The other day L. W. Elias, officer in charge of the Chicago U. S. Radio Station, was successful in sending a complete musical program to Fort Sheridan's convalescent soldiers. When he had finished, to his surprise the operator in Detroit complimented him on his progress and advised Mr. Elias that he had connected his instrument to a transmitter and that over 100 people had heard his music. He was also told that everyone in Camp Grant had heard the same program. The apparatus necessary to transmit music in this manner is a phonograph with records, a transmitter, and receiver combined with a power plant connected with batteries. The transmitter consists of one oscillating and one modulating tube. Any amateur receiving apparatus within a radius of 400 miles can intercept the sound waves as they are sent on undampt waves of 700 meters. The Chicago Government Radio Station ranks first in all experimental work and the last rating was given 99.2 per cent. The photo shows L. W. Elias and the machine.



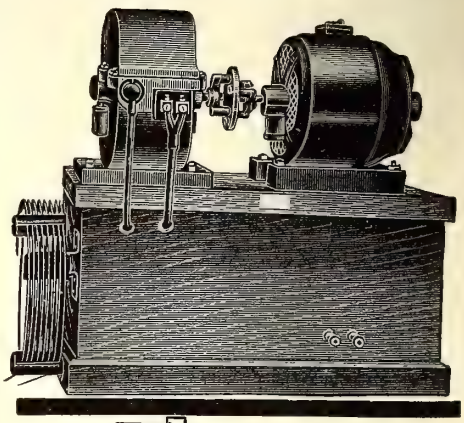
By Means of the Phonograph and Wireless Telephone Apparatus Here Shown, Dance Music Was Recently Transmitted 400 Miles by Radio to Some of Uncle Sam's Convalescent Soldiers. Photo (c) by U. & U.

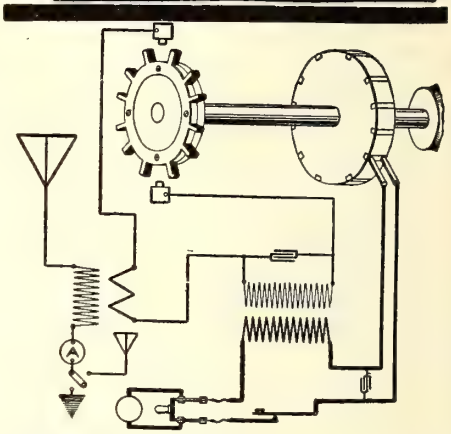
The wireless telephone is not so much of a novelty any more, altho of course, the apparatus is not to be had for a mere song. However, our radio experimenters, even the youngest, are rapidly becoming experts in the development and construction of simple apparatus, whereby it is possible to transmit articulately, the spoken word. In transmitting music or vocal records from a phonograph by means of the wireless telephone, there are several different ways in which the air waves set up in the phonograph sound chamber may be communicated or super-imposed upon, the wireless telephone transmitting apparatus, and eventually to the antenna from which this is liberated into space, in the form of electro-magnetic waves in the ether. In some cases, the microphone of the modulating circuit of the wireless telephone outfit is placed in proximity to, or secured tightly to, the phonograph sound-box proper. In other instances, one or more microphones of the modulating circuit have been placed in the amplifying sound chamber of the phonograph, and this has been found to give very good results.

A microphone placed inside the doors or grill of the phonograph has many good points about it. This is so for one reason that the sounds created by the diafram of the phonographic sound-box have not their full vibrating timbre and sonority when they first proceed along the tone chamber, but receive their full sonority only after they have entered the larger amplifying chamber.

"Direct Current" Transmitter

A new radio transmitter has been developt by L. M. Cockaday, of New York, which operates on a direct current source of power, the system being such that it eliminates the motor-generator now used in connection with spark set transmitters.





New Direct Current Wireless Transmitter Giving a Clear Note Equivalent to a 500-Cycle Synchronous Spark Set. Its Secret Lies in the Use of a Rotary Synchronous Spark Gap and Interrupter in Place of a Fixed or Stationary Spark Gap and Ordinary Interrupter.

In the primary circuit a rotary interrupter is used in series with the primary coil of a step-up transformer, in combination with a synchronous rotary spark-gap in the secondary circuit, as shown in the diagram.

The relative positions of these two wheels are so adjusted that as the interrupter closes the primary circuit, the condenser in the secondary circuit can discharge only at its maximum capacity; that is to say, the spark-gap comes into sparking position just as the interrupter opens the primary circuit, thereby obtaining its highest efficiency.

The interrupter successively opens and closes the power circuit a sufficient number of times to obtain a clear 500 cycle tone which is always steady.

Audions on Alternating Current Again!

As several readers have inquired about using audions on A.C., and how to get rid of the hum, etc., we referred these to Mr. Elliot A. White, author of the article "Operate Your Audion on A.C.," which appeared in the July issue. Here are some valuable pointers from Mr. White:

"In reply to your queries, I understand your first paragraph to mean that the queries concern the use of alternating current for the *filament only*.

"My experience has been that it is easier to use A.C. on the plate than on the filament, because in the former case the large condenser across the leads from the rectifier keeps the 60-cycle hum out of the circuit. It is more difficult to use the A.C. for the filament only, as it is sometimes hard to get rid of the hum. However, I have personally, as I said in the article, used the A.C. for *both* plate and filament, both separately and together, and got rid of all noise. A friend of mine has also had success with it on the filament alone—'as silent as a church,' he told me. I believe the Navy used toy transformers for filament-lighting at 'Great Lakes' during the war, and I have also heard of its use by the Navy and by the Federal Telegraph Company on the 'Coast,' so you see it can be done all right. I suspect the trouble in the cases you mention is probably due to the Experimenters themselves, as I suggested in the article, for I by no means claim that the device is 'fool-proof.'

"However, you might call their attention to several important points, all of which were treated in the paper: 1. The connection to the balancing resistance across the filament must be properly adjusted. 2. Connections from the tuned circuit to the detector must be made exactly as in the illustration ('ultraaudion' hook-up, the secondary being connected to grid and plate, not grid and filament). 3. The tuning adjustments of inductance and capacities must be properly made, this being delicate, as I said. 4. Any foreign sources of interference from A.C. must be eliminated.

"If your complaining readers are correct as to 1 and 2, then their trouble is with either 3 or 4. Concerning these, I would refer them again to the article, particularly to the second and third paragraphs from the end. It is, of course, also possible (I know of one such case) that the Experimenters are getting *cross-talk* from near-by power lines to antenna outside the house, or from house wiring to the set inside, either by capacity effect or by direct induction. I should think you would find it difficult to handle these problems without being on the ground."

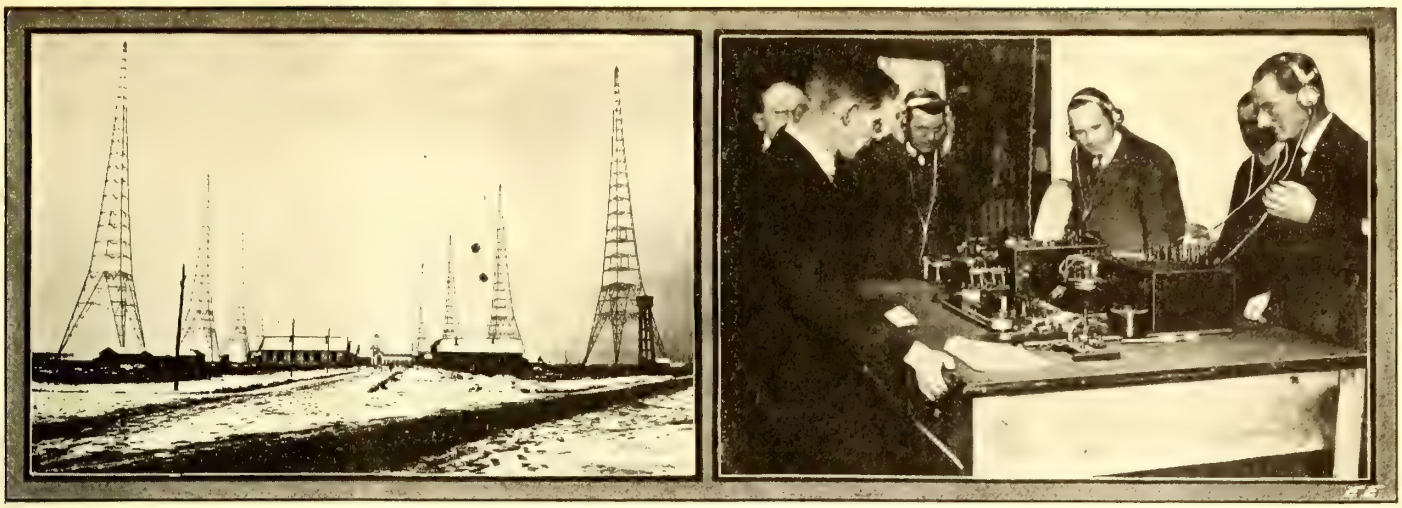


Photo at Left Shows the Famous New High-Powered Radio Station at Croix d'Hins, Which Is Located Just Outside of Bordeaux, France. It Has a Total Power Rating of Some 1,000 Odd Kilowatts. Photo at Right Shows Remarkable New Radio Receiver Which Automatically Rings a Bell Signal on Ship, When Another Vessel Is Sending Out an "S.O.S." Call for Help. This Will Avoid Delays in Answering Distress Calls at Sea.

Latest Radio News

THE accompanying photograph at the left shows the gigantic steel towers of the powerful Lafayette radio station of Croix d'Hins, located 15 miles outside of Bordeaux, France. This station, one of the most powerful if not the most powerful in the world, was started in 1918 by the U. S. Navy to enable radio communication to be carried on in a positive manner at all times with the American war vessels traversing the Atlantic Ocean and other waters.

This plant has since been turned over to the French government by special arrangement. There are eight giant masts, each rising 825 feet above "Mother Earth," which serve to support the antenna conductors.

When the armistice was signed the U. S. Navy Radio Department discontinued work on the stations, but the plant was completed by the Pittsburg-Des Moines Company for the French government.

This plant will have various types of radio transmitting equipment, including arc and spark sets with a total rating of some 1,000 odd kilowatts.

AUTOMATIC S.O.S. BELL SIGNAL FOR SHIPS.

The photograph presented herewith at the right illustrates a remarkable new radio invention which is said to pick up and translate "S.O.S." calls from ship stations and to cause a bell to start ringing in the station receiving the call. In other words, when a ship in distress sounds the S.O.S. call (the International radio signal of distress, to which ships of all nations pay strict attention under the present regulations, in order to try and speed toward the disabled ship and render succor, if possible), the radio signals, flashed out from the vessel in distress is picked up on the antenna of other ships within a radius of several hundred miles and if fitted with this apparatus the message of distress will give an audible signal on the bell at once, without taking a chance of whether it will be picked up by a radio operator "listening in." It has sometimes been the case that such signals have not been heard even by ships quite close to the vessel calling for assistance, owing to the fact that the operator may have been off duty at the time, or for some other reason.

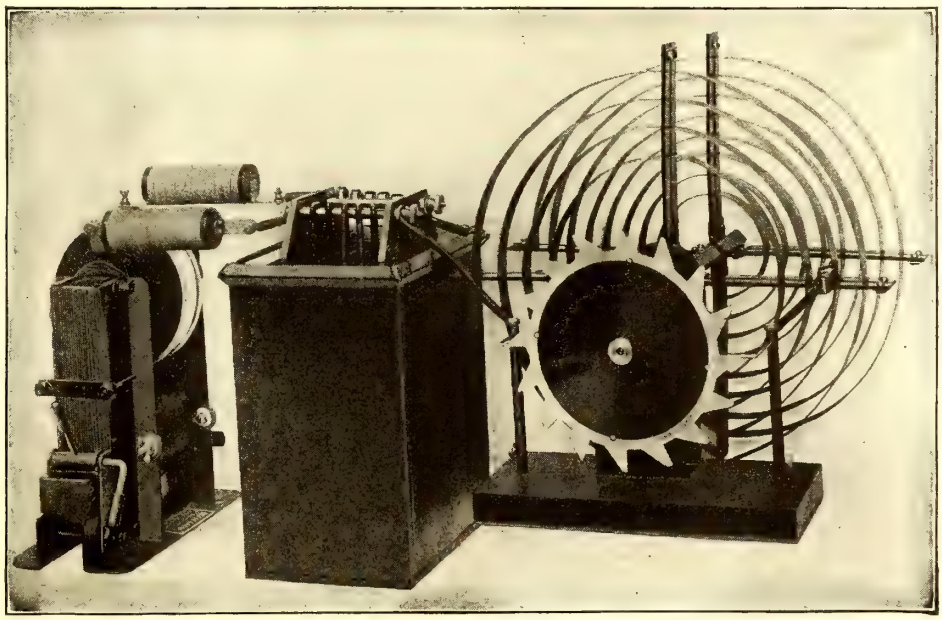
We have long advocated such an apparatus as this for receiving and interpreting "S.O.S." calls at sea, for many reasons. It is a simple matter now-a-days to rig up a positive working apparatus which, by means of sensitive relays and amplifiers, will serve to close a local circuit containing a sufficiently strong battery to actuate a call bell circuit.

The main purpose that the bell signal in this case serves is to call the attention of the radio operator in charge, and possibly the ship's commanding officer, to the fact that a distress signal is being received. When this has been done, the operator of course "listens in" in order to receive the further details of the distrest ship's location, which is given out by wireless both as to latitude and longitude.

New Amateur Wireless Transmitting Set

General amateur wireless telegraph stations are restricted to a transmission wavelength of 200 meters, and a Chicago concern has developed and placed on the market a wireless telegraph transmitting set designed to give the best results on this short wavelength. This set includes a transformer, condenser and oscillation transformer and a rotary spark gap, all of which are shown in the accompanying illustration.

The transformer is of the closed-core, air-cooled type with a double magnetic circuit. A feature of the construction is its magnetic shunt control, which protects the transformer from all undue current surges. The transformers are designed to be connected directly to a source of alternating current, no choke coils being necessary. Capacities of 1, ¾, ½ and ¼ k.v.a. (kilo-volt-amperes) are made, but the ¼ k.v.a. transformer does not have the magnetic shunt control. The center device in the illustration is the condenser. This is of the oil-immersed type. There are ten terminals arranged so that the capacity can be varied from .0018 to .009 microfarad in single steps of .0009 microfarad each. One k.v.a. = 1000 watts at 100 per cent power factor.



Complete Amateur Radio Transmitter Designed for 200 Meters Wave Length. Built in Sizes from ¼ to 1 K.V.A.

Selective Wireless Control

By EVERETT LEO DEETER

HUNT up all your old telegraph coils, your extra Audions (you who have fat pocketbooks), and prepare to settle down to business, for here's a new stunt to try, and you can become a great "professor," or a "wizard," by amazing people in your own home town by the act of controlling numerous distant apparatus, simply by pushing a button on your radio-sending outfit.

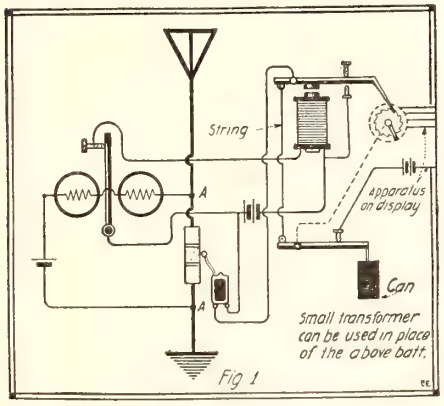


Diagram Showing Connection of Coherer and Decoherer With Polarized Relay, and Also Special Selective Relay Fitted With Dash-Pot.

By following the construction details given herewith a wireless control board which works very well can be easily constructed, and by its use the amateur can operate any certain apparatus connected to the board without first operating others, thus making it a true *selective control.*

Now if you are done with that message we'll go to work—yes, tell your neighbor to come over, too, for after he sees your's he'll want one, too. First we will see for ourselves how the thing works.

For simplicity we will consider the use of a coherer—the poor nut may be forced to use one in his actual model—and if he spent all his money for auto cable to try out the "underground trick"—but, anyhow, a coherer works quite well. But don't let anyone catch you when you file up a nickel and dime for filings. And don't break up the family thermometer for a tube, because it's too small inside, and if you were to get the "flu" your temperature might go a mile high and it would be impossible to get it down again—anyhow you could use it to hang your aerial on.

Here we go—get your electrical dictionary and turn to diagrams—make sure you know what sign represents a relay, coherer, battery, etc., as you hardly ever see this one, and then after six or seven hours of real study we can almost realize the following facts:

If you focus your luminaries on diagram No. 1 and was just to imagine that some poor jay wireless amateur was to send out a right smart wireless wave, which was by decrement and other complicated mathematics of the same metric wavelength as that of our elaborate de-cohering outfit, why then our clumsy antenna would probably make a successful attempt and "down the thing." Now if the wave gets thru the coherer to the ground it causes the filings to get close enough together to lessen their resistance, and then things begin to happen. When the platinum (if you're rich) points close, of course the juice goes thru and makes the magnet pull down the arm which operates the sprocket wheel, in turn operating the commutator or the switch controlling the display apparatus. If you think you now understand all you've been over, proceed to diagram No. 4 also. If you don't proceed anyway—it'll do your think tank good. When the arm is down it makes contact to J, and this gives a little stingy juice to the bell, what there is of it, which hits the glass tube of the coherer and knocks the filings apart, ready for another "jazz." But this is not all the clumsy brass arm did—the string seen between C and M pulls the arm B, and out at the end where the plunger R is connected at O there is quite an emotion as the arm drops thru a long arc, which may be varied by sliding the arm at N.

The plunger R is connected to a small air-tight vessel partly filled with water, and this floats upon the water enclosed in the larger tin can P (see Fig. 5-A). Now when the arm comes down the "ship sinks," and the small vessel goes under and if left alone it always takes a little time for it to come to the top, being partly filled with water. Of course, if the arm is constantly being pulled down the float is also pulled under. Now as long as the float is not entirely up the main circuit for the display apparatus is open and therefore they do not operate. But when the arm is up then the circuit and the apparatus circuits operate on the point the switch is left on.

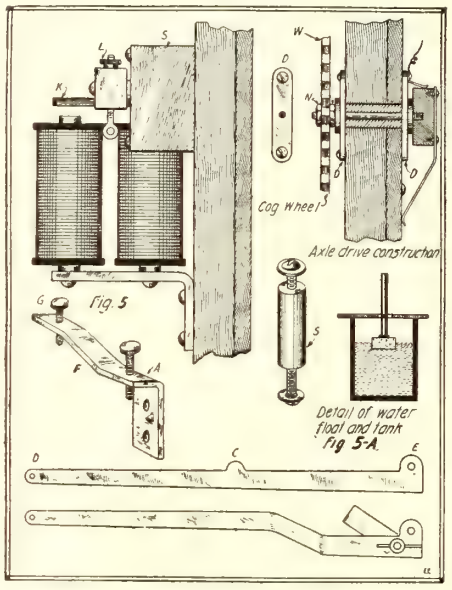
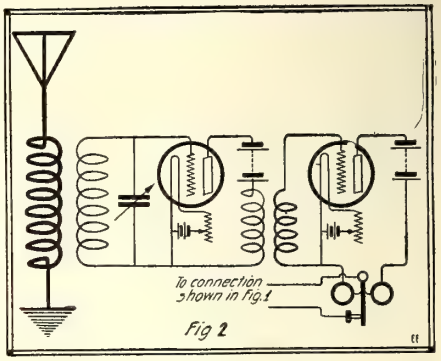


Illustration of Details to Be Followed in Constructing the Selective Radio Control Relay Here Described.



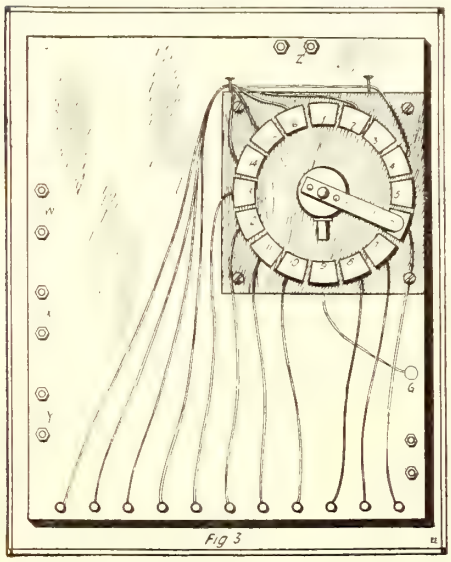
Amplifying Circuit Provided With Two Audions Connected to Sensitive Polarized Relay, Which in Turn Actuates the Special Selective Relay Here Described.

Now for the conclusive diagram, No. 3. This shows the back of the control board, and mainly the circular switch. Now supposing we had No. 1 of the switch connected to an electric train or street car, No. 3 to a little windmill, No. 4 to an electric light, No. 5 to an electric cannon, etc. We want to cause No. 1, the train, to operate. We push our transmitting button four times and toot-toot she goes. Now we are asked to shoot our cannon, No. 5, and all we have to do is to push the button four more times and bang! For No. 10 we would now push five times, etc.

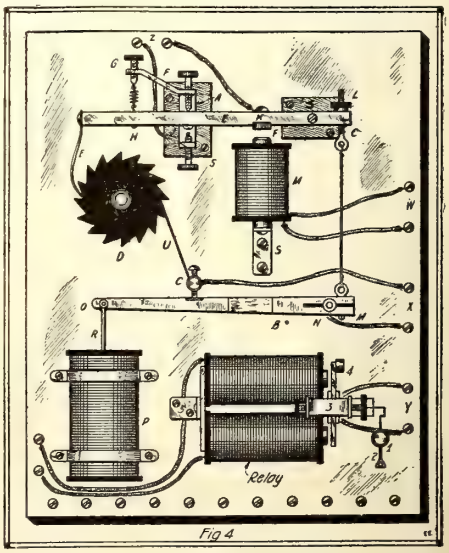
Two and ten on the switch are stop blanks, while 16 can be a place where they all operate, making the segment of eleven narrow strips, not touching one another and connected to all other segments of the switch.

Retire for the night now, for you'll need all kinds of strength and ability, as well as

(*Continued on page* 1334)



Rear View of Selective Relay Switch-board



Front View of Selective Relay Switch-board.

War Versus Pre-War Apparatus

By "SPARKS"
C. E. Radio, U. S. N.

THERE seems to be a marked tendency among radio experimenters of the present to lay their hands on the new developments in radio apparatus, particularly as applied to varis receiving instruments which have been ›ught out during the World War. From at I can gather from various publicans and l tters from the Amateurs, a :at demand has arisen for the most modn of apparatus. This demand reflects a rit of progressiveness in the Amateur, is true, but there is a limit to all things, l the adoption of all the new and fancy lls which are being described from time time will lead to a limit where the dissing facts are all too plain—that the le old stuff that we used to "gather in" signals with, was far superior to sevy-five per cent of the war apparatus.

I have had considerable experience with majority of apparatus which was ›ught out during the period of hostilities, ving used practically all the latest deopments under typical operating condins, and for the benefit of those whose igings for "Navy VT's," "loop antennæ," ., are getting the better of common sense, me outline a few of the results I have tained with new and marvelously effint (?) *war radio apparatus.*

AERIALS.

Let us start at the top, this being the ·ial, of course. Before 1917 we Amateurs ed the good old inverted "L" or "T" ›e, flat-top antennæ of the four- or sixre size, elevated from thirty to fifty feet, d we got GOOD results. A certain ›rtland (Ore.) Amateur, regularly comnicated with a station in Los Angeles d with a Reno (Nev.) station also. iicago Amateurs were heard up to one ›usand miles, and the east coast stations ·re easily heard in the Middle West and ›uth. *All this with one K.W. or less and two hundred meters!* In my tests, I ed an antenna of the typical flat-top "T" ›e, three hundred feet long and eighty et high, four wires, and with a two-kilo·itt, five hundred-cycle set, was able to ver twenty-two hundred (2,200) miles night on six hundred meters, at sea. ibstituting a loop antenna of four hun·ed ninety (490) meters natural period, obtained a radiation of seventeen amres, but my signals were *only* heard at a stance of two hundred seventy miles. ie vessel with which I carried out these sts used an Amateur tubular audion bulb, ith no amplification; with his Navy VT could hear me very faintly at two hun·ed forty miles. I made several similar sts, elevating the loop, etc., but on no ·casion was I able to do better. On the her hand, the loop antenna for receiving not at all bad. I picked up signals from ands End, England (GLD), at seventeen ındred miles, with one tubular bulb eleven hundred miles on a Navy VT), ıd merely placing the loop on the bridge. he chief objection to the loop antenna for ·ception in Amateur Stations is its marked irective effects. In some cases this would e an advantage, in cutting out interferıces, or receiving signals from but one eneral direction and its opposite, but very ew Amateurs will care to limit their receivıg possibilities to but one or two points f the compass. The loop invites experiıentation, but don't be so all-fired het up bout adopting it without trial in your prosed station. Stick to the flat-top, inverted L" or "T" types—they aren't going to be ack numbers at all.

AS TO APPARATUS.

Now as to the apparatus itself. A new form of layer wound inductance has made its début, in the form of pancake loading coils, and is also being embodied in several forms of loose-couplers. The coils have given good results, when used as loading inductances and coupler coils, and have the advantage of taking up much less space than the old type of cylindrical tube windings. It is also easily possible to incorporate these coils into panels, which are very popular, and make a neat job of it. The layer wound coil—*IF* wound with an offset winding (honeycomb coils) is a distinct step forward, and full credit should be given it. Experimenters, in buying, however, should demand this offset winding which makes the coils what they are—extremely neat, compact and efficient little units.

A word now about *capacity coupled* tuners. These were tried on various vessels, and in shore stations, but were found to be impractical for spark reception, due to their extreme sharpness of tuning, which made them poor "stand-bys." In certain cases the tone of the incoming signal was also distorted by them. For these reasons their adoption as spark receivers never became very popular, but in long wave undampt wave receivers they seem well adapted, for their sharpness is an advantage there, and it also seems that the more variables that can be crowded into an *arc set* the better it works. Capacity tuners, however, will never become popular in Amateur Stations.

In April

"Radio Amateur News"

Wireless in Modern Aircraft.
By A. J. Hall

The Priess Loop Set, Part IV.
By W. J. Henry

New Facts About the Nauen Station.
By Dr. A. Gradenwitz

Aladdin's Lamp.
By C. S. Wolfe

A Resonant Transmitter.
By W. S. Lemmon, E.E.

Easily Constructed Radio Mast.
By E. L. Deeter

The heart of the receiving station draws our attention next. I have heard more Amateurs whine, sigh and express extravagant promises of reimbursement to anyone who would get them a Navy VT than desires for all the other new apparatus that has appeared. The prevailing opinion seems to be that for sensitiveness they are marvelous—unequaled! Where this idea ever found root is puzzling, in the face of the fact that the majority of tubes developed for war purposes were, and are, miserably poor bulbs in comparison with the tubular bulbs we had formerly used. This applies to their use as detectors—they make good amplifier bulbs when used with 150 to 300 volts, plate current—but where will the modern Amateur, even, get that voltage, D.C.? Batteries are out of the question, as is a motor-generator. We are mostly concerned with detectors, however. The war tubes were designed to combine ruggedness, reliable operation in inexperienced hands, with a fair degree of sensibility. In the last named requirement they did not exceed the specifications in the least. It is true that such bulbs require no variation of plate voltage and will operate over a moderate range of filament current fairly well, but the Navy VT's all require a plate voltage of from seventy to one hundred and fifty volts. I have used probably two hundred different Navy tubes at times, and have yet to find one which equals the little old "tubulars" for sensitiveness. A new bulb has recently come into prominence, which I have had no opportunity of trying out as yet, but which seems to be "the goods," as it is becoming popular with a great number of Amateurs. It requires but a low plate voltage not required to be varied and seems to promise much. Until I have had the opportunity of trying it out, however, I shall stick to the old "tubulars" for all around satisfactory work. I have tried the new bulbs as amplifiers, by doubling the plate voltage—sometimes even tripling it—and have found them to be excellent for that purpose, better in fact than the tubular bulbs, which are poor amplifier tubes.

All this crabbing would naturally lead up to the question of what I would consider a good Amateur Set for *receiving*. My idea is, after testing, planning, designing and trying all manner of sets for the past two years, to have a *short wave set*, with a range of one hundred and fifty to six hundred and fifty meters, to include both Amateur and Commercial marine waves, and get good efficiency on each. The circuits should by all means be *regenerative*, using one of the old tubular bulbs. If it is desired to amplify these sets, I would suggest a two-step amplifier using the new Amateur tubes. The transformers should perhaps be purchased until more data is published regarding their construction than is now available. The telephones should preferably be of the mica diafram type, or if the price is prohibitive a good two or three thousand ohm, double headset.

Besides the above set, all well equipt Amateur Stations should have a long wave set, capable of receiving the undampt wave stations. While personally I do not care for the sustained wave system, it seems to be the coming thing, so we must all keep up with progress. An efficient *arc receiver* would comprise a long wave coupler, capable of receiving waves up to ten thousand meters at least, two or three variables, mica diafram phones, and a good oscillating bulb with a modern oscillating circuit. A very good undampt wave set can be made from the unit inductances now on the market, layer wound as before described. Several reliable concerns are putting out such inductances in neat individual cabinets of varying wavelengths, so that the inductances can be placed next to each other and used as primary and secondary coils, varying the coupling by changing the distance between the coils. If a receiver such as this is properly made, very good results will be had with an antenna of one single wire, several hundred feet long, which need not be more than *thirty feet high.*

A good ground connection is vitally important in every case. Solder your ground lead to a water pipe, and make it of heavy cable. In addition, ground to everything within reach—steam pipes, etc. It all helps.

If care is exercised in the construction and installation of equipment, and instru-

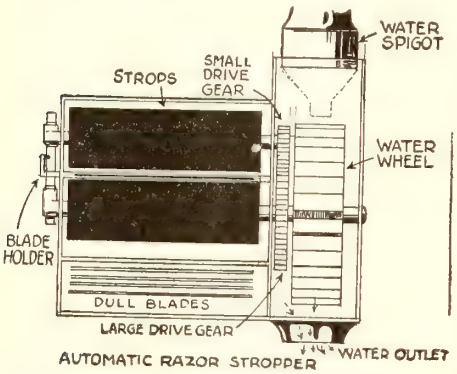
(*Continued on page* 1330)

What To Invent

By JAY G. HOBSON

THERE are several kinds of razor blade sharpeners on the market. Few of them have met with considerable success because they really sharpened as claimed. However, all of the various designs require the user to turn a small crank to operate the stropping element. It consumes enough time preparing one's face for the trying ordeal without having to stand around cranking the sharpener until the razor blade is ready to shave.

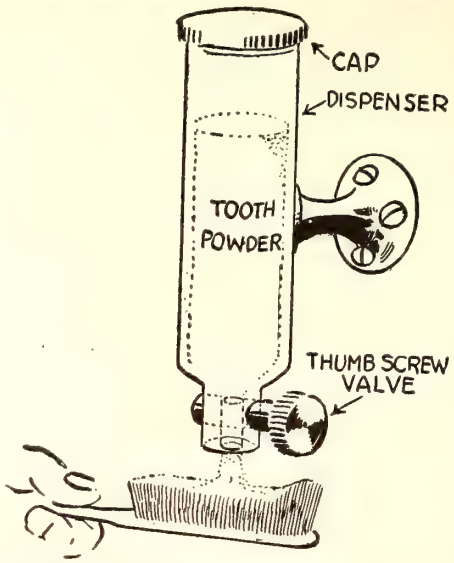
Why not construct an automatic razor blade stropper to be fastened on the water faucet as illustrated, one that will run when the water is turned on so that your razor blade will be nice and sharp by the time you are ready to shave. An efficient sharpener of this kind could easily be made as shown, with a light metal case, two round stroppers connected by small gears and operated by a little water wheel enclosed in part of the sharpener case. The blade can be arranged to strop on both of the revolving strops thru an eccentric connection with the blade holder. When you wish to shave fasten the sharpener to the water faucet, place the razor blade in the holder, turn on the water and by the time you are ready the blade will be in fine cutting condition to make shaving a pleasure. Every user of the modern safety razor would appreciate an improvement of this kind and gladly discard all other types for this design.



AUTOMATIC RAZOR STROPPER

And Speaking of Shaving,—Why Cannot Someone Give Us a Low-Priced Automatic, Safety-Razor Blade Sharpener Which Could Be Connected to the Kitchen Spigot. A Small Cheap Water Motor, Specially Designed for the Purpose, Would Rotate the Strop Wheels in Apple-Pie Order. Mr. Hobson Guarantees to Sell One of These to Every User of a Safety Razor in the United States and Foreign Countries,—the Bolshevik Regions Not Included!

During the influenza epidemic eating in public restaurants and cafés was rather a risky thing to do because public eating places are not careful in cleaning dishes and cups before using them again. In drinking hot drinks from the common cup people place the rim of the cup between their lips and draw the liquid into their mouths. This is a very easy way to catch the "flu" or some other contagious disease, of which there are many. To avoid this possible exposure a small celluloid (or even paper) lip and mouth protector could be made like that shown. It should be made to fit the rim of the cup snugly so that the contents of same could not run under and out upon the user's clothes. A little sanitary invention of this kind would undoubtedly meet with approval by thousands of folks who are particular about their health and desirous of avoiding any exposure to others' carelessness.



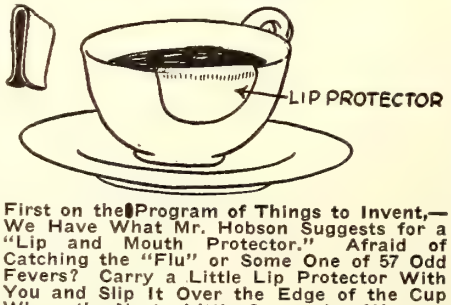
TOOTH POWDER DISPENSER

Instead of Losing About Six Tooth-Paste Tube Caps Every Month and Doing an Interminable Amount of Cussing About the Paste That Went to Waste or Soiled Your Clothes,—Why Not Invent a Neat and Cheap Tooth Powder Dispenser Like This? Zip—Turn the Thumb Valve and—Presto! You Get Just the Proper Quota of Tooth Powder on Your Tooth-Brush.

The average person becomes so adjusted to the present tooth brush and tube of paste or can of powder now in use that no thought of an improvement in this line seems to appear. However, on second consideration we can easily see that there is great inconvenience and waste in the seemingly efficient dentifrices of today. For example, remember the time you made a hurried trip to some distant point via Pullman, throwing necessities into your traveling bag as you ran out of the door. Recall how you had to stand on your head in the berth trying to find your tooth paste before retiring, and how very evasive it was. Finally you gave up hopes of finding it and went disgustedly to bed? On other occasions, at home when you were late for work and forgot to put the cover back on the tube of paste which was hard and useless when you returned home that evening? These experiences are a common kind to most of us. To overcome these difficulties and add to the pleasures of living I thought of what should prove to be a very welcome departure in every bathroom, every Pullman car, every public wash room and every place where dentifrices are used. As shown in the illustration my conception is in the form of a neat metal or porcelain bracket to which is secured a round tube or can embracing a removable top to allow for refilling the same, and the bottom end would be arranged a sn measuring cup or valve operated by thumb and forefinger of one hand wl the other hand held the toothbrush un the spigot to receive an exact amount powder or paste sufficient for one g cleaning of the teeth.

As will be seen a little device of t kind installed in each bathroom, or P man car, would not only economize in use of the preparation, but it would alw be handy and ready for use of each mem of the family. Having it ever before th with this kind of a slogan printed there "USE ME TWO TIMES A DAY A I'LL KEEP THE DENTIST AWA would remind them of the importance keeping their teeth clean. An attract device of this description would sell most every home and probably be u extensively by some large dentifrice ma facturer.

LIP MOUTH GUARD



First on the Program of Things to Invent,—We Have What Mr. Hobson Suggests for a "Lip and Mouth Protector." Afraid of Catching the "Flu" or Some One of 57 Odd Fevers? Carry a Little Lip Protector With You and Slip It Over the Edge of the Cup Where the Nasty Little Germs Are Wont to Sleep Until You Drink, and Then, Good Night! Yes, We SHOULD Have Them!

Copyright—1920—by Jay G. Hobson.

Watching a fat gentleman bending o three times trying to reach his shoes tie a broken or loosened string, while son what amusing, suggested an idea for needed improvement in shoe laces. T present kind in universal use is really u satisfactory for many reasons.

To begin with it is forever coming u tied, wears out quickly, breaks just wh we don't want it to, and causes flat f because there is practically no give in t string when we walk, run or jump. Ra ing up on the toes in walking causes t strings to force the arch of the foot dow ward instead of allowing it to follow t motion forward as is natural when walki barefoot.



METAL SHOE LACE

Ever Try to Lace Your Shoes In a Hurr This Includes Ladies and Gentlemen, as W as the Little Folks. Here's the Author Suggestion: Do Away With the Everlastir String Laces Which Are Forever Losir Their Tips, and, Instead (When They A Manufactured), Get a Dozen or So of The Spring Lacers,—and Besides, Your Foot Ca Really Have Free Movement In This Expar sible Shoe Top! Not Bad, Eh?

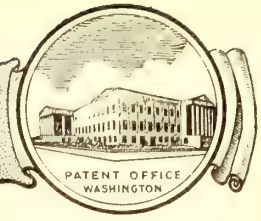
So an improvement in shoe laces is i order. One that seems practical to m could be made of a small, flat, adjustabl bar or strip of metal with a stout co spring concealed inside. This little ba is cut in the middle to allow for expansio and adjustment to shoe. At either en of this flat, hollow bar would be a blun hook or catch "U" shaped and only larg enough to fit into the eyes of both sides o the shoe as illustrated.

The small coil spring pulling on bot ends of the flat bar would force the sho sides together and hold them as securel as a shoe string, but, in addition, this im provement would allow for a free move ment of the foot when walking, thereb preventing much of the present day foo troubles. A practical article of this kin should sell rapidly and be adopted b the large shoe manufacturers.

(This is the third article by Mr. Hobson The next one will appear in the Ma issue.—EDITOR.)



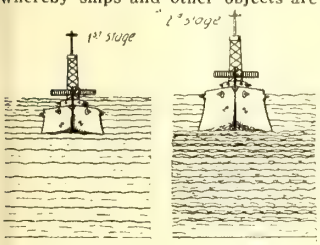
LATEST PATENTS



Theatrical Appliances.

(No 1,324,680, issued to Langdon McCormick.)

This patent relates to a method of producing illusionary effects whereby ships and other objects are

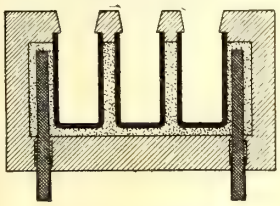


made to rise and increase or decrease in size and move forward at the same time, to give the effect of the ship or other feature moving toward the front of the stage. A large number of moving platforms cause the illusion effect to be more pronounced, at the same time a wider sea area toward the rear of the ship is effected by gradually elevating the waves, causing the illusion effects to take on the aspects found in nature. In actuality, the ship moves forward for about 10 ft.

Electric Furnaces.

(No. 1,324,156, issued to Felice Jacoviello.)

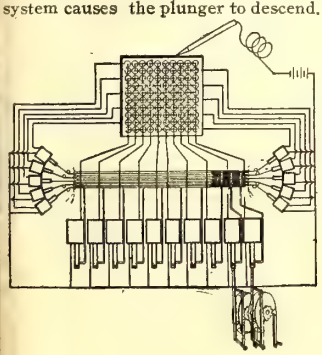
This latest invention is an electrical furnace wherein a series of grafite crucibles are imbedded in powdered coal or grafite, thus connecting them in series. The pipe or conduit communicates with the upper portion of every crucible. Molten metal can be poured from all of the crucibles at the same time. Great heat is produced in this furnace because of the relatively high and low conductivity of the alternate layers forming the grafite crucibles and the intermediate packing.



Electric Keyboard.

(No. 1,311,384, issued to William F. Drew.)

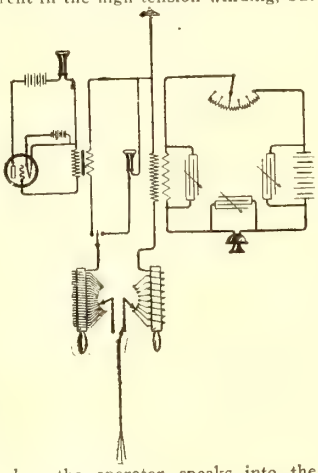
This does not relate to calculating machines only, but includes typewriters and the like. We shall describe the adding machine herewith. It consists essentially of ten solenoids which operate the adding machine levers. In addition, there are ten more solenoids connected to a tier of the same number of plates of slidable nature in the series. When, therefore, electrical contact is made by means of the stylus, two solenoids are immediately actuated. One draws the slidable plate of that series so that the plunger can only descend a definite distance, and the other system causes the plunger to descend.



Wireless Transmitter.

(No. 1,315,197, Issued to Earl C. Hanson.)

This patent is the latest for transmission of energy by means of electrostatic and electro-magnetic induction. It employs audio frequency radiation in contrast to the common radio frequency methods now used. It is extremely simple and can be controlled to such an extent that detection beyond the distance predetermined is impossible (according to the inventor). It consists of two reactances into which are placed iron cores; for sending a telephone coil is used, shunted by a variable condenser. The transmitter and battery are likewise shunted by variable condensers. Thus, the direct current, practically constant, induces no current in the high tension winding, but

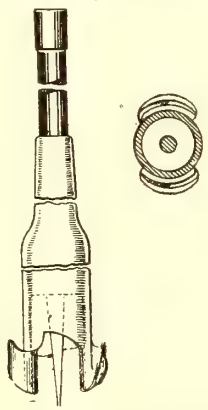


when the operator speaks into the transmitter he varies the resistance, and a considerable potential is impressed between the antenna and the ground. For receiving, a similar iron core reactance is used and is either connected directly thru a receiver or thru a vacuum tube for the purpose of amplification.

Battery Connector Remover.

(No. 1,316,485, issued to Fremont S. Kay.)

This patent is very clever and novel. Heretofore, in order to remove connectors from storage batteries and the like, it has been neces-

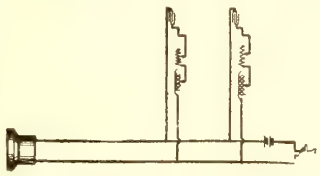


sary to destroy the posts by drilling them out. This device, however, leaves the center post intact, removing only the connector without injury to the original posts. It should meet with favor with all storage battery repair men. The tool when operated cuts two concentric zones. The inner cutter clears the solder from the periferal surface of the posts of the battery, while the outer cutter clears the solder from the wall of the eye on the connecting strip. In this way the post and connecting strip are completely saved.

Eliminating Undesired Vibrations.

(No. 1,319,521, issued to R. A. Fessenden and F. H. Leslie.)

This patent is for sound producing bodies, such as diaframs, and its object is to suppress any desired ex-

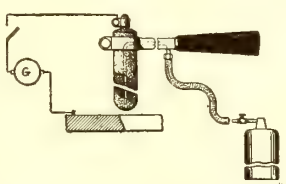


tent of vibration frequencies which are not wanted. The presence of natural vibrations are very objectionable even in telephony, as a result of which the higher tones of the voice are unduly strengthened tho still permitting speech. If used in submarine signaling they would not transmit articulate speech, so by properly proportioning self-induction, resistance and capacity in the circuit, the amount of sound absorbed can be regulated and the diafram then made to vibrate substantially correctly over an entire range of frequencies, whereby clear, sharp, articulate speech can be heard for distances of five miles, via the absorption system, whereas, prior to this only indistinct sounds were heard.

Metal Cutting.

(No. 1,324,337, issued to R. E. Chapman and J. W. Kirk.)

A very clever patent was recently granted to the above mentioned individuals on apparatus for cutting metals. It is of the simple arc-forming type in which a carbon connected to a generator creates an arc at its point of contact with the metal to be cut. The center of this carbon, however, has a hollow bore

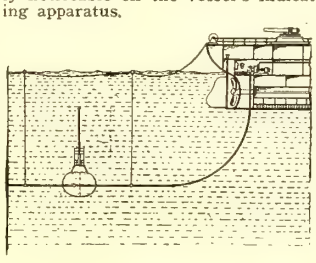


running thru it, to which is connected an oxygen supply tank; thus when the arc is started and the metal commences to fuse, advantage is taken of the better cutting qualities under the oxygen stream. This arc, according to its inventor, will operate as efficiently under water as above.

Submarine Boat Detector.

(No. 1,321,998, Issued to Giovanni Emanuele Elia.)

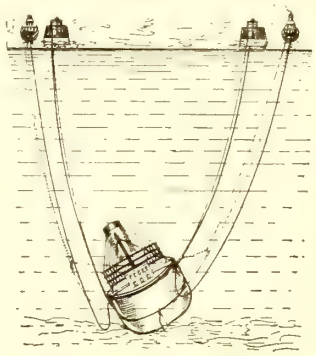
It consists of a long rubber hose about one-half inch in diameter suspended from a series of small buoys at a predetermined depth. This rubber hose may be quite long and as it is comparatively light, does not cause any great resistance upon the progress of the ship. Should the submarine now run into the hose and cut it, the sudden outflow of water which has been pumped into it under pressure, would be instantly noticeable on the vessel's indicating apparatus.



Ship Salvaging.

(No. 1,324,336, issued to J. T. Breneman.)

This is another of those patents which are planned to salvage sunken wealths and treasures. The patent, however, has the drawback in that the exact position of the ship must be known before further action can take place. Essentially, it consists of a method of dragging a cable over the bed of the river until it comes under the stern of the vessel. This cable is then replaced by a heavy chain. Immediately another chain is thrown across the top of the vessel so that it will lie perhaps 100 feet forward of the position of the first chain obtained. This second chain is connected with the first chain by a block which allows itself to slide downward only. When, therefore, the second chain is tightened, it forms a complete harness around



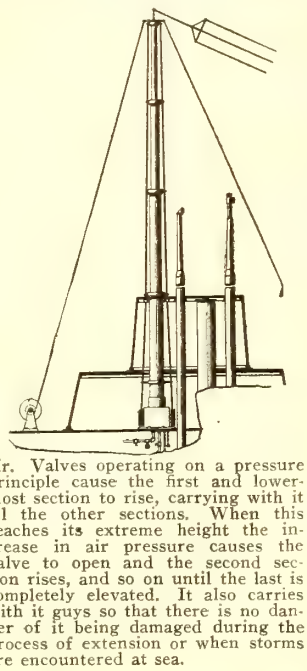
the vessel, gripping it firmly. As many of these chains are lowered as required in each case; the second chain only does the lifting, the first chain going under the bow and acting as the gripper.

A float actuated by hydraulic elevators then raises the vessel. As will be seen, the vessel for the successful operation should be in an upright position or nearly so.

Telescopic Tower.

(No. 1,325,053, issued to F. C. Steidle.)

This invention is the latest in telescopic towers for submarines and other uses. It is absolutely watertight and air-tight and its telescopic means is accomplisht by comprest



air. Valves operating on a pressure principle cause the first and lowermost section to rise, carrying with it all the other sections. When this reaches its extreme height the increase in air pressure causes the valve to open and the second section rises, and so on until the last is completely elevated. It also carries with it guys so that there is no danger of it being damaged during the process of extension or when storms are encountered at sea.



WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of th apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photo preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "Wi the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER— PAUL WALTER

I SUBMIT herewith, photos of my Electrical and Chemical Laboratory. I do my own photo work and produce many odd effects with my home made apparatus and am equipt to enlarge, reduce and copy anything from an atom to a battleship. I manufacture a glue which will mend anything but a broken heart.

I have a motor-driven chuck upon which I turn up many things to be used in the making of coils, apparatus, instruments, etc. It will drill holes in any metal or wood and can be used to polish brass parts. This little tool is really necessary to any laboratory. A good asset for a well conducted shop, is to have everything arranged in some systematic order, so that when a fellow is working or has an idea, he will not be discouraged or tempted to be careless because the tool he wants is not handy, or the piece of material he needs is way down under some transformer iron. I have everything labeled and in plain view. Each screw and washer has its special place in my shop and I don't have to stop my work to look for an article. The result is that I get something done, because things are where they suggest their use.—Paul Walter, 2725 Main St., Ocean Park, Cal.

HONORABLE MENTION, JOHN G. SPOTTON $2.00 PRIZE PAID EACH "HONORABLE MENTION"

I WISH to show in this article what can be accomplisht in a limited working space. I only have a small corner in a room. The apparatus that are permanently mounted, are either on the table, the wall, or the switch-board. On the latter, I have a lamp, battery-fan, ignition coil, telegraph apparatus, "shocker" and a motor. These are controlled by a selective switch. The "juice" is obtained, at present, from dry cells. These are controlled by rheostats and by a switch, so that any number may be used.

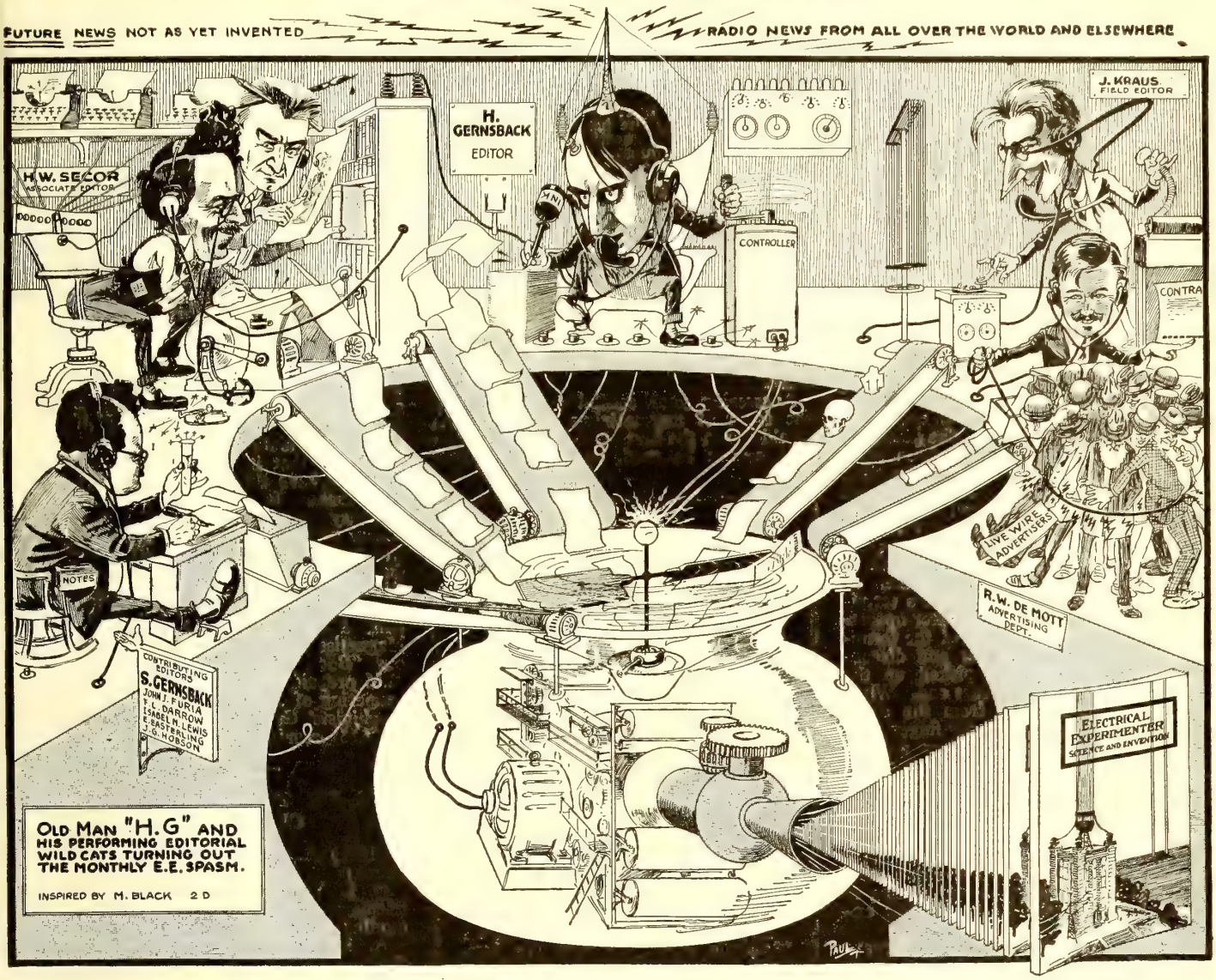
A good feature, is the combination telephone-telegraph line. For telegraphy, I now use a key (mounted on the table) Radiotone, condenser, and Pony receiver, while at the other end, a friend has a regulation Morse telegraph outfit. For phoning, I use a microphone, designed from one shown in the December, 1916, EXPERIMENTER—a phone and bell. On a shelf is an arc light run by 110 volt A.C. current with a water resistance and fuses. I am now working on a detachable part, which can be fitted over the carbons, converting it into a furnace when necessary. An eight point needle drop annunciator shown on the wall in the centre is very useful for connection with burglar and door mat alarms, thermostats, etc.

My workshop is equipt with all the necessary wood and metal-working tools. I also have a foot-power lathe which is not shown. The chemicals of my Electro-Chemical department are kept on a shelf in my desk. I don't need a very big outfit as about all I do in this line, is to experiment with wet cells, accumulators, electro-plating, photography and occasionally I do some analysis. The upper shelf holds my library of about 30 technical books. What I value the most, tho, are my back numbers of the ELECTRICAL EXPERIMENTER, from November, 1913, to date. This indeed is a library in itself, and has been my "guiding star" since I first got to be an "Electrical Bug."—John G. Spotton, Harriston, Ontario, Canada.



Science With A Bang

By EVERSON WESTERLING



Formula: A Ton of Brains, 20 Barrels of Ink, 2 Carloads of Paper, Hundreds of Telegrams (Radio and Cablegrams), 10,000 Letters, Photographs and Manuscripts By the Barrel, Seasoned With a Dash of Electrical and Chemical Experiments, a Wild Night Ride or Two, Via Pullman, An Airplane Trip, Etcetra, Served With a Layer of Meringue Glace (Varnished Covers) and There You Have It—Your "Electrical Experimenter."

"I JUST can't get over wondering how that New York bunch keeps on turning out this sheet month after month," Bender queried while loafing—beg pardon—leafing over the latest issue of the EXPERIMENTER.

"And," he continued, "it beats old Dutch, how Gernsback and his editorial wild cats manage to make each issue better than the one ahead of it. Where do you think that bunch gets all those ideas from anyway?"

Jazz grew contemplative as he looked wistfully over the broad expanse of the Pacific as it lapt its way toward 'Frisco Bay. He pulled a few times at his cigar before he replied with a sigh:

"Tell you the truth, gents, I'd rather live in my quiet two by four in Oakland than publish that nerve-racking, man-eating shark that goes by the name of ELECTRICAL EXPERIMENTER, better known as *Sperry* in Australia. And if Gernsback had the slightest sense of humor he'd call it ELECTRICAL *Exterminator*, because it sure will exterminate him sooner or later. No man can live and remain a human fountain of ideas day in and day out like that bird, and not dry up in the end.

"But you boys want to know how it's did every month—well, here goes, anyway:

"Last month when I went East I made it my business to call upon the E. E. outfit, and you may believe me or not, but I'm still dazed from what I saw, s'help me Caesar.

"Some fine Monday A. M. I trot down to Fulton St.—which is the dead line of the town—and pull up short at "Information," where I throw anchor.

"'Want to see the Editor. Name's Jazz Stokes from Oakland, Cal., I mentions to the cutie behind the switchboard. A couple hours later when she finally finds time to give me the once over, she smiles expensively at me and asks what in blazes I want. I repeat the info.

"'Oh, yes,' she chirps languishly, manicuring her nose with a powder-puff all the while, 'I remember you now, you are the Stoker from Coakland, Oklahoma. Excuse me for letting you wait a bit longer. Now what's your name?'

"I repeat it a few times over.

"'Age?' she asks next.

"Uncertain," I murmur.

"'Was your mother married?'

"Not yet, she's a widow!"

"'Have you ever been in jail?'

"Sure thing, that's my profession."

"'How come?'

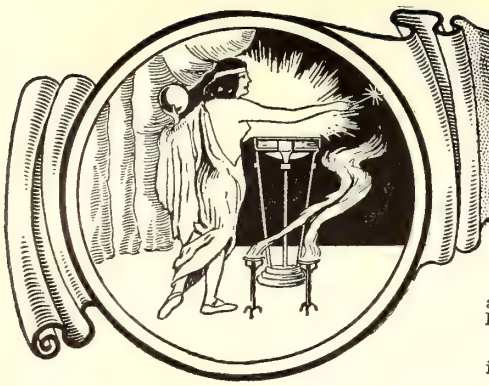
"Well, you see, I am Warden of the jail of Berkeleigh, Cal.!"

"'That's fine. Now then on what business would you like to see the Sultan?'

"Just a friendly visit."

"Just then the house bell clanged out the noon hour, and as I had no appointment with the All-Highest, I saw it would be useless to get into his Wigwam and next to his skin. So I invited the 'Info-Switchboarder' out for lunch, as a ruse. An invitation for lunch *always* works in New York. So while she got her hat and put on her outdoor complexion, I slipt by the gate, vaulted a couple of brass railings and made a home run for the sanctum labeled 'Editor.' I pussyfooted in cautiously—which, however, wasn't at all necessary. There were three or four people in his office and no one paid the slightest attention to me, so I sat down. The illustrious 'Idea-Incubator' was very, very busy with a couple of artists, his secretary, the phone, the radiophone and his managers. During the half hour I was in that editorial bug-house, I

(*Continued on page* 1292)



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

LAMP BULB A LEYDEN JAR.

(1039) H. Edwards, Deseronto, Ont., writes:

A. 1. While experimenting with Geissler tubes, made from burnt-out lamp bulbs as described in a former issue of your magazine, I noticed an odd thing which I cannot account for. The bulb used was an ordinary Tungsten lamp. The glass rod in the center of the bulb had been shattered in some way, so I covered the glass tip with wax and made a Geissler tube out of it. The tube was attached to a static machine capable of giving a twelve-inch spark, by a wire which was wound around the brass end of the bulb and attached to the positive terminal of the machine. A short gap was left between the two terminals of the static machine and after operating for a few minutes I pushed the terminals of the machine together and disconnected the bulb. Then I picked up the bulb without touching the brass end. When I was about fifteen feet from the static machine I happened to drop my finger onto the brass end to the bulb and drew a spark about one inch long from it. Rather surprised I carried the bulb downstairs to the science teacher of the school and showed her the spark. This time it was less strong and after two or three attempts it became totally discharged. The bulb was certainly a Leyden jar, and my hand was one coating. What had formed a second coating to hold a charge on the inside of that exhausted bulb?

A. 1. Undoubtedly you are not aware that the charge is retained in the glass, and not in the coating of the Leyden jar. The highly ionized air in the electric bulb acted as an internal coat, and induced the glass to take on the charge inside, whereas the outside coat, viz., your hand, was connected to the earth thru your body.

To prove that the charge is retained in the glass and not in the coat is very easily demonstrated in a separable Leyden jar. The Leyden jar is charged, the coats carefully removed by an insulating rod, and these, when away from the glass, may be touched with impunity. Should the fingers be placed on both sides of the glass, a slight crackling is soon heard, showing that there is some charge, which escapes very slowly. However, if the coats are now replaced and a discharger brought in contact with the inside and outside coats, a sharp crack is heard and a spark flies across the discharge ball and the knob on top, the metal coatings acting as good conductors of the charge.

MAKING PERMANENT STEEL MAGNETS.

(1040) M. F. McCormick, Crown Point, Ind., asks the "Oracle":

Q. 1. Several questions regarding permanent steel magnets; these bar magnets measuring ½x½x3 inches.

A. 1. Regarding first question, would say that a compound steel magnet made up of two separate magnets, would be approximately twice as strong as either one of the single units, as you mention; presuming that both South and both North poles are placed together, i. e., both S.S. poles at one end, and the N.N. poles at the other.

Answering your second question as to the form of magnetizing coil required, would say in the first place alternating current cannot be used, and direct current either from a lighting circuit, or else from storage or dry cells must be utilized for the purpose. A very powerful magnetizing coil may be made as follows for service in conjunction with this battery current. A brass tube, ⅝ inch inside diameter and measuring three inches in length, may be wound with 20 layers of No. 22 B. & S. gage, S.C.C. magnet wire. The magnet steel may be placed in the coil one after another and the current switched on, after each magnet is placed within the tube, the steel bars being magnetized from ¼ to ½ minute. The strongest magnetization has been found to take place in such steel bars when the current thru the coil is interrupted at short intervals. This may be done by means of a telegraph key or switch operated by hand, or else a motor or slow speed vibrating relay may be rigged up to produce this effect.

In regard to the hardening of the steel, will say you will do well to look up some good machinists' handbook on this subject, but in brief, it has been found that the steel used should preferably be a tungsten steel, and that it should be glass-hard in order to have the greatest retentivity for magnetism. It is common practice for ordinary magnets to heat the steel to a cherry red and then to plunge the bar in water; thus quenching it quickly and producing a practically glass-hard temper. We take pleasure in recommending one of the best books on magnets, i. e., the work entitled "Experiments in Electricity and Magnetism," by Sylvanus Thompson, which our "Book Department" can supply for $1.65 prepaid. A very good book covering tempering of steel, etc., is entitled "Rogers' Machinists' Guide," which can be supplied at $2.15 prepaid.

DOLLARS FOR JOKES

A SCIENTIFIC magazine is supposedly notorious for its dry reading. Still we flatter ourselves that the ELECTRICAL EXPERIMENTER can hold your attention without your yawning too frequently.

Of course you like to laugh—we all do. Sometimes we make you smile while you peruse the EXPERIMENTER. Perhaps sometimes you laugh out loud—at some of our "preposterous ideas" which we print here. And then of course the joke's on us, because we were real serious!

Now it occurred to us that we would like to print a column of real, original jokes every month, but here's the hook: The joke must be a SCIENTIFIC JOKE. No, this is no joke, we mean it!

Anyone can print or re-print jokes, but we want them with a dose of science. So, till further notice we will pay $3.00 as a monthly 1st prize for the best joke, and $1.00 for each other one we print.

So you will know what we mean with a "Scientific Joke," we print one here, which we purloined from the "Baltimore American":

LOGICAL.—"I want some good current literature."
"Here are some books on electric lighting."

Now of course, our readers can do much better than this. So let's wait and see. One reader can submit as many jokes as he pleases. Even if it is old the joke is not necessarily barred or condemned. There is one rule however: The joke must not be too technical; in other words, it must be readily understood by anyone. Not more than 100 words can be used. Use only one side of the paper.

Address
SCIENTIFIC JOKE EDITOR,
Care of this publication.

ONE OR TWO TELEPHONE RECEIVERS BEST?

(1041) A. Jarrett, New York, N. Y., inquires:

Q. 1. Which is the best, the single Bell telephone receiver or this, together with an auxiliary watch case receiver.

A. 1. With respect to the efficiency of the watch-case telephone receiver, which is commonly used and supplied by telephone companies in different cities in order to hear long distance calls more plainly, etc., would advise:

There is no doubt about it that the addition of the watch-case receiver helps very considerably. As regards the electrical efficiency, you can rest assured that there is invariably sufficient current at the telephone terminals to operate at least two receivers connected on parallel. It is the same as connecting two lamps on parallel. Twice the current is required for two telephone receivers as would be required for one, but the editor of this department has never noticed any depreciation of the speech reproduction when the multiple phone is connected, when either receiver is tested separately. Secondly the hearing efficiency is increased by this arrangement of two receivers, as has been proven in wireless work, where two receivers are always used.

In the first place, as you state, there is more sound produced, but the main and most important thing is that you in this manner bring into operation the combined hearing forces of the two ears, which co-act in a very much better manner when they are both acted upon simultaneously by the same sound, as compared to the action when one ear is affected by the sound only. Besides, as you state, there is always trouble due to external noises affecting the open or unused ear.



Radiator Cement

In liquid form and easy to use. Will ordinarily seal leaks in from two to ten minutes.



Hastee Patch

A quick, permanent, inexpensive repair for tubes and casings. Can be applied in three minutes at a cost of 2 cents.



Valve Grinding Compound

Will remove pits and foreign substances from valves, giving a velvet seat. Will not cut grooves.



Carbon Remover

An occasional dose will stop that knock—quiet the motor—and save the batteries. You can do it yourself in ten minutes.

Keep Your Car Young

It isn't fair to yourself or to your car to run it without any attention and then sell it at a big loss. With but little effort you, yourself, can keep your car in such condition that the depreciation will be very slight. We offer for your use **Johnson's Car Savers.** No experience is necessary for their use. They can all be applied by the amateur with perfect satisfaction.

Johnson's Car Savers are of the very highest quality that can be produced. You will find cheap make-shifts on the market, but when you insist upon **Johnson's** you are taking no chance, for all of our preparations are fully guaranteed.

JOHNSON'S Car Savers

Start today to reduce the depreciation of your automobile. An hour or two every month and **Johnson's Car Savers** will prove their value in dollars and cents when you come to sell or turn in your car.

Johnson's Car Savers have been on the market for several years. Millions of cans have been used by motorists everywhere with entire satisfaction.

For years our employees have been our partners and share the profits. Because of this personal interest unusual care and skill enter into the manufacture of the Johnson products—overhead is reduced to the minimum and we are enabled to sell at a very slight increase over pre-war prices, notwithstanding the tremendous advances on all of our raw materials.

Representative dealers and jobbers all over the world handle **Johnson's Car Savers.** Don't accept or handle unknown substitutes. Write for our booklet "Keep Your Car Young"—it's free.

S. C. JOHNSON & SON

Dept. E. E. 4, RACINE, WISCONSIN



Top Dressing

Johnson's Black-Lac is the ideal top dressing. One coat imparts a rich, black surface just like new.



Auto-Lak

A splendid elastic varnish for bodies, hoods and fenders. A coat will increase the value of your car from 10% to 35%. Dries in 24 hrs.



Stop Squeak Oil

It seeps between the springs, thoroughly lubricating them. Makes your car ride easier, reduces the liability of spring breakage.

Know Your Man

—to sell to him
—to employ him
—to direct him

If you should seek for the one big qualification that has made for the success of Schwab, Carnegie, Morgan and others, you would find that they *knew men;* their ability to gather around them the right men for the right position more than any other factor contributed to their success.

Until you know how to judge men correctly, you cannot sell, direct or employ them to the full extent of your ability. You *can* know. It is easy. Mr. Wilson M. Taylor has given an infallible, correct and simple method in his new book

"The Science of Approach"

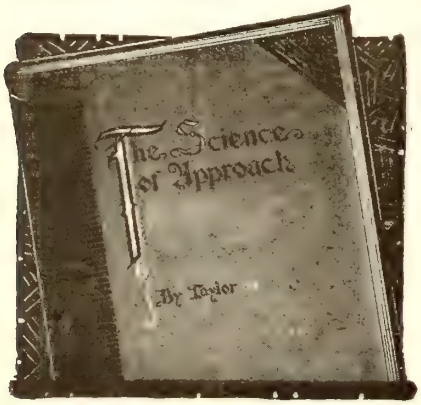
He classifies all types of men and shows you the best way to appraise quickly the minds of men of various types, to determine their inclinations, their process of thinking, their basis of judgment and decision.

Get This Key to Men's Minds

Stop guessing. Know why people like you and why they do not. Learn how to make them like you. Be able to recognize the type that thinks slowly and acts slowly, the type that thinks quickly and acts quickly, the emotional type, the mercenary type, the generous type and all other types. You can realize what an advantage this means to be able to do this. The largest firms in America are adopting Mr. Taylor's method. You, too, should have the knowledge this book contains.

Mr. Taylor Has Agreed to Send it on Five Days' Approval

Your opportunity is presented in the coupon below. Use it. All it requires is a little initiative to determine whether or not "The Science of Approach" will benefit you as greatly as it has benefited other men. You take no risk in determining this. Sign and mail the attached coupon *TODAY.*



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Please send me copy of your book, "The Science of Approach," on 5 days' approval—enclosed find $2.00. If I decide not to keep the book, I will return same to you within 5 days and you are to return the $2.00, without question.

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Science With A Bang

By EVERSON WESTERLING

(*Continued from page* 1289)

never got the hang of it how he made himself understood with them, or they with him. I never knew if he talked to them, to the phones, or to himself.

"Howard Brown, the gink who smears the monthly canvas cover was discussing the next spasm with the Pasha. Brown wanted to know what the main color was to be.

"'Weather Bureau,' yells the High-Chief into the phone. He gets it in a couple of seconds. 'What sort of weather will we have next month?' he bawls. 'Rain, all month, you say? O. K. Fine.'

"'The cover will be *sky blue,*' as he turns to Brown. 'As it will rain all next month, people will be tickled to see a blue sky, even if it's only on a cover. We ought to sell a couplo thousand copies on that argument alone!'

"'Fine,' says the paint cuckoo. 'Now what's the subject?'

The Grand-Duke scratches his head thoughtfoolishly while he toys with his telegraph instrument. Just then a nice ripe tomato comes sailing in thru the open window and lands squarely on the Mikado's bean. Quick like a flash he turns to Brown, and chuckling gleefully says, while blotting up the ketchup with a few blotters:

"'*That* gave me the idea. Subject will be an artificial big steel man. Show him working in a field; paint him red—like this tomato sauce. Good combination—red steel monster with a skyblue background. People will be interested in him, now that help is scarce. Open his back to show the propelling machinery inside of him—ah yes—wireless aerial on his head and in foreground radio man with a lot of wireless junk, who directs the automaton's movements in the field.'

"Fine, wonderful," we all applauded. "That's going to be *some* cover," yelped the manager. "All our competitors will die of envy, but how on earth do you get all those ideas?"

"'Simple,' chuckles the Rajah, 'the tomato gave me the idea of course! Don't you see, tomato—auTOMATOn—and where does a tomato grow? In a field! There you have it, *automaton working in field.* Next!'

Just then Secor, the associate Editor comes in with a bang thru the loud talking telephone on the wall: X ! ?!! -....---!xx Wow—R-rhrrrrrr...what in thunder do you mean by adding 8 more pages to this infernal sheet, ain't we got enough now... r-r-r--R-R-R X ! ?**——can't possibly do MORE. Killing myself now. Absolutely Impossible to do more work—I quit right here——Wah—wow—wow—whizz—bang—"and he's gone!"

"But the High-Priest thru it all keeps on smiling; it seems he likes those gentle outbursts. No sooner has the enraged editorial bird ceased fluttering than the Grand-Turk presses a button and chirps into a mouthpiece:

"'Great stuff, Secor. That talk of yours gave me a bunch of ideas to fill those eight pages: You spoke about *killing yourself;* why not send Kraus up to Sing-Sing and get some recent dope on how they electrocute the murderers up there—good for two pages with a full page washdrawing showing how it's did!

"'And you said *"What in thunder,"* didn't you, darling? Well what's the matter with making a full page drawing showing all the different stages of a thunderstorm—good for two pages.

"'Then you said *absolutely impossible,* yes, no? Well; two pages of good stuff showing historical instances how inventors made the impossible come true; ought to make fine reading—full page drawing showing those inventions, what?

"'Finally, you yelled so loud that my ears hurt. Seems as if the acoustics in my office are too good—how about two pages on acoustic freaks—echos—strange acoustic phenomena—full page illustrations how to do it—there are your 8 pages—no, don't thank me, call me up later if you need more ideas!'

"I had heard enough. I collapsed right then and there. After I came to a couple of hours later, I slunk out of this idea-monster's office. *He had never even seen me.*

After I had sufficiently recuperated I thought I'd waltz up to see this Secor bird. He looked—or rather sounded promising. As I had no appointment with the gink I bribed the elevator brigand who took me up, hidden in a big ashcan, which just went up after having emptied its load of rejected manuscripts on the paper dealer's wagon.

I was dumped onto the associate editor's floor and crept to the door labeled

HARRY WINFIELD SECOR,
E.E. I. R. E. S.O.S. P.D.Q.
ASSOCIATED EDITOR
The guy who thinks he does all the work AND DOES

Thru the door came murderous sounds, and I had already turned back on second thought, but a tall young giant who wore a sign on his hat "Field Editor" rushed up in a monstrous haste. He collided with me and we both burst thru the door into the sanctum. However, he paid not the slightest attention to me, so I sat down and looked at the scenery.

Miscellaneous, gum chewing, powder-puffing damsels sat at various desks manipulating their keys.

On the floor lay a long-haired cuckoo, "artist" painted all over him. The associate editor was just then drumming an editorial point or two into the artist's anatomy. The Grand Vizier was waving a drawing hysterically at the unfortunate rat on the floor and lambasted him for some minutes soundly.

"What in X!?X RRR do you mean by crabbing my illustration this way R!X? RRRRrrr Wow Bang Ziz.....look at this face—what will our readers think of me—I didn't want a pig's face—I want a MAN'S face—wow, bang, Rrrrrr !X..... and look at this electric current—why, it looks like a bunch of spaghetti, you fish-faced, enaemic son of a rainworm. And then look at this thing—Lord have mercy on his brain that he hasn't got. Didn't I tell you to put a derrick here—and look what this poor idiot of an evaporated mollusk-brained flea puts in its place—a HERRING, instead of a derrick. And here we're scheduled to go to press at 4:39 A. M. and the drawing must be made over again. Whizz, Bang, BANG, WOW X!?XX!?X————"

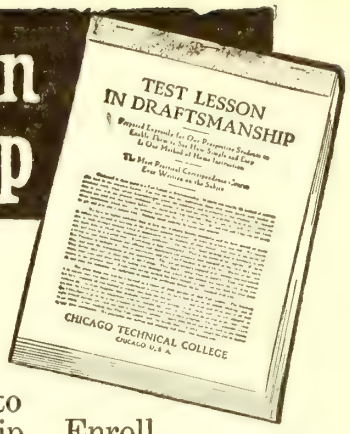
Just then the loud talker with the voice of the Editor-in-Chief's started:

"Listen Secor, I got a glorious idea, for you to work out. Best I've had since five minutes ago. Let's make a $100 prize contest what to do with discarded mouse traps. Readers like these contests—besides these popular contests bring in from 6 to 9 tons of paper which we can sell to the paper deal————"

But the voice was cut dead by a large inkstand that the irate Secor threw at the loud talker.

(*Contniued on page* 1294)

FREE Test Lesson In Draftsmanship



Send for this free lesson which explains the Chicago "Tech" method of teaching Draftsmanship by mail. Positions at big salaries are now waiting for competent men. Even draftsmen of limited training and experience are snapped up and paid good salaries. If you are dissatisfied with your opportunities, learn Draftsmanship. Chicago "Tech" will train you in the most practical way in the shortest time. Mail the coupon today and let us tell you about the Chicago "Tech" method. The free lesson will show you how well equipped you are to follow Draftsmanship. Enroll in the course only if you decide that you can take it up to advantage. No cost, no obligation on you to make this investigation. Send the coupon.

$25 to $100 a Week

Draftsmen always command good salaries. And now when American industries are to be called upon to meet vast foreign and increased domestic demands, the opportunities are greater than ever. This is the time for you to prepare for a better position—a higher salary.

Come to the College or

Learn At Home

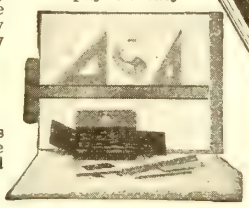
Hold you present position while training. Our experts will instruct you by mail. Only your spare time is required. You are directly under practical draftsmen and engineers. You are taught exactly the work required in the drafting rooms of big concerns. No time put in on unnecessary studies. This means thorough instruction and early graduation.

Easy Payments

The fees for Chicago "Tech" Courses are very moderate—and you can pay on easy terms. And also, you obtain in a few months what it would take several years to acquire by ordinary methods. You can get an early start. You are soon ready to take a paying position and to quickly get back the cost of your course. Then keep on earning more.

FREE Instruments

Every student of the Chicago "Tech" mail course in Draftsmanship receives this set of instruments, or a cash credit in case he already has a set. These instruments are of the same make and sizes as are used by high salaried experts in drafting rooms of factories, shops, railroads, etc. You use them while learning—then take them right into your practical work.



Auto and Gas Engine Course

All about automobile mechanism—its construction, operation and REPAIR—taught by mail. You train directly under the Chicago "Tech" automobile experts. Splendid opportunities open now. Send coupon and get all the facts.

Learn All This in Spare Time

Principles of the Automobile. Every point made clear about the basic principles of propulsion—steam, gas and electric cars. Power transmission systems in pleasure and commercial cars, etc., etc.

Gasoline Engines. All about the different types. A complete course in gas engine construction, operation and repair.

Power Plants and Transmissions. Application of power by 4-6-8-12 cylinder engines. Types of clutches, gears, drives, axles, etc.

Carburetors and Fuel Supply Systems. All methods demonstrated. Fuel values. How to test. Gasoline and air mixtures. Regulation, care and management, etc., etc., etc.

Lubrication and Cooling. All about oils and how to test them. Splash and circulating systems. Operation in different cars explained. Diagrams and tables. Cooling systems completely illustrated, etc.

Batteries. Electrical principles explained. Instructive diagrams of wiring and connections. Coils, condensers, vibrators, etc., etc.

Magneto Ignition. Principles and practical operation of various types and systems with diagrams. Generation of current. Field, armature, high and low tension, all explained. Complete in every point.

Starting and Lighting Systems. All modern methods. Starters—spark, mechanical, air, acetylene, electric, battery—shown in detail with diagams and full explanations. Charging. Motor and generator adjustments, etc., etc.

Know How to Find and Fix Troubles

Most complete instruction in auto repair work. Equips you for high pay or to start a business. Big demand for trained repair men and men who know how to inspect cars. This course makes you proficient. Prepares you to take a job as an expert. Not enough competent men now available.

WRITE Send the coupon and get catalog and all information about the Course, the small fee and the easy terms. All this sent on request. Mail coupon now.

Chicago Technical College 445 Chicago "Tech" Bldg. Chicago, Ill.

Send the Coupon—Now

The sooner you are prepared the sooner you will be holding a job that pays a large salary and opens the way to advancement. Many executives, general managers and superintendents began as draftsmen.

Other institutions ask you to pay first—and then to find out later how well qualified you are for this profession. We send you the free lesson first and place you under no obligation at all. Discover your qualifications before you pay anything.

The coupon will bring the Test Lesson, free. Also information about the profession of Draftsmanship and detailed facts about Chicago "Tech" methods, the fees, terms, etc. Mark with X the branch you are interested in—or if in doubt about which course to take, write a letter stating facts about yourself and asking our advice which will be freely given. Mail either the coupon or letter today.

CHICAGO TECHNICAL COLLEGE,
445 Chicago "Tech" Building, Chicago

Without obligation to me, please send me your FREE Test Lesson and other interesting literature covering the subject indicated below. Mark X opposite work in which you are especially interested.

- ☐ Architectural Drafting
- ☐ Machine Drafting
- ☐ Electrical Drafting
- ☐ Structural Drafting
- ☐ Sheet Metal Drafting
- ☐ Builders' Course
- ☐ Plan-Reading—Building
- ☐ Plan-Reading—Shop Men
- ☐ Estimating
- ☐ Surveying
- ☐ Map Drafting
- ☐ Autos and Gas Engines

Name.....

Address.....

City.....State.....

College or Home Study? State which.....

$1.00 Postpaid

SHAVES WITH GILLETTE BLADES

equal to any $5.00 safety razor.



Rogers Bros. new safety razor is as nearly perfect as any safety razor can be made. No expense is spared to make it the very best offer to the users of high-grade safety razors.

Note the exclusive *"Hexagon Handle"* with a *guaranteed* double silver-nickel Electroplate throughout.

Mail this Coupon Now

D. A. R. Sales Company

2521 17th Ave. So.

MINNEAPOLIS, MINN.

Enclosed find one dollar for your special safety razor offer

Name .....

Address .....

.....

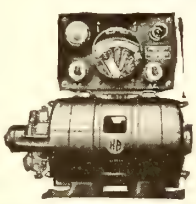


$150 to $300 Profit Every Month

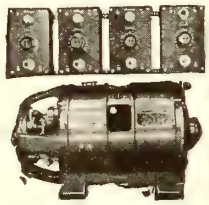
DO YOU WANT IT?

You can get it with an HB Charger. Sturdy, reliable, nothing to wear out or break. No burn-outs or expensive renewals. Charges batteries for 10c to 15c each—customer pays 75c to $1.50. Figure those profits! This season brings biggest business. Start NOW!

WHICH ONE DO YOU NEED?



HB 500-Watt Charger—Recharges 1 to 8 6-volt batteries at a time. Uses power from lines now in your garage. Should pay $100 to $200 profit a month. A big money-maker for a small battery business.



HB 32-Battery Charger—Recharges 1 to 32 6-volt batteries or equivalent at a time. Four separate charging lines, each capable of charging up to 8 batteries. Ideal equipment for big garage or battery service station. Will clear as high as $250 to $350 a month.

Sold on Trial Under HB Absolute Money-Back Guarantee. All HB Equipment is sold under our absolute guarantee of complete satisfaction. You run no risks. If not satisfied after using any HB Equipment 10 days, you may return it and receive all you paid us. The HB monthly payment plan is an additional guarantee. Write today for full information about the HB Charger that fits your battery business.

HOBART BROS. CO. **Box 48E, Troy, Ohio**

STAMPS 50 all diff. British Guiana, Cuba, China, India, Jamaica, Japan, Portugal, Venezuela, etc., only 10c; 100 all diff., 15c; 1000 all diff., fine collection in itself, $5.00; 100 diff. U. S., 30c; 1000 hinges, 10c. Agents wanted, 50% commission. List free. I BUY STAMPS.

L. B. DOVER **OVERLAND, MO.**

Science With A Bang

(*Continued from page* 1292)

"That'll keep him quiet for a while," fumed the august Vice-Chancellor. Turning to one of the female inmates of his cell at his elbow he growled:

"See, there he goes again! Ideas, IDEAS, nothing but ideas all day and night long. Any idiot can have ideas, but does he work 'em out? Not on your lip-rouge! I'm the crab that does the dirty work, and then I have to wrestle with this scum—pointing to the prostrate form of the artist—so the readers will know what it's all about. And then, five minutes before going to press that Editor-in-Cheese countermands the order and sings out that he thinks a contest of discarded straw-hats would be preferable to old mouse traps——"

Just then there was a comparative lull while His Majesty came to blows with the Field Editor, because the latter hadn't fielded about something or other.

I took the occasion to approach the Lady in Waiting to his Highness.

"Enchanted inmate," I ventured, "could I speak for a few seconds with the Chief of the Harem? Name's Jazz Stokes from California. Tell the Señor I am here to talk on business, but if Monseigneur is too busy, I will wait awhile."

The Lady in Waiting gave no sign of approval, either negative or positive, so I took the occasion and made good my threat. I waited. I got even, however, because I pulled out my stopwatch and timed her gum chewing. She batted a high average. As a matter of fact she could chew faster than the rest of the ward inmates.

Just then a herd of draftsmen, photo engravers, boys with printer's proofs, professors with manuscripts in one hand and bills in the other, descended upon the unfortunate Secretary of Labor. He singled out one of the draftsmen who was twenty-four hours overdue with his drawings, and threw a bulky "Encyclopedia Germanica" at him. It caught the victim amidships, and as I stood behind *him,* he caught *me* well on my starboard side. We both had a pleasant sail thru the door and before landing, the draftsman introduced himself. "That's the second time he threw me out this week, but I don't mind it. *I* carry accident insurance—and he needs the exercise, poor boy——"

On my way down I stopt at a door labeled

S. GERNSBACK
CIRCULATION DEPT.
WRINKLES & FORMULAS

On entering softly I found this worthy flanked on all sides by many female assistants and keybangers all equipt with gas-masks. Unlike the other offices, a supreme quiet reigned here. It took me some minutes before I could make out the form of the Captain of the ship. Clad in an acid-stained duster, he was sitting behind a curious desk arrayed with every conceivable piece of junk, chemical glassware, magazines, bottles, shower bath, miscellaneous cats, minerals, one or two gross variegated ash trays, each with a legend: *No smoking;* files—letters, mail and cross cut—books, books, books, manicure set, test tubes, goggles, gold fish, auto tire, and too many other items impossible to encompass into the four ends of a compass.

The air reeked of the smell of putrefied codfish, but changed to the perfume of a dying rose the next, only to be transformed into the odor of fragrant frankfurters a second after. I then understood the gas-masks of his victims sitting about the office.

Just then by means of a dozen retorts and test tubes he composed an odor sonata in B-sharp. I felt myself transported from the perfume of a vamp's boudoir, to the Chicago stock yards, thence to a sweet jasmine and rose field, only to be hurled immediately into the agonizing stench of a glue factory.

Before I had recovered there was a slight explosion of one of the formulas, and a large brick came sailing my way. It knocked me down flat, but the odor liberated by the explosion soon revived me. Coughing, puffing and sneezing, I galloped down the stairs forgetting entirely to introduce myself to the Wrinkle Professor. I went down six flights of stairs and cast anchor on a door mat resting before a door neatly smeared:

ROBERT W. DEMOTT
(accent on the Dee)
Advertising, etc.

This office was mostly desks. A whole forest of them. The inmates of the dormitory when they wanted to cross from one state to the other used an overhead trolley and a rope about the neck. This was by far the most elaborate Harem of the whole joint. The types varied from the opulent oriental to the Indian version of a Totem Pole. Being in the advertising office, they believed in advertising: bare arms, bare backs, and neat ankles were well advertised. By their flashing white teeth you saw at once that they were using a widely advertised brand of toothpowder. They all wore expensive smiles of the well-known and advertised brand: "The smile that won't come off."

The Chief was doing an elaborate War Dance, accompanied by the tam-tams of the typewriter keys.

Thomas A. Edison and Nikola Tesla, who had a story running in the next issue begged humbly to be allowed to have their articles run "next to pure advertising." Edison wanted to have most of his story sandwiched in between Correspondence Schools and Patents because he was cuckoo on them, while Tesla, having more aesthetic inclinations, wanted his story to run alongside the Wireless Ads and the High Frequency Machine Ads. These being his inventions, he thought it was no more than right that his story should be well garnished with them.

But the Chief of the Tribe was obdurate. He wouldn't listen. He said the other writers must have a show, too, and so on and so forth. Finally Edison hit upon a fine idea. *He would pay for the space alongside the ads* and run his story in that space. Before the Advertising Admiral had recovered from his surprise, both Edison and Tesla had planked down a thousand dollars on his desk and flown the coop.

The only comment the General made was: "Chump that I was. If I had only thot of it myself, I could have played those birds against each other and gotten double the rates!"

Just then six or seven trembling men stalked in. I soon saw that they were big advertisers of the magazine. Their contracts had run out at 6 A. M. that morning, having been in force for four long days. By that time a new rate had gone into effect which threatened to ruin them. Would the Secretary of State not allow them to let the old contract run for two more days? Or if not, would he not be satisfied with a raise of 450%.

The Sheik pondered for a long time. Then he called over one of his Phoebe Snow's and asked for the latest time table, better known as *rate card.*

(*Continued on page* 1298)

Revitalize Your Tired Nerves!





Vitality

The Violet Rays send a spray of mild, tiny currents through every part and organ, vitalizing and invigorating every cell. It acts like the refreshing effects of a shower bath—and leaves you with a delightful feeling of bounding health and bouyant energy.



Beauty

Violet Rays purify the scalp and stimulate hair growth—a wonderful aid to beauty. Removes eczema, pimples, blackheads, obesity—giving the skin a smooth fine texture, free from blemishes and sallowness.

Magic-Like Treatment For:

This is only a partial list of the many ailments that can be treated successfully with Violet Rays right in your own home.

Asthma	Goitre
Barbers' Itch	Insomnia
Boils	Lumbago
Blackheads	Nervousness
Bunions	Neuralgia
Callous	Neuritis
Catarrh	Obesity
Chilblains	Pains
Colds	Paralysis
Corns	Piles
Constipation	Pimples
Dandruff	Pyorrhea
Deafness	Rheumatism
Earache	Skin Diseases
Eczema	Sore Throat
Eye Disease	Sprains
Falling Hair	Tonsilitis
Hay Fever	Whooping
Headache	Cough

Simple, Delightful Treatments Right In Your Own Home

Enjoy wonderful, sparkling health! Feel the thrill of the bounding vitality of youth! Increase your store of energy, revitalize your worn out cells, make every fibre of your body tingle with a new vim and vigor! All this you can have through the magic of Vi-Rex Violet Rays right in your own home!

Violet Rays penetrate to every cell in the body, imparting that stimulating vigor which brings the glow of health, tones up the entire system, putting life into over-taxed and sluggish tissues. As a quick relief from pain Vi-Rex has no equal. Its soothing rays quickly find the source of distress and afford speedy comfort. Headaches, nervousness, skin blemishes and many other complaints vanish as if by magic through this marvelous treatment. You will be amazed at the splendid, quick results through the use of this wonderful new Vi-Rex Violet Ray Machine—right in your own home!

VIOLET RAYS

The Amazing New Source of Health, Energy and Beauty

Vi-Rex Violet Rays are effective for a host of disorders and ailments. Physicians in all parts of the country are adding this scientific outfit to their equipment and recommending its use to their patients. Beauty specialists have long realized its efficiency for inducing a clear and healthful skin. Until recently expense prohibited the use of this remarkable health-building force in private homes. Now the practical, inexpensive Vi-Rex Violet Ray Machine enables everyone to enjoy all the benefits of this marvelous treatment at home.

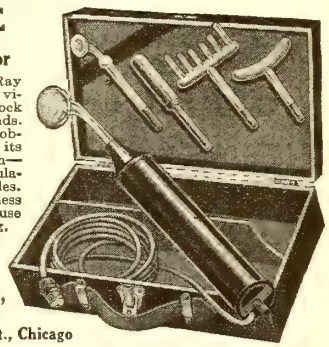
The operation of the outfit is simplicity itself. Current from your electric light socket is transformed into an effective healing agent as pleasant to the senses as a ray of spring sunshine. It may be used on the very young and the very old without the slightest discomfort. No shocks or jolts—just a soft steady ray of violet light filled with an abundance of health and energy. (Special equipment is supplied to you at a trifling cost if electric current is not available.)

20 Home Self-Treatments FREE

You don't have to take any risk in giving Vi-Rex Violet Rays a trial. Take 20 treatments in your own home. Use this marvelous machine morning and night for ten days. If you do not find quick relief—if you do not feel better, sleep better, *look* better, send it back and you will not be out one penny. This special offer is now open but it may be withdrawn at any time so act quickly!

Not a Viabrator

The Vi-Rex Vlolet Ray Machine is not a vibrator—does not shock or jar the nerve ends. Its effectiveness is obtained through its power of penetration—not through manipulation of surface muscles. No feeling of soreness or exhaustion after use—only a comforting, agreeable sense of relief.



Write for Free Book and Trail Offer

Write to-day for our free booklet describing the wonderful Vi-Rex outfit in complete detail, and particulars of our liberal 10-day trial offer. Find out how Violet Rays will help you. Read what hundreds of users say about the Vi-Rex and astonishing results which have been obtained. Learn why it is the most economical and practical machine of its kind available. You may use it to gain health, vitality, beauty! There is no limit to its beneficial powers. Mail the Coupon or send a postal. Do it now.

Vi-Rex Electric Co., Dept. 44
326 W. Madison St., Chicago

Vi-Rex Electric Co.,
Dept. 44
326 W. Madison St., Chicago

Please send me without cost or obligation your free book describing your wonderful Violet Ray Machine.

Name.....

Address.....

City.....State.....



RAILWAY TRAFFIC INSPECTORS ASSOCIATE WITH BIG MEN

That is what gives them chances for promotion. They start in at a good salary—$110.00 a month and expenses.

The work is important, for the safety of thousands depends on their vigilance. And when they do their work as we teach them they attract the favorable attention of their superiors. Promotions then are rapid.

Learn This Profitable Profession

All you need is a common school education for entrance to our three-month's course, which is easy to learn at home during your spare time. Take the initiative now, while the demand for Railway Traffic Inspectors is so good. THERE IS A BIG DEMAND IN THIS FIELD.

We know of fine openings for our graduates. Many who started our course a few months ago now hold positions.

OUR BOOKLET tells of this ideal vocation—out in the big out-doors—how you associate with big men—how you can earn an excellent salary from the start—how you can climb to the very top. The opportunity COUPON (below) is your key to a better salary now and a much bigger future. Why not send it today? Remember you start at $110 a month, and WE SECURE YOUR POSITION.

WE ARRANGE FOR A POSITION

Standard Business Training Institute, BUFFALO, N. Y.

Please send without obligation to me, your Booklet D119, explaining your Railway Traffic Inspector's Course.

Name .....

Address.....

MARKO
STORAGE BATTERIES
ARE GOOD—TRY ONE
Paul M. Marko & Co., Inc.
1402-1412 Atlantic Ave.
Brooklyn, N. Y.

ARE YOU BASHFUL, TIMID

Self Conscious, Embarrassed in Company. Let us tell you how you can overcome these troubles and acquire Poise, confidence, assurance and a magnetic personality. Address The Veritas Science Institute, 1400 Broadway, New York, Desk 15.



Printing Cheap

Cards, circulars, labels, book, paper. Press $8. Larger $25 Job press $100. Save money. Print for others, big profit. All easy, rules sent. Write factory for press catalog. TYPE, cards, etc. THE PRESS CO., D-47, Meriden, Conn.

Advertising Talks

NUMBER 6

AN OPEN LETTER TO MR. THOMAS REED.

Dear Mr. Reed:—

A long time ago you wrote me this letter. I'll reproduce it here because it's so long ago you probably have forgotten it.

Mr. R. W. DeMott,
Advertising Manager,
The Electrical Experimenter,
New York City.

Dear Sir:—

I was interested in your address to the readers in this month's Experimenter, and will bring to your attention a little suggestion which I think you may be glad to have.

You will understand that the incident related in the enclosed letters was to me nothing more than an annoyance, but if the practice is a general one of this advertiser, it must be causing real disappointment among our readers, most of whom are boys with little money to spend. My suggestion is that you require all advertisers to state that their merchandise is "postage free" or else give the weight or something to indicate that postage is extra.

In the case referred to I assumed that the price of 50c on these ringers included postage. The advertiser sent me the ringers charging me the 30c postage as an extra to be collected C. O. D. As the cost of the merchandise was only $1.00, the 30c extra charge was quite annoying. It also gives this advertiser an unfair advantage, because his prices look lower than they really are.

I have no doubt that the advertiser omitted the postage information thru oversight, but I don't want our boys to feel "stung" in the slightest degree when they answer our ads, which are not the least interesting part of the magazine. There is a chummy atmosphere about "E.E." which extends to the ads to quite a degree and which I should think the advertisers would find it to their interest to cultivate.

Very truly yours,
(Signed) Thomas Reed.

Now, Mr. Reed, I want to apologize first off for not having answered sooner. The point you bring up is so important to our readers that I thought the best way of answering your letter would be thru this column. But there has been such a rush of other news these past few months—so many items of big interest to our readers—that my little sermons temporarily "got the gate". (Bet you never even noticed that they weren't in.) And so your letter remained filed away in a special folder and, frankly, it slipt my mind.

It wasn't until Friend Secor, Boss of the Ink Slingers from the Editorial Department, just because he happened to be in Cincinnati, 750 miles from home, with a hole in the magazine, and no news to fill it, stuck No. 5 of my little talks in the November issue. But lots of other things just as bad happened to that issue—that one we printed out in Cincinnati while the printers were on strike in New York.

Anyhow it did one good thing—it reminded me that I had a letter to answer. So I got busy and by exerting every pull I could spring got the loan of part of two columns in this issue.

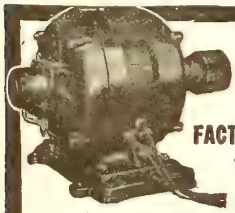
Mr. Reed, your point is well taken from one standpoint. But here's the big rub in the mail order field. Suppose you buy some goods from New York. You live in Boston. Parcel Post rates are cheap between these points. Now suppose someone else living in San Francisco buys the same article. Do you want to pay part of his parcel post or express charges? That is what it would amount to if transportation charges were included in the price. The manufacturer or seller would have to add an item for shipping that would constitute the average shipping cost for all his sales. That means that the man nearest his plant would pay part of the shipping expense of the man far away and the one at a great distance would get his goods more cheaply than he should.

For this reason it is customary in the mail order field to quote prices net (without transportation charges).

And so it has become a recognized fact that most mail order concerns require the shipping charges added to the cost of the goods or else they ship "charges collect." It is pretty safe to assume that unless the price of an article is marked postpaid the price does not include the transportation charges.

It seems to me that it is more my duty to explain this to our readers rather than to try to change the advertisers' policy. Don't you agree? We certainly don't want any reader to feel "stung" when he buys from an advertiser and it is my aim to keep

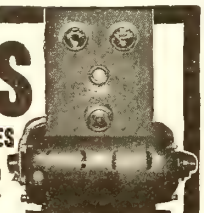
(*Continued on page* 1326)



NEW MOTORS

FACTORY GUARANTEED - ALL SIZES - IN ORIGINAL BOXES

Your Opportunity To Buy New Guaranteed Electrical Apparatus of Standard Manufacture.



Single Phase Motors
110-220 volts, A. C., 60 cycle, 1800 R. P. M. with pulley

1/4 H. P., 110 volts, induction, full load start - - $24.50
1/2 H. P., 110-220 volts, induction, full load start - $38.50
1/2 H. P., 110-220 volts, repulsion, for compressor $46.50
1 H. P., 110-220 volts, repulsion, with sliding base - - $67.50
2 H. P., 110-220 volts, repulsion, sliding base $108.50
3 H. P., 110-220 volts, repulsion, sliding base $124.50
5 H. P., 110-220 volts, repulsion, sliding base $164.50

Charging Generators
Suitable for all lighting Battery Charging and Power Requirements.

6 volts, 10 amp. $16.50
15 volts, 10 amp. $21.00
40 volts, 6 amp. $24.50
110 v, 2½ amp. $24.50
40 volts, 12 amp. $38.50
110 volts, 5 amp. $38.50
40 volts, 25 amp. $58.50
110 volts, 10 amp. $58.50
Moving Picture Arc Generator $85.00

Polyphase Motors
2 and 3 phase, A.C., 220 v, 60 c. 1750 RPM., complete with base and pulley.

½ H. P. - $42.50
1 H. P. $59.50
2 H. P. $72.50
3 H. P. $84.50
5 H. P. - $102.50
1 H. P., high speed, 3600 R.P.M., 220 v 2 phase only - $36.50

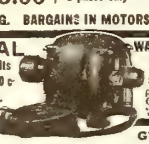
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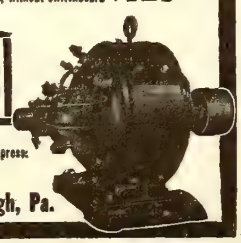
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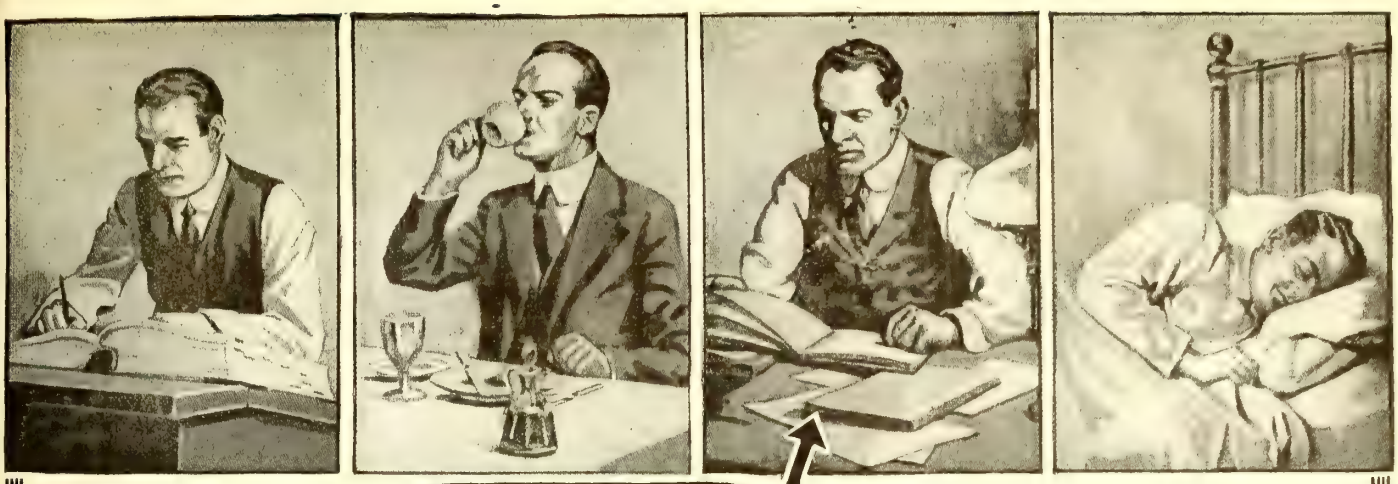
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Science With a Bang

(*Continued from page* 1294)

"When did this rate go into effect?" he queried.

"Ten A. M. this morning," she sang out in "His Master's Voice." "But," she added, "there's a new rate going into effect at 3:51 P. M. this afternoon. The gentlemen are just in time to catch it, the ten o'clock one being obsolete by this time."

"Have you figured out the 3:51 P. M. rate yet?"

"No, not yet," she coughed nervously over a "Smith Brothers' Cough-drop."

"Alrite, I do it myself," gravely spoke the Maharajah. "And to show you that our advertising rate is absolutely legitimate I will place my (rate) cards upon the table and show you the scientific manner by which we dope out our rate."

"By referring to 'Bradstreet's index' you will find that the price of paper has gone up, 22% since last night. Printing went up 26%. Ink 14%. Face powder 29%—my squaws here use it, hence it must go into the rate card. Rent's gone up 110%. Chewing gum 11%—used by our amazons for efficiency. Salaries increased 14%. Typewriter ribbon 16%. Cost of printing rate cards went up 84%. Dog biscuits 21%—this item too goes into the rate card because I own a watch dog. Fountain pen ink increased 15%. Desk blotters 5%. Bill heads—to send you your bills 22%. To this I must add an increase of 100% to my family—had twins last night, you see. Adding up these figures gives a grand total of 489%. The last rate being $300 a page, that makes this evening's rate $1,467 per page.

"Please sign on the dotted line. You'll excuse me while I catch my train, must see how the twins are getting along——"

"Well, boys, they had to carry me out on a stretcher," concluded Jazz, "and you may believe it or not, but I hadn't shook hands or spoken to anyone of that tribe of wild cats."

"Well," said Bender, "as far as I can see, you didn't miss much."

Telegraph, Cable and Radio Dispatches

By PIERRE H. BOUCHERON, Ensign U. S. N. R. F.

(*Continued from page* 1259)

letters in length they are not accepted by cable or radio companies at code rate, but must be counted and charged for at cipher rate; that is, five letters to the word.

Cipher language is a group arrangement of disconnected letters or numerals having a secret meaning known only to the sender and receiver. It is accepted by telegraph, cable or radio companies when a message is made up of unintelligible and unpronounceable groups of letters or figures representing words and is counted and charged for at the rate of five letters or figures to the word. When letters and figures are mixed in one word, however, each individual letter or figure is counted separately. The following are examples of how such cipher is counted:

CZOTN—1 word.
TRNSIM—2 words.
73570—1 word.
C51N7—5 words.

Exceptions: Words which are not considered as having a secret meaning, such as the trade-marks COF59, IP76 and the commercial expressions COD, OK, FOB, CIF, AM, PM, USS, RR, SS, etc., are counted and charged for at the rate of five letters to the group or word.

Miscellaneous: Recognized names of foreign countries, states, provinces, cities, vessels, etc., are counted and charged for as

(*Continued on page* 1300)



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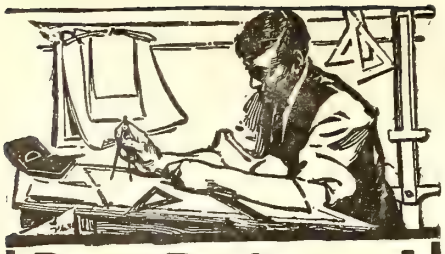
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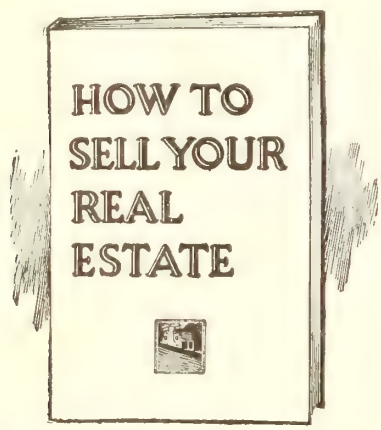
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Telegraph, Cable and Radio Dispatches

(*Continued from page* 1298)

one word each in the address of cable or radio messages, irrespective of their length or the number of separate words they contain; for instance, Havre de Grace, New York, East St. Louis are counted as one word each. In the body or text of a message, however, such names are counted and charged for at the rate of fifteen letters to the word in plain language messages; at the rate of ten letters to the word in code messages, and at the rate of five letters to the word in cipher messages.

In dispatches written in a mixture of plain and code language the maximum length of a chargeable word is set at ten letters or characters.

In dispatches written in a mixture of plain, code and cipher languages, the passages in both plain and code language are charged as code language, and the passages in cipher language are charged at cipher rate.

In dispatches written in plain language and cipher language, the passages in plain language are counted as plain language, and the passages in cipher language are counted as cipher language.

A sender may prepay a reply. To do so he must write before the address of the message the indication of prepayment, as well as the number of words prepaid for the answer; thus R.P. 10 (to) Lathrop, Paris, etc., the expression "R.P. 10" being counted and charged for as one word.

RADIOGRAMS.

Radiograms are messages which must be transmitted thru the medium of the ether by means of radiated electro-magnetic waves and may originate on board a vessel at sea to a distant inland point or vice versa. There has also been recently inaugurated a radio service between the United States and various European points, whereby radiograms may be sent to and from England, Norway and other nations in the same manner as cablegrams.

In general, the system of counting the words in a radiogram is identically the same as that employed in cablegrams; in other words, the "cable count." Names of ships are counted as one word each, irrespective of the number of letters in the address. In the case of two or more ships of the same name (which is not an uncommon occurrence) the line controlling the vessel should be included in the address, as in the following manner: "Smith, Ward-line Steamer *New York*, via Cape May Radio."

Radiograms originating on land and destined for vessels at sea are sent by land wire to the coastal radio station nearest to the point or zone within sending and receiving radius of the vessel, after which the coastal radio station holds the message until it has establisht communication with the incoming or outgoing ship, as the case may be.

Before sending a radiogram to a vessel at sea the sender should first ascertain from the local ship news office or marine department of a newspaper as to the latest radio report received from the ship, giving her position or probable date of arrival or departure, as the case may be, so that the message may be properly timed. In some of the large seaports, such as New York, Boston, Baltimore, New Orleans, San Francisco, etc., it is well to first secure the above information from the local office of the radio system, as the latter is in a position to inform the sender as to the proper coastal station to route the radiogram, as well as rates and other necessary information. Ordinarily, however, any telegraph office will accept radiograms to and from ships and properly route and deliver them.

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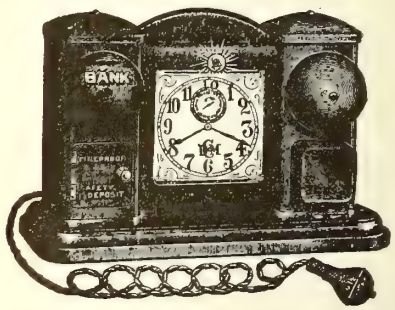
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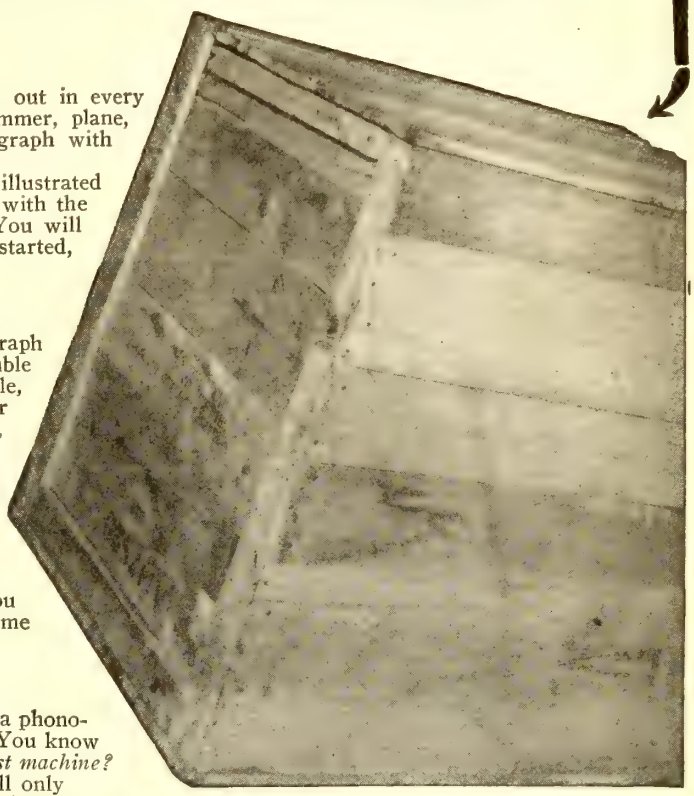
rich, sonorous, like a violincello, due in part to the shape of the sound chamber, an exclusive feature in all our machines. It plays all records, giving them a new beauty which has been a delight to all who have heard them.

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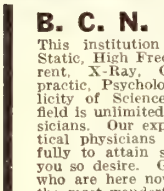
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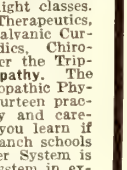
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Hello Mars!

By H. WINFIELD SECOR

(*Continued from page* 1250)

well, and it is not formed of any earthly combinations or codic conjugation with which you are familiar. Can you imagine what your first effort would be towards solving this problem?

For the moment we may even consider that you have at your disposal even the interplanetary wireless telephone, but of course in its infancy, so far as communication with the Martians is concerned.

Is it not a most interesting philosophical conundrum to try and think just what you would do in this case? Would you try to talk to the Martian and encourage him in the English tongue in your endeavor to find out what the word "gouka" meant? Or perhaps, if you are a linguist of high attainment, you might possibly try talking to him in several different tongues, of which there were at the last count, 420 different species on the face of the earth.

But we won't keep you guessing any longer, because we know you will undoubtedly tire of this reasoning, and in the next issue we shall tell you what this (supposed) Martian word means.

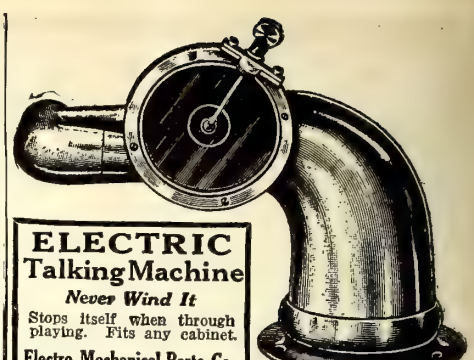
Looking at Fig. 4 once more, take a piece of paper and cover up the little animal at the left of the word r-a-t, and just imagine what a quandary you would be in upon your first sight of the word *rat*, even tho by long and patient study you had learned the outlines of the letters and knew that they constituted elemental parts of a certain language,—it matters not which one. Remember, the Martian could not talk to you, even tho he had a wireless telephone transmitter which reached the earth, because he does not know your language. And how are you going to ask the Martian in a language which you know nothing about what the word means, and what is still worse, how would you know the proper pronunciation of the word? The answer is, you *could not!*

But supposing that after you had been looking at this word for a long, long time, that suddenly one night an outline appeared alongside of it of an animal that looked like a rat! In other words, remove your piece of paper from over this part of the illustration on the left of Fig. 4 and lo and behold! you at once perceive that R-A-T equals a rat. All your difficulties have been swept away instantly.

And so it begins to look as if the only logical method by which to start a communication with the Martians in either direction is by means of *words and pictures.* This method is not entirely new, for several of our foremost astronomers have made this suggestion; but in the latest outburst from our radio and other communication experts, who are talking of sending radio or flash-light signals to Mars, or, in other words, dots and dashes of the Morse code, forming letters of a language which *we* know,—the homely philosophy and simplicity of the kindergarten rule have been entirely forgotten, it seems!

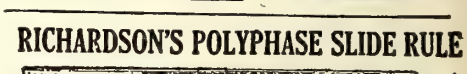
Picture yourself standing opposite a man whom you never saw before and whose language bears no similarity whatever to yours, and that by means of a semaphore or by a wireless instrument or perhaps a telegraph sounder, he starts shooting dots and dashes at you! Suppose the dots and dashes correspond to letters in *his* language. Can you by any stretch of the imagination conceive as to how you are going to interpret these dots and dashes and finally ascertain what in Sam Hill he is driving at?

(*Continued on page* 1304)



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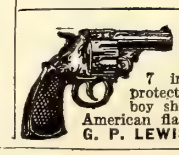
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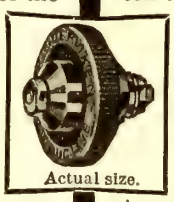
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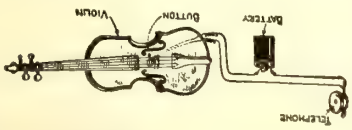
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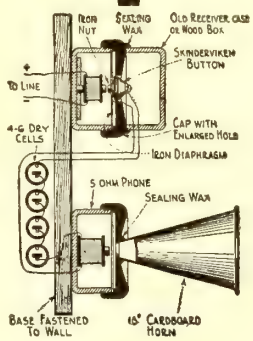
You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *This outfit was used by secret service operatives during the War. It is being used on the stage.*





So much for its commercial adaptations! *You* can procure apparatus of the same type.

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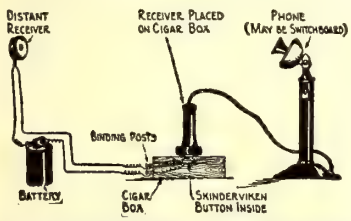
Full directions for connecting up the button for use as a detectophone are given in booklet which is sent with each button.

The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.



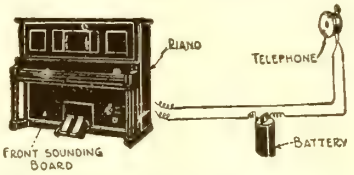






AMONG electrical experimenters the button has created a sensation. It is not uncommon to receive unsolicited letters like these: "I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

"I have been using one of these transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimenting." "I have been using one of these transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"

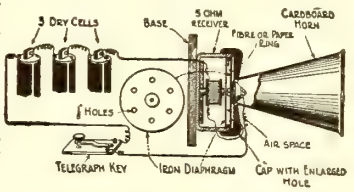


Mr. H. Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In the writer's opinion, obtained by actual elaborate tests, the Skinderviken Transmitter Button is probably the most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."

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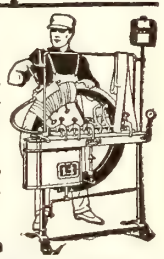
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Hello Mars!

(*Continued from page* 1302)

It is of course evident that as aforementioned, and granted that both parties have average intelligence, most likely one can make the other understand numbers from zero to nine, so that number combinations could be transmitted and interpreted—but think of hearing for the first time or, for that matter, a thousand times, a string of five dots and five dashes of the Morse code. In the other *man's* language it might mean "d" or "h" or "z" and again it might mean a house or a cat-boat or a three-ringed circus, for all you are concerned.

HOW DO WE LEARN FOREIGN "EARTHLY" LANGUAGES?

It is common to hear people say: "Why, that is easy,—when they happen to overhear a discussion of interplanetary language communication,—"If this is as hard as it sounds," say they, "then how do you account for the fact that a Frenchman readily learns German, or a German learns Dutch?" And yet it is commonplace! Very true, it is a common, ordinary everyday occurrence, but did you ever really stop to think about it at all, and how it takes place? Several very important and peculiar things happen when you learn a word of a foreign language. Supposing you are an American and that you visit France, let us say.

As you leave your ship and take a railroad train for the great city of Paris your attention is suddenly arrested by a large electric sign erected on a tall building. Remember, now, that you do not know a word of French, and assume that all of those around you knew not a single word of the English language. How would you find out what the illuminated word meant?

Possibly, if you nodded your head in the direction of the display a sufficient number of times to make the Frenchman near you eventually awaken to the fact that you were in doubt as to the word on the sign, he would make some bodily motion to give you some inkling as to what the word meant. But unless you happened to live to be so old that you could look thru a marvelously high-power telescope a couple of thousand years from now, which would magnify the Martian himself, so that you can see his bodily movements, then it is evident that you are going to have a merry old time finding out what a similar strange word, if presented to you in the form of illuminated letters on Mars or otherwise could mean.

While speaking on the subject of how we assimilate the language of another nation, it should be remembered that never do we learn a word of a strange tongue and its full meaning *unless we see in some way or other a comparative picture of what the words means.*

The American Doughboys in France picked up many French words. Of course they did, why not? The French man or woman would show him a bottle or cup, or saucepan or stove and utter at the same time the French word. Naturally, as he is an intelligent being, he will know that the particular word uttered in each case represents the object which was shown him.

So once more we see that it is in every case the simplest and the shortest method and in fact the *only logical method* whereby to teach the language of one nation to the other,—that is, by *words and pictures* simultaneously, or by a similar and equally clear illustration.

Another very important element in interlanguage relations is the fact, particularly in Europe, that there are a dozen and probably several dozen different languages, so-called, which have a very large number of common generic roots, and this explains all

(*Continued on page* 1306)

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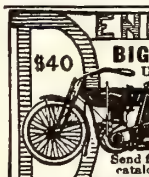
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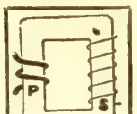
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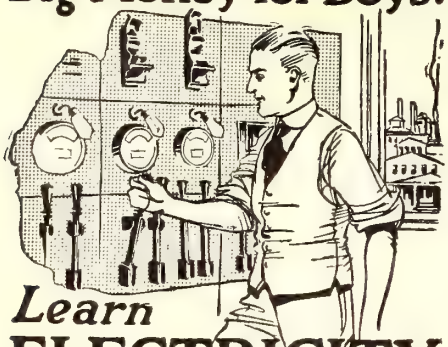
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Hello Mars!

(*Continued from page* 1304)

the more clearly how it is, for example, that an European comes to America and tells you he speaks six or eight languages, or possibly ten. Of course he can do it, and so would you as an American, if you were continually thrown in with people of other nations as the people of Europe are intermixed, some of the countries being very small, and if the languages of these different peoples had numerous generic roots similar to your own. But when you meet one of these high-brows ask him if he speaks some radically different tongues, such as English, Chinese, Eskimo, Indian, Russian and Turkish, which have no similar generic roots. That is another story, you can bet!

HOW A CHINAMAN LEARNS ENGLISH.

Fig. 5 shows an interesting case right in line with the would-be Martian conversationalist's theories. This experiment has actually been tried out as a professor of languages explained to the writer, and shows just what he has always contended,—that, lacking a picture or verbal description together with a word of a strange language, or else some other visual effect, such as a motion of the body, jerking of the head, or pointing of the finger, etc., that it is practically impossible for two exponents of two radically different languages to interpret a single word of what the other is talking about.

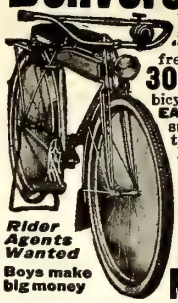
The illustration at Fig. 5 shows how a Yankee and a Chinaman were placed on either end of a telephone line. This happened some years ago in the South Pacific Islands, where the linguist aforementioned was stationed at the time, and this gives a very good illustration of what we have been talking about, as the two languages are widely separated and have no comparisons in common. If you think they have, go into the nearest Chinese laundry and get John the Chinaman to wish you a "Happy New Year" or some equally plain or well-understood salutation in his native tongue. !**!!-?-* Would you *ever* recognize it?

Well, to make a long story short, the "Yank" gabbled away at the telephone at his end of the line—and the "Chink" did likewise. They kept this up for a good many days, in fact for several months all in all, and the sum total of all this talking and wasting of dry batteries,—not to mention the time which might have been enjoyably spent fishing on the coral shores,—was *NOTHING!*

Very few linguists have attempted to learn Chinese, but that language is no more difficult for a moment than trying to learn *Martian;* for you can go to China (if you have the price) or for that matter get acquainted with a Chinaman who speaks English, right in New York City or your home town, and after spending several months in special sessions with him you will perhaps have an idea of a few (?) Chinese words. Some languages are simple and some not so simple. Ours is fairly so, and the Chinaman thinks his is first class, altho his children spend the greater part of their lifetime mastering its intricacies.

There are about 16,000 different signs used in the Chinese language to indicate the different objects. If you want to write the word house, you make a sign like this  and if you want to become a real high-class Chinese college man, you must learn over twice this number, or 40,000 signs each signifying a different object. Suppose the Martians have such a language? How do we know? We don't; and even with word-pictures it would be a slow job, for their objects might not be familiar to us.

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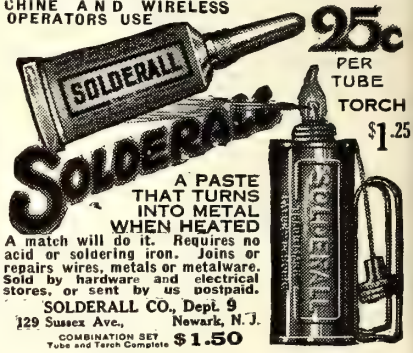
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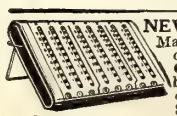
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WHAT THOMAS A. EDISON AND SIR OLIVER LODGE SAY.

Thomas A. Edison believes, according to a recent publisht interview, that contrary to the contentions of many eminent radio scientists, the Heaviside *ionization layer* in the upper atmosphere of the earth would prevent earth-borne radio signals from passing out into interplanetary space—that these earth-borne radio signals would be propagated into interstellar space for hundreds of thousands of miles by means of the ether waves, and that it is possible that the Martians, if there are such beings, had received these signals, altho they might not have the slightest idea as to what they might mean.

As he jocularly remarked in an interview at the recent celebration of his seventy-third birthday, and granting that the messages radiated by our powerful trans-Atlantic radio stations had reached such distances as Mars, how do we know whether they are received or impinge upon a *human* or a *chimpanzee?* It is the opinion of the writer that the stray signals to which both Dr. Marconi and Dr. Tesla refer to, as having been heard in their long-distance radio stations from time to time, are either signals from unknown distant stations or else they are static disturbances caused by disturbances of the electrical equilibrium of the atmosphere, or possibly of the earth itself.

Now that everyone in the scientific world is taking a crack at the interplanetary communication game, Sir Oliver Lodge, the well-known British scientist now touring the United States, made the following suggestion:

"Nonsense," said he, when asked if he thought it possible to communicate with other planets by *wireless telegraphy*. "It would be possible to place an immense geometrical figure, say on the Sahara Desert and then, if the inhabitants of Mars are of a high order of intelligence, they may be able to distinguish the figure and determine that it had been the work of man. Geometry is a universal science, and it is not unlikely that if they are of a higher order of intelligence than we that they can interpret the gigantic figure as an effort at communication." (See illustration, Fig. 6.)

"ILLUMINATED WORD PICTURES" FOR THE MARTIANS.

A writer in the *Western Electric News* recently made the following suggestion which seems almost comic and, in fact, tragic, when we come to figure the bill, but still it has the essence of sound logic in it, when it comes down to real Earth-Martian intercommunication. He suggests that we take a large piece of ground, such as the whole State of Illinois, and install upon this nice flat piece of ground several million 1,000 candle-power flood lights fitted with reflectors and shutter attachments. These, of course, would all point sky or Martianward, then he continues: "Choose a dark night and start the flood-lights working. I would suggest that a complex net-work of shutter control circuits he hooked up with some automatic printing telegraph machines, so that by shoving a piece of perforated tape thru the automatic transmitter the whole set of lamps could be illuminated in any pattern desired

"For instance, an outline of the United States could be shown by the lamps (see Fig. 7 herewith) and at the bottom *huge letters, about three miles long,* can spell out the words 'U-N-I-T-E-D S-T-A-T-E-S.' By the aid of their modern ultra-powerful telescopes, the scientists on Mars can or should see at a glance what we were driving at, and it would not matter whether they saw the period mark or not."

SPERRY PROPOSES 250,000,000,000 C. P. MARTIAN TORCH.

And now comes a proposal by Elmer G. Sperry, inventor of the world's most power-



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YOUR opponent has you about the throat —he is choking you! What can you do? Simply reach up with your hands, get hold of his two little fingers and give them a quick snap back. He will let go immediately.

Or suppose he has his arms around your waist, and is forcing you back and down. How can you break that hold? Simply put your two thumbs on your opponent's eye-balls and your other fingers on his forehead. Then, while pressing upward and inward with your thumbs, give your opponent's head a quick snap backward. He will release you at once. (Be careful if you try this on friends.)

Then if you knew something about boxing, you would be in a position to give him a sound thrashing. You would know how to put the entire weight of your body behind each smashing blow, and how to land the blow where it would hurt most. And at the same time you would know how to guard against his blows for your face, stomach or ribs.

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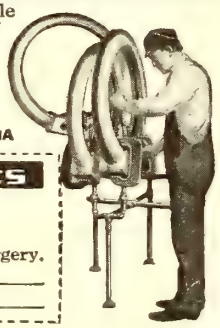
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ful electric searchlight, shown in the accompanying photographs, to utilize a battery of 200 of his 1,250,000,000 C. P. searchlights in one gigantic bank and to concentrate their rays into one powerful beam of light, which it is figured that the Martians cannot miss. It is claimed that this flash of light would be visible on Mars as a star of the seventh magnitude, which is easily picked up by our telescopes.

The accompanying photographs were taken on the roof of the Sperry Gyroscope Company's factory in Brooklyn, New York, and certainly shows in a very interesting manner the great power of this most powerful electric searchlight ever built. Two hundred of these searchlights would give a total candle-power for Martian signaling of 250,000,000,000—rivaling the sun itself.

The fan arrangement of light beams in one of the photos was formed by an arrangement of six large reflecting mirrors which produced a very brilliant and spectacular effect, as will be seen. See Figs. 1 and 1-A.

MYSTERIOUS DOTS AND DASHES MIGHT FORM MARTIAN PICTURE.

Mr. H. Gernsback has suggested that if the proper interpreting apparatus was brought into play, that the mysterious dots and dashes received on the radio antenna of the Marconi station, and also those cited by Dr. Tesla, might yield some very surprising results. In other words, if these were recorded, as for instance by a light beam controlled by a set of magnets connected to the radio receiving apparatus antenna as shown at Fig. 8, on a sensitized photographic cylinder, fitted with a threaded axle or shaft, which would cause it to move longitudinally as well as rotatively, past the fluctuating light beams, that when this was unrolled from the drum there might be developed a word-picture or such as we have shown in Fig. 8.

Now, there is nothing startlingly novel about this apparatus. As a matter of fact it has been used about ten years ago for the transmission of pictures by radio and considerable success was had with this method. The pictures can be transmitted entirely either by dots or by dashes—it makes no difference which, and a minute's consideration will show that with a transmission of this kind no regular sequence of the dots or dashes is feasible or even possible.

In other words, the time element between the succeeding dots or dashes all vary and will never be alike. Due to these differences in time between succeeding signals, the radio picture is built up.

As Mr. Gernsback points out, were the Martians to send us such radio pictures, they would probably first pick out some astronomical fact, as for instance the planet Saturn with its rings. Alongside of this would then appear the symbol in the Martian language whatever they might be.

This is shown in our illustration, Fig. 8. If the Martians were to send us pictures such as these, extending over a number of months, it would be very simple for anyone versed in deciphering foreign languages to become acquainted with the Martians' alphabet or language, as the case might be, and very soon we would master the language without much trouble. By this method the Martians could show us how they transmitted the messages to us, and we in turn could then follow suit and answer back by a like method.

This idea was prompted by the fact that it is apparently almost impossible for us Earthians to interpret intermittent signals such as dots and dashes or short and long flashes of light hurled toward us by another planet, into intelligible language—and as the Martians are supposed to be far more intelligent and more scientifically developt than we, it is possible that some such scheme as this may be eventually worked out by our scientists. Many wonderful things have

happened in the past twenty-five years and in the past one hundred years there has been a greater advance in science than in all the centuries that went before.

SOME OTHER OPINIONS.

Dr. James Harris Rogers, of Hyattsville, Maryland, the well-known inventor of the underground and underseas wireless, has recently announced that he is preparing to set up delicate radio receiving instruments in his laboratory capable of responding to signals up to 150,000 meters wave length. This is said to be 50,000 meters greater wave length capacity than that used at the Marconi station, where the mysterious signals have been noticed by Marconi himself and which he believes to have come from some far distant planet—such as Mars.

In a recent interview Dr. Nikola Tesla had the following to say: "That the planets are inhabited is a foregone conclusion. I believe that the time has come for a serious attempt in the direction of interplanetary communication. We can begin by erecting a plant for transmitting the signals conveying the knowledge of numbers, which would be the simplest truth that could be communicated to the Martians or other worlds' inhabitants, and which would be answered immediately if the planet is populated by a race as civilized as ours. Once the first step is successfully carried out, it would then be very easy to install more elaborate apparatus *for the transmission of pictures,* by means of which the most intricate thoughts can be communicated."

Another writer on interplanetarian communication, believes, like Sir Oliver Lodge, that geometric figures would be very plausible as the first stepping stone to open up relations between the earth and the Martians, and the sponsor of a very interesting theory, Mr. J. G. Carter of Clifton, Ohio, puts forward the suggestion that the snow flakes which fall during our winter season may even be influenced in a positive manner by agencies controlled by the inhabitants of other planets, such as Mars. This theory is based on the fact that there is a very large number of different geometric designs assumed by falling snow flakes.

In closing, we may very well take a few moments to digest some remarks of an interested reader, Mr. Martin C. Hansen, on the subject of communicating with Mars.

"From some recent newspaper clippings I have noted the following statement: 'Some wireless experts believe we shall soon be able to exchange wireless messages with such planets as may be inhabited.' YEH! says I. And again, one article claims Venus to be a 'younger' sister of the earth. Well! well!

"Now, if Venus is so much younger than the earth, then we must also concede its race of inhabitants are also younger, both in nature and inventions. If this is true then we may have to 'feel' *them* for radio signals for generations to come, before we can hope to get any answer. And just as Martians are supposed to have done the same thing with us for hundreds, if not thousands of years; so will we have to keep on signaling the Venerians.

"To return to the subject of intellectual Martians. If the Martians are so much wiser than we by a million or more years, *then they have NOT tried to wireless us for the past thousands or more years,* as they certainly ought to have telescopes and other instruments to actually ascertain what we are doing along the line of inventions and mechanics, etc., and they would not be such fools as to signal us, *when they would know we had no instruments of any kind to record their signaling.*

"If Venerians are a million years younger than we (if we knew this to be true), then we are certainly the most consummate fools in believing we can send messages to them because they are as yet the lowest cave men of the stone age."



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Every day you see men around you stepping up into better jobs and drawing bigger pay. It isn't a question of "how do they do it?" You know they have trained themselves to handle the jobs ahead of them. The question is "WHY DON'T YOU DO IT?" You want the things that better pay will bring you so why not decide NOW to prepare yourself for a better job and better pay?

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Promotion and better pay is up to you and not the boss. The big pay checks go to those who can think, act and do things for themselves. Training will make you a master of your work **and place you in the job you want.** There are no two ways about it; while you ignore the benefits of training you are **dodging a better job.** Without interfering with your work you can prepare for bigger pay right in your own home—after supper in some of the hours you now waste. The thousands who have marked and mailed the Coupon to the right have doubled and trebled their pay. That is just what you can do—so do as they did. Send the Coupon.

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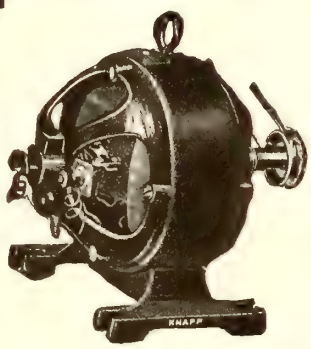
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Light and Power from the Sun

(*Continued from page* 1241)

A year or so ago there was described in this journal another solar power plant and an elaborate scheme was detailed and illustrated therein for revolving glass heating units in perfect synchronism with the sun by means of an electric-clock regulating device, so that not only did the complete bank of solar units rotate from east to west, but also the angle of the surface of the units was tilted so that this surface was kept exactly at right angles with the solar rays, which means that the surface of the glass tank or units must swing from right to left in the course of the daylight period from eight to ten hours, and also they must be tilted from a nearly vertical position in the morning—thence to a horizontal position at noon—and then once more to an approximately vertical position again in the evening.

In Mr. Willsie's solar power plant there is a trough arranged at the bottom of the glass heating tank into which the heated water at a temperature of 150 degrees or more runs off thru a pipe into the storage tank which in insulated with layers of dry sand. Mr. Willsie explains that *the water will remain hot from four to ten days* when stored in this tank, and here we have the key to a very novel principle involved in Mr. Willsie's plant, viz., that he can run his engine and dynamo at night without any storage batteries and obtain electric lights, etc., which he actually did at his Arizona plant.

Originally, however, when the plant is put into complete operation, the heated water runs from these storage tanks into the sulfur dioxid engine and boiler system, as shown clearly in the diagrammatical illustration herewith. Sulfur dioxid, as is well known, has a low boiling point, so that it can be placed in the boiler and heated up, allowing the hot water to come into contact with the boiler tubes containing the sulfur dioxid. When the sulfur dioxid in the boiler commences to boil, you then obtain the necessary *sulfur dioxid steam* wherewith to run the engine. In other words, instead of using the fire to make steam in the boiler, hot water is used instead, which originally obtained its heat from the sun directly.

As the sulfur dioxid steam leaves the engine cylinder it is not exhausted into the open air, owing to its initial high cost, but it is exhausted into a series of pipes over which cold water is sprayed. This water, in the case of irrigation plants, such as that developed by Mr. Willsie in Arizona, is the same water that is pumped by the engine (the pump being a separate machine connected to the engine by belt or otherwise) for irrigation purposes, so nothing is lost in this stage, but the sulfur dioxid steam is condensed and is then repumped or otherwise directed back again into the boiler, only to be heated all over again by the hot water coming from the sun tanks.

As Mr. Willsie has pointed out, electric light was had at night at his Arizona solar plant, which was actually made by the rays of the sun shining during the preceding day, a *seeming paradox,* were it not for the facts explained heretofore—that he has found it possible to cause the hot water to retain its quota of heat energy even for several days at a time, when it is stored in properly built tanks insulated with layers of dry sand, or other heat insulating materials.

Where this may not be practicable, we can always have recourse to electric storage batteries, in which the dynamo would pump electric energy during the day on

certain days. Then whenever the battery became sufficiently low in its charge, the electric energy required could be drawn from the storage battery at night or at any other time. Under certain conditions it would probably not be necessary to operate the solar plant to charge the storage battery more than one day a week, as, for instance, where such a plant was installed (of the proper size, of course) for, let us say, lighting a private dwelling or farmhouse and outbuildings, etc. By having a sufficiently large storage battery which would generate the energy required for lighting purposes for a period of one week, this could be taken care of by charging for just one day complete.

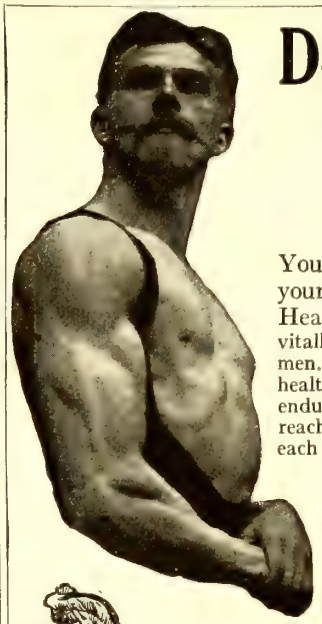
At any rate, it is a case of getting *something for nothing,* so far as spending the "coin of the realm" is concerned, and this is what most people are worried about today, with the H. C. L. still soaring skyward. Of course, it is not something for nothing in a strict sense of the word, for we are utilizing the *energy of the sun's rays.* The foregoing covers the doubt exprest by many people when they first hear about solar energy plants, for their invariable and natural first question is "What about cloudy weather, and, even tho we have quite a number of sunny days, you may even have three or four cloudy days in one week?" This is very true, but the aforementioned explanation as to charging the storage batteries but one or two days a week, or possibly, as Mr. Willsie points out, by suitably storing the heated water in special storage tanks, explains this problem.

And, anyway, it will probably not come to pass very soon that we shall be selling and installing solar electric lighting plants on the roofs of apartment houses, in the northern parts of the United States, as if these were as cheap as sand in the Sahara Desert, the average city dweller would not bother with it, when he can spend $2.00 or so a month and have the local electric lighting company supply all the "juice" he requires without bothering his head about it. But it is another question when we come to consider the vast stretches of land such as those in the South and Southwestern parts of the United States, where the fight for survival of plant life is seen to be dependent upon the all-important quantity—*water.* And here is where these solar plants should and will find their ultimate goal and adoption in large quantities, for it is uneconomical under any consideration, to attempt on a large scale an irrigation of such large tracts of desert by means of *coal or oil driven plants,* as these fuel commodities are becoming more expensive each year.

TRANSMITTING ENERGY.

Wireless telegraphy and wireless telephony suggest the possibility of transmitting energy by wireless waves. "Suggest" is right—we'll say. A Rumanian engineer, M. Constantinesco, has been experimenting in England with a method that seems novel.

He uses a tube filled with water or some such liquid, in which vibrations of the nature of sound waves are produced at one end and the energy is reconstructed at the other end in a mechanical form. The details of the apparatus are kept secret, but Constantinesco's researches have been financed by the British Government, and it has already been applied in the mechanism that stops the discharge of bullets from the rapid firing gun of an aeroplane each time that the blade of the propeller passes before the muzzle. This is what makes it easy to fire 2,000 shots a minute thru a propeller making between 1,000 and 2,000 revolutions a minute. (But what has this got to do with the wireless transmission of energy? Leave it to the daily "news technicians."—EDITOR.)



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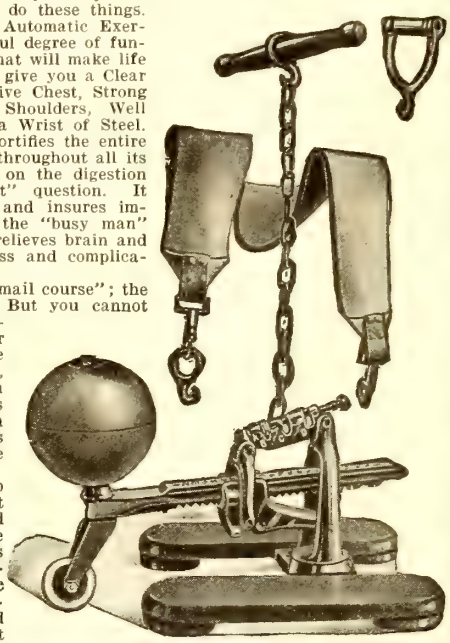


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Ten minutes daily on the Automatic Exerciser will build up a wonderful degree of fundamental, physical strength that will make life and work a pleasure. It will give you a Clear Brain, Powerful Heart, Massive Chest, Strong Lungs, Fine Back, Broad Shoulders, Well Shaped Arms and Legs and a Wrist of Steel.

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Calves and Ankles	410 lbs.	892 lbs.	482 lbs.
Back	508 lbs.	1,382 lbs.	874 lbs.
Shoulders and Arms	356 lbs.	641 lbs.	285 lbs.
Neck	185 lbs.	375 lbs.	190 lbs.
Biceps	87 lbs.	280 lbs.	193 lbs.

His fingers show an average gain in strength of 100%.

Records of one month's results by Mr. Thomas Waring, Hamilton, Ont., Can.

First Record	Second Record
159 lbs.	411 lbs.
134 lbs.	461 lbs.
.....	.....
54 lbs.	88 lbs.
41 lbs.	86 lbs.
20 lbs.	54 lbs.
.....	.....
Abdomen	
46 lbs.	102 lbs.

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Hundreds of thousands have tried this PLAN and have succeeded. Would you not love to try it?

The first step in demonstrating THE LIFE WAY PLAN for yourself is to get my free book—THE LIFE WAY. It explains the PLAN and is brimful of facts you will be glad to know. It tells you how you may have for your very own this "Secret of the Ages," and go singing the song of abundance through life.

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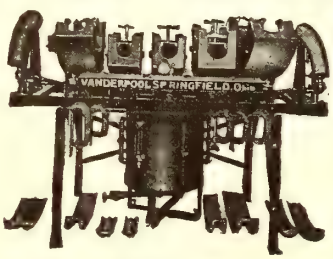
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Electro-Medical Frauds

By JOSEPH H. KRAUS

(*Continued from page* 1254)

concern, in advertisements, claims that low sounds and whispers are plainly heard and altho it may be used in a few cases, the claims are misleading.

The device is a small oiled silk artificial drum having a waxed silk thread attached to it. A piece of flexible rubber tube is likewise included for insertion of the "phone." The total price which the Morley concern charge for this device is $5.00, its cost being about 25 cents. Something similar was originally constructed in 1852 by Toynbee, altho the heads of the Morley concern claim the invention, having secured several patents on the same. It is nothing but an artificial drum head, which is inserted into the ear. Indications for the use of the same can only be determined by a *competent aurist,* after a most rigid examination.

Another drum of a similar nature is being sold by the Artificial Ear Drum Co., which is a rubber contrivance called a *Medicated Ear Drum.* Each end of this is enlarged with a constricted portion in the center. All that is necessary is to push the device into the ear and Zowie! you can hear!

Likewise, we have yet to see where a case of discharging ears has been remedied by a similar device. The Wilson ear drum is another of the wonderful w'reless telephones for the ears for which great claims and testimonials have been advanced.

Quite different from the above devices is one even now on the market and claiming International Notoriety, called the *Macaura blood circulator* shown in Fig. 6. The inventor organized institutes and gave lectures for the sake of perpetrating the sale of his blood circulator or pulsator. This prince of fakers, Dr. Macaura, then went so far as to rent auditoriums and gave two shows weekly. His advertisements appeared the world over. Finally, after having the most marvelous advertisements, rivaling everything in splendor and imagination in various papers, announcing the discovery, and after having shifted his scene of operations thru various countries, the self-styled "Doctor," who had swindled so many thousands, was imprisoned for three years and fined $600.

It is here called the Cirkulon, and costs over $15.00. It is a simple hand-operated, vibratory device which will do none of the things claimed for it, and is far less efficient than the vibratory massage devices being sold at a much cheaper rate.

The greatest series of ridiculous and nonsensical devices are those known as the *gas pipe* cures, among which are found the Electropoise, Oxydonor, Oxygenor, Oxypathor, Oxytonor, and Oxybon.

These wonderful discoveries consisted of a nickel plated gas pipe, beautifully finished at both ends, with two wires running into the same. This cylinder was about 3½ inches long and weighed about 5 ounces. At the end of the wire is a small disc which is attached to the wrist or ankle, or both, by means of an elastic band and buckle, according to the treatment. In general, they are filled with either *nothing* or else a worthless compound, such as carbon, either in stick form or pulverized, iron filings or perhaps coke dust.

The first two of the aforementioned devices were *empty, altho claimed* to possess remarkable *electric* (?) qualities. The Oxygenor was claimed to *oxygenate* the blood of its victims. This fake was filled with "rare and costly" materials, according to the makers (sulphur and charcoal by analysis). The ozone so generated traveled directly "thru the pores" and was so pow-

erful that a *regulating cord* had to be attached to the device.

It cured everything from chicken-pox to epileptic fits and from measles in childhood to heart failure at old age. When placed into a tube of water it absorbed all the oxygen from it and *pumped* it into the blood—(at least the inventors said so). Particularly in view of the fact that water is made up of two atoms of hydrogen and one of oxygen, we are hence, questioning what the water looked like after all the oxygen had been removed!

Another of these same *gas pipe* frauds was guaranteed to cure everything except cancer and tumor, on which it had no effect. Of course, the makers had to admit that there was some *trivial* disease that could not be cured, as a *cure-all* is sometimes looked upon as being a fake, but if glaring headlines state that we can cure everything but tumors, why, of course, that sounds more reasonable.

These devices were sold at prices ranging from $10 to $35. Their actual cost not being more than 50 cents to one dollar, and their actual value being about .00007 mills, i. e., they would bring this as *junk*.

The magnetic blanket shown in (Fig. 8) is another of the magnetic frauds which need not be discust at any great length as magnetic devices have already been described. It is another method of extorting the "coin" from an unsuspecting public.

A wonderful seller at one time was the *vacuum head cap* which stimulated the scalp and induced the naughty hairs which the great bald headed man desired, to stop playing hide and seek and come out for a little air. It just seemed to suck this hair out. This rubber cap, connected by a hose to a pump operated by foot power (or a motor driven suction device if the person had the wherewithal to pay for the same), was clapt on the head and placed into operation.

As to the fallacy of the *modus operandi*. When a suction device is applied to any part of the body, it causes the blood to be drawn to that part, *but at the same time causes a congestion* in the superficial veins, arteries, and capillaries, hence, the much desired results are not produced.

In addition, it may be of some slight value to note that the hairs are only modifications of the skin and consist of the same structure as that membrane. When therefore, once the root of a hair has been killed, and its follicle destroyed so that a shiny bald pate presents itself, it is impossible to coax any hair from the head.

Storage Battery Repairing

By HENRY KLAUS

(*Continued from page* 1277)

battery out of an old one, altho this is not the case every time. A method of refilling the old frames was given in a back number of the EXPERIMENTER, but they would have to be sawed off in order to get at them and then welded back on. It is better to put in new plates and refill the old grids for use in small cells which can be sold to run toys for kids.

A battery with the plates short circuiting will show little or no voltage, while one with the active element gone will give the normal E.M.F. but hardly no amperage.

When the plates must be taken out you will be careful and not spoil the rest of the outfit. Ordinarily it is practical only to take out one cell at a time. The connections between the cells must be unscrewed or unfastened if possible or else sawed in two. The pitch around the ends is melted and the plates pulled out as shown in the diagram. We have used two methods for this, the blow torch, and moderately high pressure steam. The first is more practical because it is more convenient, handier,

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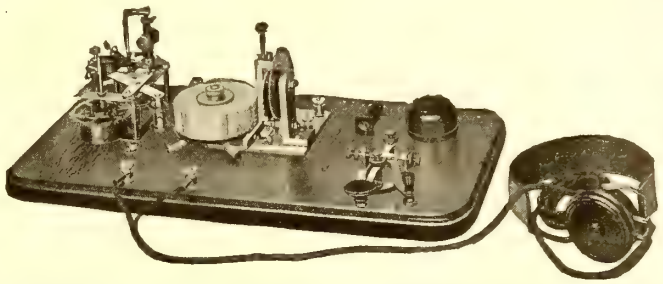
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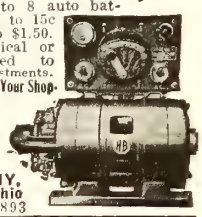
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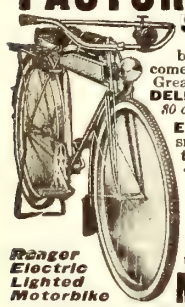
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and cheaper, altho more care must be taken not to burn the wood or the hard rubber covers and jars. If the hard rubber is accidently heated too much it must be held in the right shape while it is soft.

A common trouble is a cracked jar. A supply of the sizes most used would be a good investment. When they are not broken too bad we have found a recipe in a back number of the EXPERIMENTER that worked well. Also, when only one of two adjacent cells is cracked a home-made celluloid jar (EXPERIMENTER) did the work nicely.

Be sure you don't get the cells reversed when you put them back in. They are pusht down as far as before and the pitch melted again. The connectors are soldered together with the electric welder as the picture shows.

The carbons from old flashlight batteries are ground to a point for use on the electric soldering outfit. If a high amperage battery is used it gets red hot the moment the contact is made. Always connect it to negative pole.

A still for making the distilled water is given in the diagram. It can be put in glass jugs and sold, at a good profit.

A few hints.

Don't fill the cells more than ½ in. above plates.

Don't pound the plug to get it out of the terminal lug, loosen it with a pincers.

Keep the vent plugs out while charging.

Wear a rubber apron if you have one while working on batteries.

If you file a soldered joint down smooth don't leave the filings on the top, it may short-circuit. Acid or water spilled on the battery may do the same.

Home-made 110-Volt, 60-Cycle Induction Motor

By H. H. PARKER

(*Continued from page* 1272)

about three pounds will be required. Care should be taken that the coils are well insulated at every point from the iron core.

Assuming that all coils are wound in the same direction, connect the end of one coil to the end of the next, the beginnig of that to the beginning of the third, and so on. This will leave the beginning of the first and the beginning of the last to be connected to the terminal block (Fig. 1, 12), and so to the 110-volt A.C. 60-cycle mains. Fig. 12 shows one method of terminal block construction: two 1" by 2" fiber blocks held together by the terminal bolts. The inner block is held by a 5/16" carriage bolt, which also acts as the top clamping bolt for the stator core; the square head being countersunk in the fiber prevents the blocks from turning.

The rotor must be thoroly insulated with thin fiber, paper or tape and shellac before starting to wind the coils. These are four in number, one surrounding each rotor tooth, tho to do this it must have a right-angle turn. There are two ways to wind the rotor: coils wound over a wooden form, taped and bent into place before inserting the bolts and fiber posts, or assemble these and wind the wire directly on the core and getting the turns as even as possible under the conditions. No. 24 D.C.C. wire is used for the rotor, using as much as will go on, but taking care that about the same amount is used on each coil so that the rotor will not be unbalanced when the motor runs. The windings are short-circuited: assuming all coils wound in the same direction, connect the four inside ends together and then the four outside ends. Soak the coils well with shellac or insulating varnish and allow to thoroly dry. For protection from injury, the stator coils may be wound with a layer of heavy string, or covered with tape and shellacked.

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In assembling the completed parts of the motor, see that the rotor turns freely without touching the *pole faces* or the *stator coils*. At least 1/32" end play but not more than 1/16" should be allowed the shaft. The air gap ought to be practically even (1/32") all around. Any size holes can be drilled in the feet to screw the motor to its foundation.

If any other frequency is used, the motor speed in revolutions per minute may be found from the formula

$$S = \frac{2 \times f \times 60}{p}$$

where "f" is the frequency in cycles per second, and "p" the number of poles, four in the case of this motor.

Talking Over a Sunbeam

By PROFESSOR A. O. RANKINE

(*Continued from page* 1263)

would open and close. In actual practise, the movements of the diafram are extremely small—a few thousandths of an inch only—and it would be extremely difficult to make the grids at once so fine and so rigid as to operate satisfactorily. The author's modification of this method, as will be seen later, surmounts this difficulty.

Graham Bell's second device is much more practicable. It depends on the fact that a vibrating diafram is constantly changing its curvature, first being flat, then convex, then flat again, then concave, and so on. By silvering the diafram, thus making it a reflector, and allowing light to fall upon it, the reflected beam is made more or less divergent according to the shape of the diafram. The latter, being set in vibration by speech sounds, thus causes the amount of light received at a distance from the reflected beam to fluctuate in the manner desired. It was with this instrument that Bell first communicated speech by light, and he called it a "photophone."

After Bell's experiments there was a long period during which little was done. But about 1900 the German physicist, Ernst Ruhmer, made a long series of interesting experiments. He attacked the problem from a different aspect. Starting with an electric arc, he devised means of causing small fluctuations in the arc current, by using a microphone. He thus succeeded in making the arc itself change in brightness in accordance with speech vibrations. These light variations were projected to a distance by means of a searchlight mirror, and received on selenium in the way already described. Ruhmer claims to have telephoned in this way to a distance of several miles. But the method suffers from several disadvantages. In the first place it is limited to the use of an electric arc, and thus one cannot use sunlight, which is very much more efficient. Also it is very difficult to keep the arc in the necessary sensitive condition—it continually requires adjustment.

It was these considerations which caused the author, when asked in 1916 by the British Admiralty to re-open the investigation, to revert to the general principles underlying Graham Bell's methods. The device which the author has produced, and, to some extent perfected, depends on the fact that it is much easier to move a beam of light than a material grid, and that it is necessary in some way to magnify the very small movements which occur when a diafram vibrates. Figure 2 is a diagram showing the essential features of the transmitting apparatus. On the right hand side of the diagram is shown a trumpet at the end of which there is a phonograph sound box. At the place where the needle is ordinarily placed, there is rigidly attached a small mirror, about ½ inch in diameter. If speech sounds enter the trumpet the middle of the diafram vibrates and actuates the lever so that the small mirror executes angular os-

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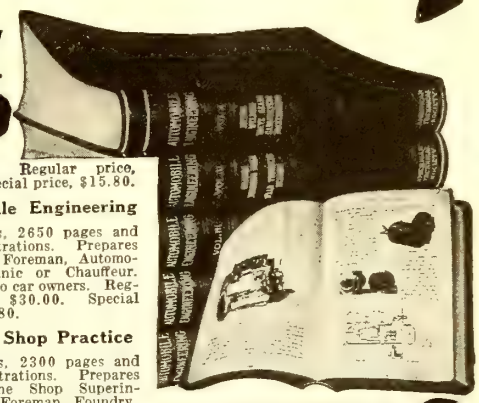
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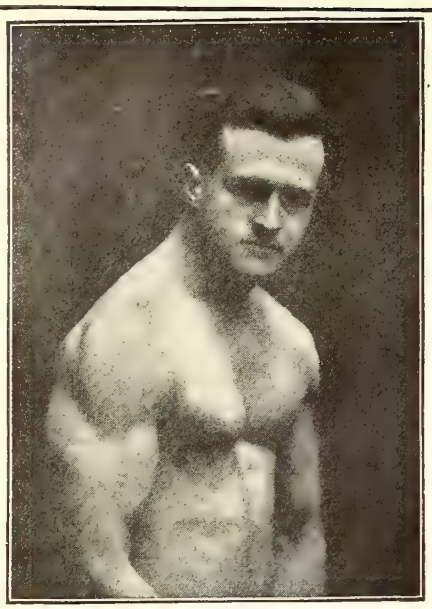
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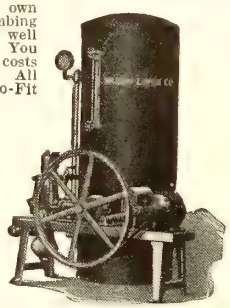
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cillations of small extent about an axis perpendicular to the diafram. Light from a source, such as an arc, or, it may be, the sun, is focust by means of the first lens upon the vibrating mirror, whence it is reflected to the second lens. The latter is arranged so that the vibrating mirror is at its focus, and the beam of light is thus made parallel, ready for projecting to a distance. Close up to the first lens is placed a grid, with spacings equal and alternately opaque and transparent. A second exactly similar grid is placed close to the second lens. The incident light is thus split up into segments (indicated by the unshaded parts) and these segments are reflected by the small mirror to the second grid. Now when the small mirror turns through quite a small angle, the reflected segments of light turn also, and the amount of light penetrating the second grid evidently depends on the position of the vibrating mirror. *In the diagram the position shown is that in which 50 per cent of the maximum is being transmitted.* When the vibrating mirror is set in oscillation by speech sounds the light filaments shown on the left hand side of the second lens get broader and narrower and we have the fluctuating beam of light which is required. The advantages over Graham Bell's method are obvious. The grids need not be inordinately narrow, provided the distance between them and the vibrating mirror is considerable. The grids themselves do not move at all, but we still get the effect of a shutter which is controlled by the speech sounds.

A photograph of the mounting of the vibrating mirror and the sound box is shown in Figure 3, and Figure 4 is a photograph of the whole transmitting apparatus mounted for use. In this case the sun is being used as the source of light. The sunlight falls upon the large mirror shown on the left-hand side, whence it is reflected thru the first grid on to the small mirror, thence again thru the second grid and the projecting lens. The apparatus is mounted on the equivalent of a gun mounting and provided with sights so that the beam of light may be projected in the desired direction, and thus caused to fall upon the collecting lens, which concentrates the light upon the selenium cell.

The reproduction of the speech sounds by the selenium is extraordinarily faithful. It is easy to recognize the voice of the speaker. Of course, for conversations to be carried on, *there must be two transmitters and two receivers.*

It remains to add a few remarks concerning the ranges over which speech can be transmitted in this way. Everything depends on the brightness of the source of light used, and the sizes of the transmitting and receiving lenses or mirrors. The sun is the best source of light. With it, and using lenses only 6 inches in diameter for transmitting and receiving, speech is readily audible 8 (eight) miles away. There is no reason why, with larger apparatus, and more sensitive receivers, this range should not be greatly extended. It is necessary, of course, to have an uninterrupted straight line between sender and receiver. Fog, also, interferes to some extent, altho, owing to the fact that selenium is very sensitive to red light and this light penetrates fog better than blue, the interruption is not as great as might be supposed. The curvature of the earth will impose the ultimate limit of range, and for this reason telephony by light could not be a substitute for the electrical wireless telephony which is now developing so rapidly. But light ray telephony has the considerable advantage of *complete secrecy.* It is only those upon whom you purposely shine the light who will hear what you say. For this reason telephony by light over comparatively short ranges, particularly between ships at sea, and between hills in sunny countries on land, may in the future prove of considerable use.



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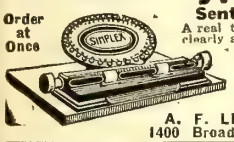


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This Fire Alarm "Talks"

(*Continued from page* 1264)

separates, resulting in the weight being released. This immediately lifts up the hook on the telephone and allows the phonograph to start its call, which has been previously inscribed on records adapted for this purpose. The record is also fitted with a very simple mechanism which causes it to be repeated many times over and either stops its action because the motor is run down, or else that the fire has dangerously neared the fireproof box of the apparatus, when the link outside the cabinet fuses and separates; the telephone hook then drops down into its normal non-operating position. In the electrical system for operating the announcer an idea equally clever has been utilized. Regular thermostats are placed thruout the building so that a rising temperature of 130 degrees will affect the closing of their contacts. In this way a magnetic device very similar to a telegraph sounder, having a tooth filed in the beam, would be drawn toward the magnets. Into this "V"-shaped tooth or notch is fitted a two-pronged hinge so that it is free to drop downward when the circuit is closed.

A steel ball is attached to the cord holding the weight up. This cord is now past thru the opening between the prongs so that the ball rests nearer the hinged portion, and thus very little weight is applied directly to the beam of the sounder. The instant the armature is drawn toward the magnets, the pronged fork is released and drops downward, due to the slight weight upon it. Immediately the pole is free to slide from between the forked lever and the weight coming downward with a sudden thud releases the phonograph and raises the telephone receiver hook.

When the link on top of the box fuses, the weight drops harmlessly to the bottom, releasing at the same time the hook which it had previously held suspended, causing the phonograph to stop.

The phonograph can at any time be removed from the cabinet and used for pleasure purposes and no connections whatsoever are made to the telephone, except for the string which is caught around the receiver hook.

"Rabbit Contest" Awards

(*Continued from page* 1269)

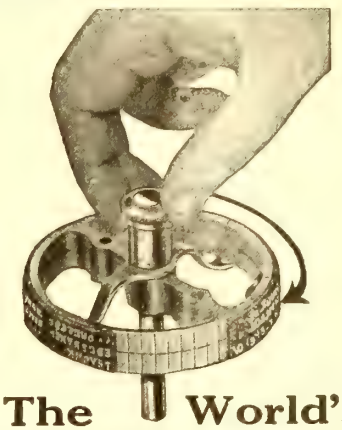
SIXTH HONORABLE MENTION

The phenomenon of the film of the rabbit electrified to 500,000 volts, shown on page 798 of Dec. 1919 issue, may be explained as follows:

Motion picture films are taken at about the rate of sixteen exposures per second. Each exposure I presume lasts about 1/100 of a second or perhaps a little more. The streamers or flashes from the rabbit do not occur at every cycle of the 200,000 cycle high frequency current. The rabbit acts as a capacity and holds the charge for an instant. When the rabbit is fully charged, the charge escapes into the air in the form of streamers and corona. The duration of the charge was not too short to allow more than one discharge to occur during the time of exposure, but too fast for the eye to perceive. The first five pictures of the portion of film shown were taken just before or after the full discharge, hence showing the streamers leaking out. At the sixth exposure, a full discharge took place at the instant. The last two pictures were exposed just at the time when the charge was being accumulated by the capacity of the rabbit right after a full discharge had taken place. JOHO YASUMURA.

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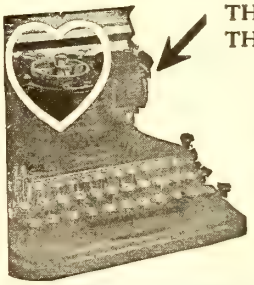
Sounds like an Arabian Nights story—but the machine itself is very practical, very real. It is the typewriter President Wilson uses personally—the typewriter he took with him when he visited King George.

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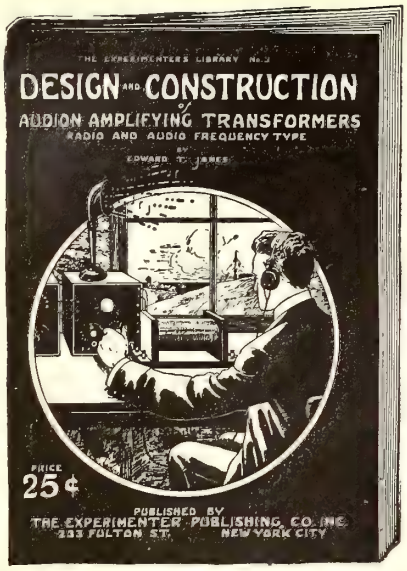


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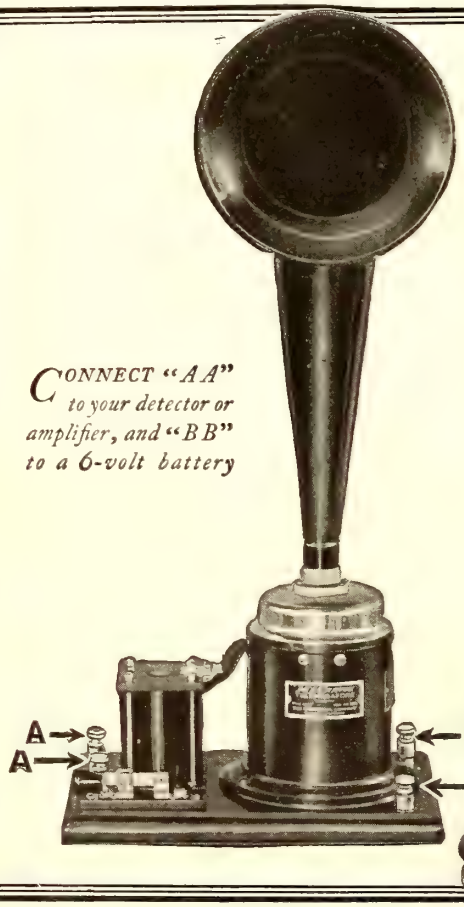
Watching Plants Grow

(*Continued from page* 1247)

This outflow of water is roughly adjusted by opening the stop-cock to a greater or lesser extent. The finer adjustment is then effected by the suitable variation of the difference of level in the two limbs of the syphon. One end is connected with a flexible india-rubber tube, which is attached to a string passing over a pulley, and fixt to the adjustable wheel B, attached to the observer's table. Rotation of the wheel in one direction will depress this end of the syphon, so increasing the flow, and in the other direction will raise it, diminishing it.

The rate of descent of the float is thus regulated with the utmost nicety, till an absolute balance is obtained. The observer recognizes the condition of the balance when there is no drifting of the spot of light on the recording-drum. The adjusting wheel is now fixt at this position of balance. If any agent should induce an acceleration of growth, the balance is disturbed, and the spot of light moves, say, to the right, or in a *positive* direction. Any agent which induces retardation will, on the other hand, cause a deflection of the spot of light in a *negative* direction.

The record is made in the usual manner on a revolving drum. Our figure illustrates the complete apparatus, which enables us to obtain a record under *balanced* —or by closing the stop-cock of the syphon, also under *unbalanced*—conditions. The wheel is graduated, and the absolute value of the compensatory movement, at any position of the circular scale, can be previously calibrated, by fixing the plant mirror, and observing the extent of movement of the spot of light on the drum, due to the subsidence of the float in a given time.



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Electrifying Canal Boats and Barges

By ROBERT G. SKERRETT

(*Continued from page* 1262)

ble of energizing the otherwise powerless boats. The latter would have the space now occupied by boilers and engines to utilize for revenue, devoting it either to the carriage of more cargo or a greater number of passengers, and would not be hampered or made dirty by frequent fueling. The prime movers, on the other hand, could go direct to the coaling pockets or the fuel-oil tanks and, being designed purely for motive purposes, grime and smoke would not entail the same property injuries. Finally, this separation of the steam plant from the freight or express vessel would measurably reduce fire hazards and lead to the lowering of insurance rates.

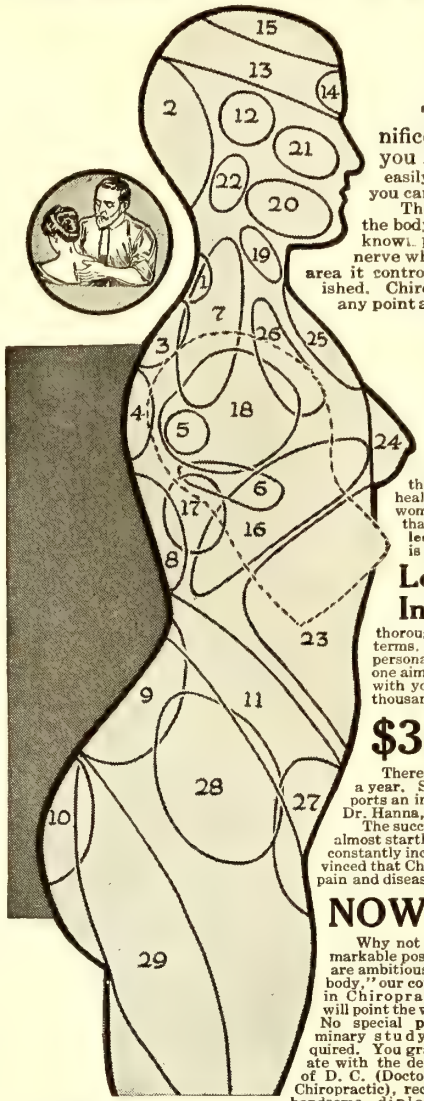
But probably the most conspicuous gain would be in shortening the lay-over periods. That is to say, the power steamer would be kept well-nigh continuously on the job; moving one ship by day and starting back shortly afterwards with another during the hours of darkness. Thus a single central plant would be able to take care of two "trailer vessels" upon a twenty-four-hour schedule. Fantastic as such a project may appear offhand, still a little analysis shows how thoroly rational the scheme really is. In effect it amounts to nothing more radical than applying afloat principles and practises that have become commonplace in the operating of electrified railways and the running of multiple-unit trains.

And now the reader will ask, what has Mr. Donnelly done both to satisfy himself and to convince others that there are not insuperable obstacles in the path of putting his system of distributive propulsion into effect? To begin with, a little over four years ago he built and operated his yacht, the *Dawn,* a craft 50 feet overall of 12 feet beam and drawing close to 4 feet of water when laden. By way of power plant he installed a prime mover in the form of a 60-horsepower gasoline engine, and this he connected directly with a 40-kilowatt electric generator working at 450 revolutions a minute. To drive the *Dawn* he provided a 20-horsepower motor directly connected to the propeller shaft, and this, when making 450 turns a minute, sufficed to give the boat a speed of 9 miles an hour. It will be observed that the generator was capable of furnishing more than double the current needed to energize the motor for the yacht's screw.

Last summer another yacht, the *New Era,* modeled and dimensioned like the *Dawn,* was constructed and equipt with a 20-horsepower motor for the little vessel's propulsion and arrangements were made by which the needful electricity could be supplied from the *Dawn* to insure a speed of 9 miles an hour. The conducting cable is led from a reel over an elevated pulley at the bow of the *Dawn* and thence thru the water to the stern of the *New Era,* where it is linked with the latter's operating circuit. This cable is less than an inch in diameter, and trails with a very modest pull astern of the *New Era,* looping easily and smoothly between the boats when they are maneuvering.

The *New Era* is provided with a number of storage batteries from which "juice" is drawn for lighting and cooking service when the yachts are at anchor. At one time during a trial run from New York City to Schenectady and return something went wrong with the *Dawn's* gasoline engine, which called for the machine's stoppage. However, the boats went right on—both of them obtaining, for the time being, their motive energy from the storage batteries of the *New Era.* The normally de-

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The Physiophone

By H. GERNSBACK.

(*Continued from page* 1253)

does. They have not the slightest conception of perspective and will invariably put the hands out before the eyes in order to judge the distance. The far away mountain will look to them just as near as a wall three feet away, and it is only gradually that a previously blind person learns to judge the distance, i. e., by experience.

The same is the case with the deaf person and physiological music. He must first learn the rhythm of the music, and after a

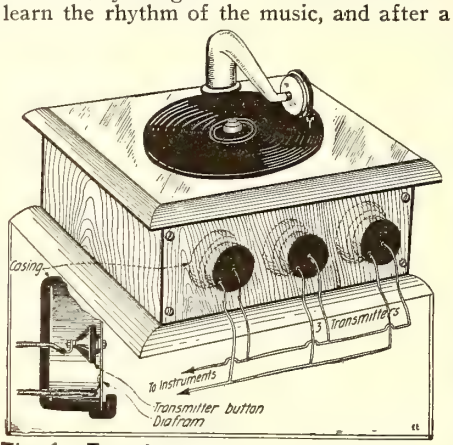


Fig. 1. Experiment to Transmit Sound Impulses Into Electrical Impulses. This Scheme Works Very Well to Transmit Music.

while it will become easy for him to understand what the music or even the human voice is like if introduced to him by means of the Physiophone.

I even go further and predict that sooner or later a totally deaf person will carry around with him an apparatus along the line of the "deaf-phone" type, the apparatus consisting of a sensitive microphone such as is used with the deaf-phones now. The microphone will be in series with a portable battery and telephone coil, while the secondaries of this coil will go to metallic wrist bands of the wearer. Then when he is spoken to he will soon be able to understand the meanings of the small electrical shocks which are the result of the human voice impinging upon the sensitive microphone.

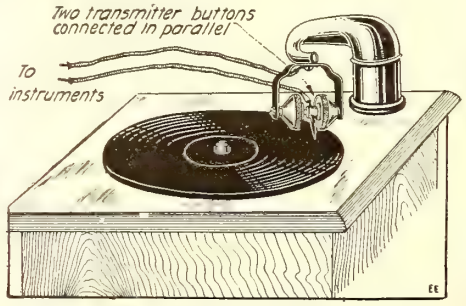


Fig. 2. Two Transmitter Buttons Connected in Parallel, Attached to Phonograph Arm. This Scheme Works Fairly Well For Transmission of Music, But Not so Well in Connection With the "Physiophone."

Coming back to our phonograph experiments, the deaf person can now enjoy dancing which he certainly could not do before, for he had no music or rhythm to dance by. One of our illustrations shows how deaf persons will now be able to dance by means of phonograph music and the Physiophone. The revolving wheel below the ceiling in the room or dance hall has flexible wires hanging down, which in turn connect with the secondaries of the telephone coils. These are connected with the microphone and battery near the phonograph in the manner stated above. Wires hanging down from this wheel connect to metal wrist pieces attached to each one of

(*Continued on page* 1322)

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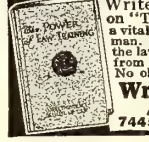
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SPECIAL NOTICE!

Of late we have received so many letters from our correspondents regarding patent advice, that it has been quite impossible to publish all of them.

Altho printed in the smallest type possible, we cannot accommodate more than ten or twelve answers a month. At the present time we are about four months behind. Of course, if our correspondents have time, no harm is done! We would however, advise that if a quicker answer is wanted, correspondents should avail themselves of our special service, as per the notice printed at the head of this column.

All letters are answered in turn as they come into this office, and for this reason it will be understood why it takes so long for an answer to be publisht. Will correspondents please bear this in mind?—EDITOR.

Printing Stamp.

(No. 380) Russell Fletchie of St. Louis, Mo., says as follows:

"I have an idea on which I would like to ask your advice.

"It is a rubber stamp working like a date stamp now greatly in use, but instead of the numerals running from 1 to 9-0, it has the alphabet upon each rotating line or rubber belt. This stamp could be made as wide as wished or as narrow by manufacturers. Instead of stamping dates it would be used to stamp words (any words). I think this would be a great deal better than the small printing outfits now sold in department and 10c stores."

A. This is a good idea, but is neither new nor very practical. It would be all right for somebody who had a tremendous amount of time to spare, otherwise it would be impractical. Take for instance, if you would wish to spell out the word *"extraordinary."* This would mean that you would require *thirteen* bands, and the average word having seven or eight letters, the amount of bands to manipulate would be very tedious, and we do not think that people would wish to bother with it.

Electro-Magnetic Brake.

(381) Ralph E. Hast, Elkins, W. Va., submits the following:

"A number of powerful electro-magnets are placed along the under frame of the cars directly above the rails, and very close to the rails. An automatic coupling socket is at the end of each car so that when the cars are coupled a circuit is completed. The amount of current used is determined by the number of cars, and is controlled by a rheostatic switch within the cab of the engine. The current is supplied by one or more generators in the engine, used in connection with storage batteries. The electro-magnets would be connected in series.

"This method of breaking would prevent the 'flat wheels' resulting from the present form of 'air brake' as the wheels would continue to revolve until the train came to a standstill.

"As additional cars are added to the train, more current is used when braking. This braking would also, I think, be more easily controlled.

"Of course the proximity of the electro-magnets to the rails would have to be determined by the average weight and speed of the cars."

A. There have been many patents taken on electro-magnetic brakes in the past, but for some reason they have not proved very successful, as none of them have been adopted to the best of our knowledge. It seems that electro-magnetic brakes do not stop the train very much quicker than an ordinary brake does. It should always be borne in mind that a train is heavy enough to brake itself once the ordinary brakes have been applied and the wheels grind along the rails. Any additional tractive effort on the rails would not be worth while expending extra energy. Besides in order to energize these electro-magnets, an extra current supply would be necessary, which is not always available on all trains.

Snow Melter.

(382) Hugh Reynolds, Brooklyn, N. Y., writes us:

"I have been very much astonished that New York was unable to run its street cars for weeks at a time because of the recent snow storm. I have personally examined the third rail slot and I convinced myself that in some cases ice covered all of them as high as one foot. It occurred to me that it should be possible for the traction companies to place an electrically heated boiler on a specially designed car and then generate steam. Three jets of steam would be expelled in front of the car, one for each rail and one for the trolley slot. With this steam it seems to me that it would be only a matter of a few hours to thaw out the railroad. Of course, where the snow and ice was over one foot thick the progress of the steam car melting its way thru the snow and ice would be naturally slow, perhaps only a few feet per hour. But, the main point is that in a day a vast stretch would thus be melted out. I would like to know why a scheme such as this is not practical? If so, please give me the reasons. If you think it is practical, could I obtain a patent on it?"

A. It seems that we have read of a similar scheme that had been tried before, somewhere in the West, but we believe it was not very successful. While it is possible to use a device of this kind, we think the main trouble lies in the fact that it is difficult to keep up sufficient steam by means of electrical power, because the amount of steam which would be required to do the thawing would be quite prodigious. Furthermore, it would not be practical just to thaw away the ice and snow *only* where it covered slot as well as the rails, because if the snow were deep enough the cars could not proceed unless *all* of the snow and ice had been melted on the roadbed, and this probably would require too much power. This is one of the reasons why we believe the scheme would not prove practical.

Patents and Citizenship.

(383) Max Kroner, Detroit, Mich., seeks our advice.

"I wish to apply for a patent in the United States, but I am not a citizen of this country, having been born in Denmark. Can I apply for a patent, and will the United States Patent Office grant me a patent if I do apply?"

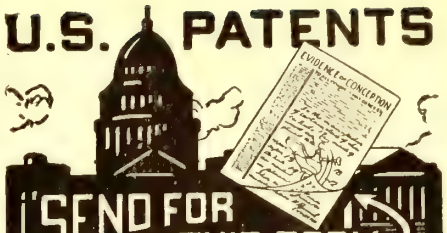
A. Yes. You can apply for a patent, and the United States Government will issue the patent to you. You will, however, have to state of what country you are a citizen in your application. You do not have to be a citizen of the United States to obtain a patent.

"Interference."

(384) Pierre Bordeaux of Los Angeles, Calif., writes to us:

"If I applied for a patent and another man has also applied for a patent at the same time on

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a similar device, who will get the patent? How does the Patent Office discriminate in such cases?"

A. This is technically termed "interference." In other words, when two inventors apply simultaneously for a patent as a rule the Patent Office throws the case out and the two inventors will have to revert to litigation.

The Physiophone

(*Continued from page* 1320)

the dancers. As soon as the music starts, the dancers become conscious of the music and begin to dance, enjoying the dancing, perhaps, even more than normal human beings, due to the electrifying effect of the current. As the dancers progress, the overhead wheel keeps turning so that the wires do not become entangled.

As for the normal human being he can also enjoy the physiological effect of the electrical current for the principal reason that Faradization is healthy and invigorating and entirely harmless. Another one of our illustrations shows what can be accomplisht along these lines for the normal

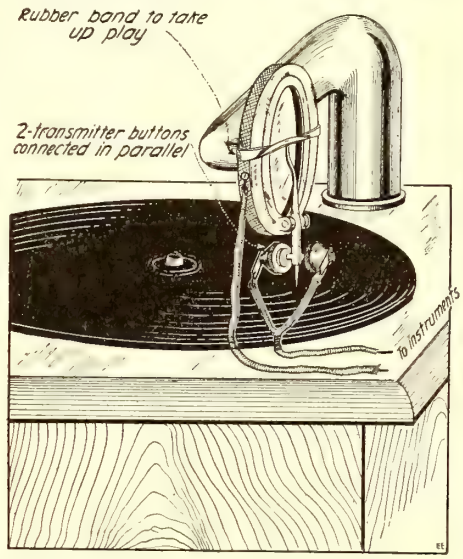
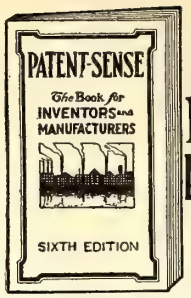


Fig. 3. Using Two Transmitter Buttons in Parallel. Note Feathering Arrangement.

human being. Picture a concert hall, along the stage of which a battery of sensitive microphones is located. The current is led to the primary of a large induction coil in series with the battery. Secondary leads go to metallic handles hung at the back of each orchestra chair thruout the theatre. As soon as the music starts, every one in the audience can grasp the handles, and they will now experience the novel effect of *not only hearing the music but also feeling it in a very invigorating manner.* This thing has already been tried out by the writer in a small way. It is perfectly possible to put your body in series with a loud-talker telephone. Of course, the music coming out of the horn will now be weakened, but if your hands are wet or moist, the weakening of the loud-talker music is not too great. You are now enabled to *hear* the music as well as *feel it.* It will be noted in one of the photographs that a rheostat is used, which is quite necessary to reduce the current. Some phonograph records as for instance band music are so loud and act so powerfully upon the microphone diafram that it is quite impossible to hold onto the handles comfortably. It should be noted that on some phonograph records not all the sounds can be transmitted. In other words, very high sounds do not make themselves felt at all, and some such records as the flute or other soft musical instruments do not lend themselves well for physiological effects. Records containing xylophone, piccolo, band music and the ones with singing voices are probably the best.



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The Electrical Machinist

(Continued from page 1278)

at Fig. 3-B. In leveling medium and large size dynamo and electric machinery, recourse is often had to the methods shown at Figs. 3-C and D. At Fig. 3-C a leveling trammel or bar is used, and this is placed across the two machined surfaces on front and rear of the motor or dynamo base.

As these are accurately machined and in perfect alignment with the two bearings of the machine, this invariably gives accurate results. However, this gives the alignment of the machine but in one position only, and it must also be leveled in a crosswise direction by placing the leveling trammel or bar across the machined surfaces where the field frame is secured.

The scheme of leveling shown at Fig. 3-D implies a taut cord or else a piece of shaft which may be past thru the two bearings of the motor frame. The frame is then leveled until the shaft shows it is at the correct point or else the frame is leveled until the bearings measure with equal spacing around the center cord or string. In this case also the base must be leveled in a crosswise direction, as at X, by placing a leveling board or bar across the two machined surfaces where the field frame will later rest.

SECURING MOTORS IN PLACE.

Small and medium-sized dynamos and motors are frequently secured in position after they have once been aligned with the shafting or other machinery which they are to drive, by means of lag bolts. A lag bolt is, in reality, a glorified wood screw, and it resembles a bolt at one end and a wood screw at the other, this end being brought to a point so that it can be driven into wood and then turned with a monkey wrench, which will cause it to thread its way into the wood the same as any ordinary screw.

At Fig. 4-A a motor is shown fastened to a wooden ceiling. It is usual to place two pieces of wooden joist across the feet of the motor as shown at A, and these joists are *lagged* to the wooden floor beams. The heads of the lag bolts should be countersunk down into the wood so that the surface of the joists present a perfectly level plane. Then the motor is blocked or held in position, and the feet of same are secured to the small cross-joists by the lag bolts. It is usually necessary to prevent splitting the wood with large lag bolts, to drill a small hole before they are started with the hammer and then turned with the monkey wrench.

At Fig. 4-B another method of motor installation is shown. The floor beams under which the motor is here secured may be of wood or concrete.

Cotter pins passing thru small holes drilled thru the ends of the bolts are best used, but some motor concerns who supply bolts for this purpose provide self-locking nuts, or else cut spring-lock washers, which are placed behind the nuts so that when these are tightened up against the washers, the spring in the washers will exert pressure against the nuts, and thus prevent them from being shaken or vibrated loose.

At Fig. 4-C one scheme for mounting a motor on a concrete floor is detailed. The motor is mounted on two wood stringers made of two pieces of joist placed under the feet of the motor. These joists are countersunk for lag bolts, which are threaded down into expansion sleeves placed in suitable holes drilled for them in the concrete. The motor is later placed on these wooden stringers and secured by suitable size lag bolts threaded down into the wooden joists.

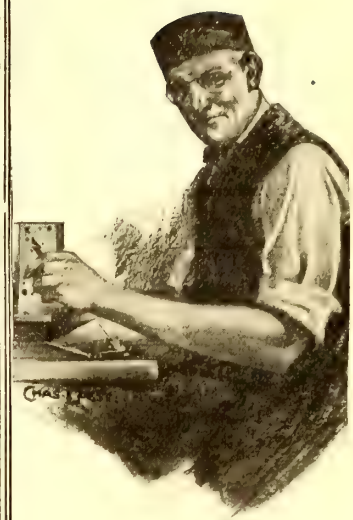
(This series to be continued.)

The toolmaker says:

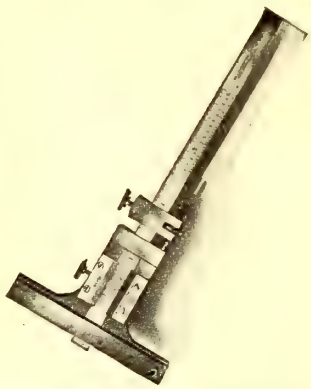
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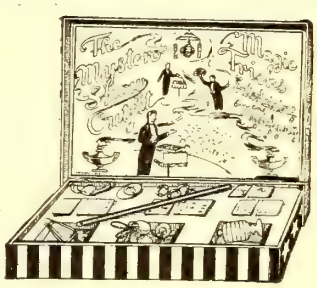
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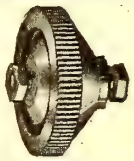
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The "Finer Workings" of Static Electricity

By FREDERICK VON LICHTENOW

(*Continued from page* 1275)

However, as I have stated before, *induction* takes place first, and that is what we have here to do with. Then follows attraction. After the short while occupied by neutralization of their "in-between" charges, the light objects retain only their induced "outer" charges (naturally opposite to those of their respective sources!) and upon separation fly, "stronger than ever" over to these and make contact with them (See Fig. 7-a).

The behavior of the balls during neutralization evidences in this as well as in experiment No. 4, Part 1, very graphically what I have said in reference to their properties as conductors and insulators. They are a mixture of both; they are the "Guinea pigs" of the electrostatic-research worker, for they respond to anything belonging in that sphere.

Whenever an object susceptible to an electrostatic charge is subjected to the neutralizing process while under the influence of an inductive (outside) force, such object will invariably become charged (in this case oppositely!) to the extent of holding the charge for a given period. In other words: if neutralization is followed *instantly* by induction, a charge will be effected without the usual resort to contact (with the charging body!). This is clearly demonstrated by the action of the gold leaves of an electroscope, when the latter is inductively charged. The *neutralizing process* is *the magic factor,* which makes this possible and, to emphasize again, it must take place "just ahead" of (almost simultaneously with!) the inductive action. This magic factor was made use of by the author in the successful workout of Experiments Nos. 3 and 4, of Part 1.

(*To be continued*)

Measuring Electric Current with the Eye

By C. A. BRIGGS

(*Continued from page* 1276)

the figure, by means of a potentiometer connected by leads to a standard resistance interposed in the circuit.

In using the device the current to be measured is past thru the bulb nearest the eyepiece and the current in the other bulb is varied until the observer sees that the filament at one point disappears against its background, on account of the intensities being matched. From the value of the current past thru the bulb at the closed end, as shown by the potentiometer, can be determined the current passing thru the other bulb.

A temporary set-up of an instrument of this character showed that very good results can be obtained. This accuracy is in part due to the fact that under ordinary circumstances a small change in the currents heating either filament will produce a proportionally greater change in the intensity of the illumination. It was found that by this arrangement the value of an electric current could be established to within an accuracy of two parts in a thousand; and with further development it is very probable that the accuracy could be increased. Before use this apparatus is calibrated against direct current instruments.

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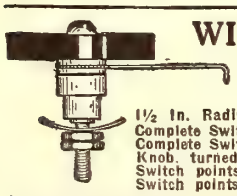
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Advertising Talks
NUMBER 6
(*Continued from page* 1296)

our columns clean and allow only reliable firms to use them. And if there are any readers who have not understood the point you bring up I hope they will read this letter carefully and write me if they feel they have not been justly treated in any transaction.

On the other hand, I do think that manufacturers should publish the shipping weight of all articles which they do not ship prepaid. Many of them do, but to those who don't I want to recommend it now, right here, and I hope that all who read this will think it over and follow the suggestion.

Write again, Mr. Reed.

Very cordially yours,

R. W. De Mott

Advertising Manager.

Some Long Distance Radio Telephone Tests
By ROBERT F. GOWEN
(*Continued from page* 1281)

reporting good reception when using only one receiving tube.

While continuing tests with Mr. Charles Candler at St. Mary's, Ohio, the signals and speech were picked up by Mr. R. H. G. Matthews, Chief Engineer of the Chicago Radio Laboratory at his Chicago Station. He reported that the speech could be heard plainly at a distance of over 10 feet from the telephone, altho the buzzer on the modulated wave was slightly louder. The power imput for these tests was 285 watts.

A continuance of tests with Mr. Matthews during the last week in January, brought in reports from Little Rock, Arkansas, and from Valley City, North Dakota, distances of about 1200 and 1500 miles respectively. Mr. Clayton at Little Rock reported the speech particularly understandable, but Mr. Pray at Valley City, North Dakota, stated that the speech was weak, but that he was using a very inefficient receiving set. In February, the speech was successfully heard and copied at Baudette, Minnesota, which is nearly as far away as Valley City, and many letters have been received from St. Paul, St. Louis, Minneapolis, and many cities in Michigan to the same effect. In the latter instances, however, the imput was increased to 510 watts and in one or two cases the tests were made on a prearranged schedule.

In practically every instance the reports were most enthusiastic as to the modulation or clearness of the speech. Whole spoken sentences were quoted and some even went so far as to comment upon the accent of the person talking. The reports unanimously indicated that once the receiving station found the tune of the transmitted wave, there was no difficulty in hearing the speech clearly and loudly. Mr. Candler at St. Mary's reported one night that he could not use his two steps of amplification as it hurt his ears. He telegraphed back that the writer's voice fairly screamed at him.

The experiments have shown that with a remarkably small power imput, stations practically half way across the United States can be reached even when the set is operating very inefficiently on an aerial and on wave-lengths for which it is not designed.

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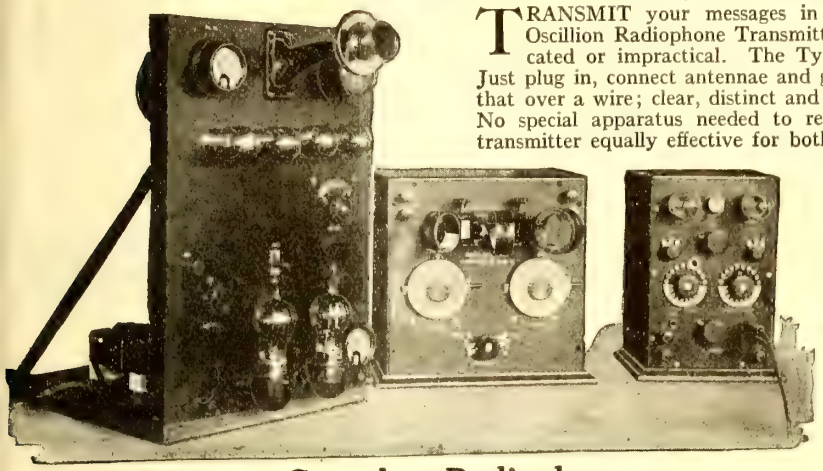
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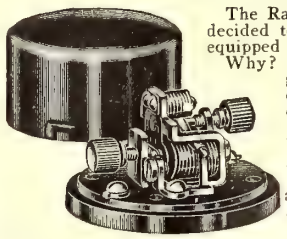
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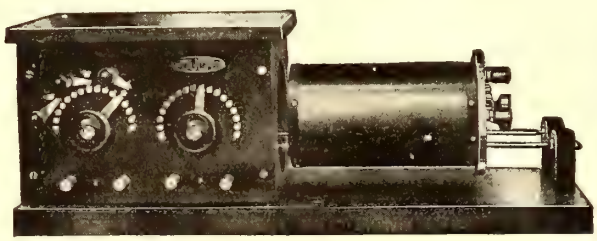
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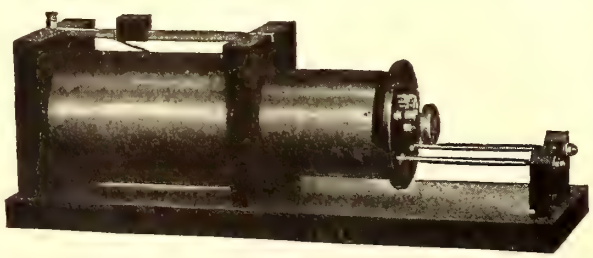
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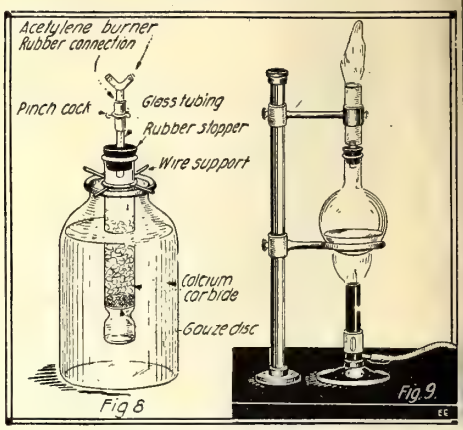
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By PROF. FLOYD L. DARROW

(*Continued from page* 127)



Here You Are, Boys. Make Your Own Gas Light for Your Lab.

A Gas Formed by Boiling Borax, Sulfuric Acid and Alcohol Gives a Beautiful Green Flame When Ignited.

Put the apparatus together as shown in figure 8. Then fill the chimney two-thirds full of lumps of calcium carbid and pour water into the bottle. Open the pinch cock and the water will rise thru the disc and coming in contact with the carbid will generate the acetylene, which in a few moments may be lighted at the burner.

PRODUCING A GREEN FLAME

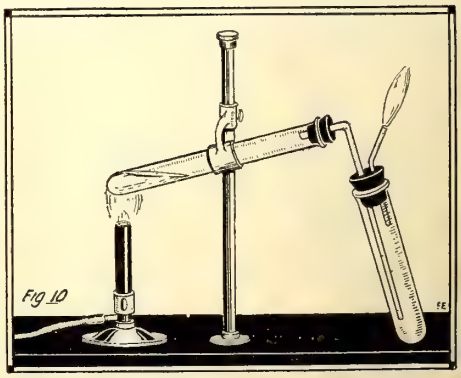
In a small flask place a mixture of 3 grams of borax, 3 c.c. of concentrated sulfuric acid and 20 c.c. of alcohol. In the neck of the flask insert a stopper and short length of glass tubing. Over this, as shown in figure 9, mount a short length of medium sized combustion tubing. Boil the mixture and light the vapor issuing from the top of the large tube. The result will be a brilliant green flame.

GENERATING COAL GAS.

Arrange apparatus as shown in figure 10, placing in the hard glass test tube some pulverized soft coal. Heat the tube strongly with a Bunsen burner flame and presently a gas will be given off which may be lighted at the end of the delivery tube, where it will burn with a luminous smoky flame.

In the condensing tube will be found a tarry distillate, which is commercially known as coal tar and is the source of a host of organic compounds.

In the hard glass tube will be left a steel gray residue of coke.



Even Coal Gas Generation Is Not Exempt, Provided You Have Two Test Tubes, a Burner and Some Sort of a Stand to Hold the Same. The Gas Coming From the Small Tip in the End of the Terminal Test Tube Can Be Ignited and Will Be Seen to Burn With a Luminous Flame.

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PREPARATION OF WATER GAS.

Water gas is one of the most important fuel and illuminating gases and may be prepared as follows:

Set up apparatus as shown in figure 11, using a hard glass combustion tube 18 inches long and ¾ of an inch in diameter. In the end of the tube next to the flask of boiling water insert a roll of previously ignited asbestos paper, into which the tube from the boiling flask should lead. The asbestos is to prevent the breaking of the tube from the condensation of steam. In the combustion tube place lumps of charcoal and heat them to redness with a 4-tube burner. Then boil water in the flask and pass the steam over the glowing charcoal.

REFINING CRUDE PETROLEUM

Arrange a distilling flask and condenser exactly as they were for the distillation of alcohol, as described in the February issue. *Be sure all connections are tight.*

In the flask place some glass beads and fill it half full of crude petroleum. The thermometer used should be able to register as high as 360° C. Having provided a wet towel to smother the flames in case of accident, begin heating the flask. Notice that the petroleum very soon begins to boil. Catch the distillate in a small dry flask and when the temperature has risen to 70° C., replace it with another flask. Continue the distillation changing the receiving flask at 80° C., 120° C. and 150° C. stopping when 300° C. has been reached. This will give five fractions and a thick tarry residue in the flask.

The products are practically the same as the petroleum products sold on the market:

Petroleum ether
Light gasoline
Heavy gasoline
Naptha
Kerosene
Lubricating oils, Vaseline, Parafine } Obtained from the residue in the flask.

Pour the residue from the flask while it is still hot and rinse the flask with gasoline.

FLASHING POINT OF KEROSENE

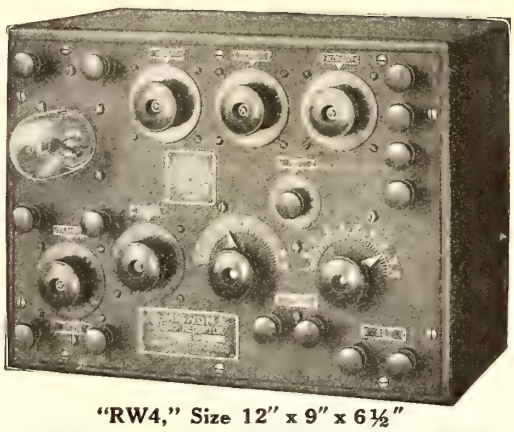
A sure index to the grade and safety of kerosene is its "flashing point." This is the temperature at which the vapor rising from oil will "flash" when a flame is brought near it.

In a tin cup placed over a Bunsen burner pour four tablespoonfuls of kerosene. Try to light it with a match. If it is a good grade of oil you will not succeed. Gently heat the cup and contents and at frequent intervals try to light the vapor, at the same time taking the temperature. The temperature at which the vapor will just ignite is approximately the *flashing point* of the oil. The flashing point of good grades of kerosene is from 120 F. to 140 F. If the oil does not simply flash and go out but continues to burn you have past the flashing point. In that case put out the flame by covering the cup with a glass plate and allow its contents to cool. Every minute or two test with a lighted match. The lowest temperature at which the vapor will just ignite is the *flashing point.*

(The next paper will appear in an early issue.)

ATTENTION!!!

RADIO, ELECTRICAL and CHEMICAL laboratory owners, refer to our monthly laboratory contest on Page No. 1288, for prizes offered for laboratory pictures. We have not received any worth while photos for several months. Now is the time to get busy with that camera and take a photo of your "Lab," and do not forget one of yourself! The more good ones we get, the more we will publish,—so send us some "real Lab" photos by the very next mail, won't you?



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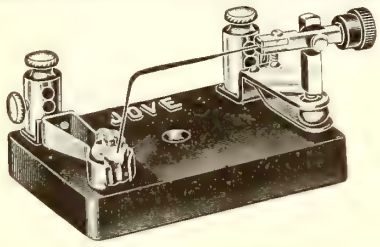
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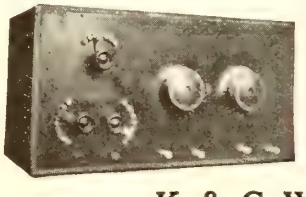
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War Versus Pre-War Apparatus

By "SPARKS", C. E. Radio U. S. N.

(*Continued from page* 1285)

ments are purchased intelligently and carefully, the amateur station can pick up signals from stations many thousand miles distant.

TRANSMITTING APPARATUS.

The prevailing question in Amateur circles in regard to transmitting apparatus seems to be whether or not it will be "arc or spark." Personally, I am firmly convinced that the spark will stay for some time to come. The arc is being widely developed commercially, but so is the spark, and for short wave lengths, the spark has proved the more satisfactory to date. In view of the rapid development of the arc, two or three manufacturers have put an amateur undampt wave transmitter on the market, all of which are excellent sets of their kind. They are capable of doing very good work with the small amount of power which they consume. They may also be used as radio telephones, with a slightly decreased range than when used as telegraph transmitters.

A vacuum tube transmitter is also on the market now, and looks promising, but the choice today lies with the individual Amateur. It will probably mean that a bunch of us will have to install arcs at the same time or let the old spark do the work for a few years longer. She has done so well in the past, and there is still such room for improvement in spark sets that it's a little early to think of undampt waves for two hundred meter work. Let's turn our attention to better results with the spark sets. Develop the non-synchronous rotaries. There is room and then some for improvement there. Get after them and let's see what can be done toward making an ideal spark set. Go after oil condensers, or at least those with reliable insulation. Oscillation transformers should be wound with heavy ribbon and of a width that will count—not quarter inch stuff, or even half. Make one or one and a half inches wide for a one-kilowatt set. Transformers, too, should be of proper design and are often better purchased than made at home. Above all, keep your leads short, and heavy, and get enough turns into your oscillation transformer to chase the energy across. What will a quarter turn in the primary do?—make it one and a half, and cut down your leads elsewhere.

There is a vast field for the development of a good spark coil set. We don't all live in the city where we can have "AC" by turning a switch. Get a spark coil with a good vibrator or substitute some sort of interrupter for the vibrator—they are woefully poor at best. Then see what you can do with it, and if you hit something real good, let us all know about it—don't keep it to yourself. In your spark coil experiments, tho, watch your wave, for the spark coil and little boy are the pests of the "relay game," and no one wants to be clast with them.

Get busy now, and let's see if we can't have some really good stations this season. We had scores before the war, but we want hundreds now. Let's have descriptions and data on the good stations and apparatus so that we may all benefit. I have made receiving outfits such as described herewith, and they have given me wonderful results. Lying in the harbor at Antwerp, Belgium, quite a way inland, I had no trouble in getting Arlington's spark, Tuckerton's alternator and several U. S. arcs, with one bulb. If they prove as satisfactory on short waves as they have proved on the long ones, I'm going to describe them for you fellows. Let's all do that.

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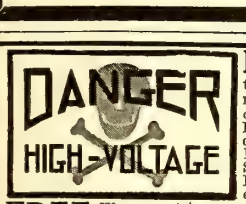
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Electricity Foils German Seals

By FRED C. KELLY

(*Continued from page* 1251)

One of the five men had establisht himself as a lookout in a public washroom down the corridor, a few paces from the outer door of the consulate.

It was arranged that if danger should threaten he would walk down the corridor and give two quick taps on the door. On the night mentioned he did hear some one coming up a stairway. Quickly he gave the alarm and then hastened back to his secret post in the lavatory. Then men who had been operating on the filing cases flicked off their electric light, which was a specially arranged one that illuminated only a limited area. They gained hiding places under tables and behind desks barely in time to be out of sight when the watchman, if such it was, opened the door and peered inside. But he was there evidently just as a matter of routine, in the course of his regular rounds, and did not chance to notice anything unusual about the office, tho one of the searchers was lying within four feet of him. After a moment or two he continued on his way.

Every detail of the plan of restoring the safes and filing cases to their usual condition was carefully thought out. One man was even assigned to the job of seeing to it that the dust on the filing cases was about as it had been. He swept up dust from the floor and placed it where finger marks might have showed.

The visits of the five men continued, beginning probably late in April, until the early part of July, and it is believed that in the early morning of the Fourth of July, by way of patriotic coincidence, the last of the German documents were removed from the consulate.

On this final visit the five men arranged to open a section of filing cases and also the steel trunk, which was locked and sealed about as the safes had been. It had been left until the last, because, for some reason, the men had an idea that the papers it contained might be of the least importance. The truth was that the Germans had intended this trunk to contain the most important documents of all.

But when the men succeeded in opening the one remaining section of the filing cases and this steel trunk they had a surprise that left them breathless.

Both the filing case and the steel strong box were already empty!

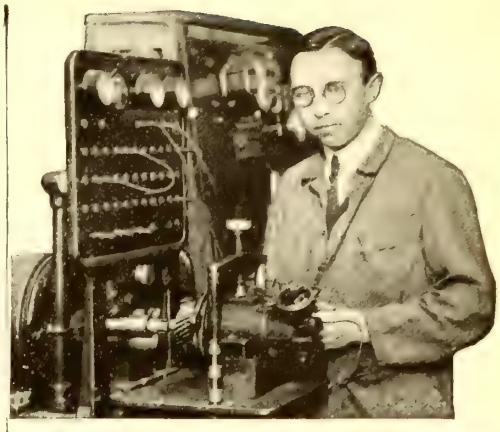
They had been carefully sealed up by the Germans without containing any papers at all. It is now pretty well understood that the papers had been secretly taken away by one of the Germans who was intrusted with the job of storing and sealing them up. Just what personal use he intended to make of them never has been disclosed. They were found by the merest chance, so I have been told, in two large suitcases and a steamer trunk in an obscure storage warehouse some weeks later.

When discovered these papers were promptly turned over to the United States Government. It so happened that they reached the possession of Government officials at about the same time as the other papers taken by the five adventurers from the consular offices.

FIVE ADVENTURERS UNKNOWN.

Thus it came about that the United States Government does not know even to this day how, when or by whom the papers were captured.

Having once obtained the papers, the Government set translators at work on them. The variety of information then acquired was really astounding, for the seized correspondence showed how intricately Germany had allied its industrial with its espionage system.—*New York Tribune.*



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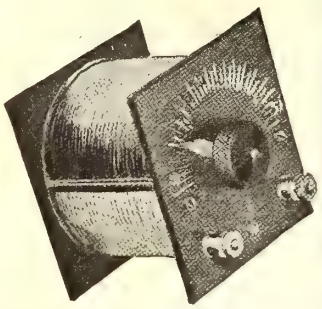
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We recommend our 43 plate condenser for primary and secondary tuning on sets of fair range and for use in oscillating circuits. Our 21 plate condenser is well adapted to short wave tuning for use in small wave meters and a great variety of work calling for a small variable capacity.

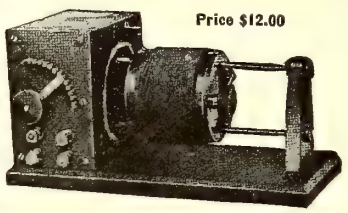
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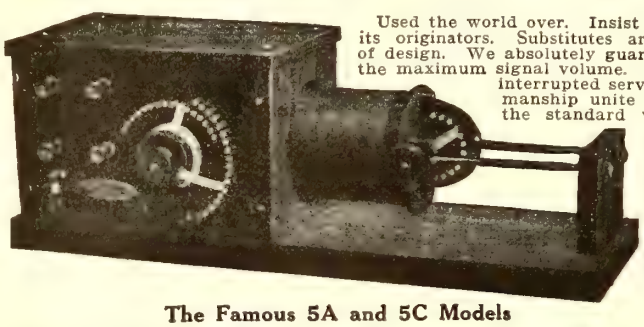
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The Battle Tracer

(*Continued from page* 1242)

tom of which is attached a driving whe with a perifery of sharp teeth preventir the Tracer from slipping off the table.

When a distant transmitter is actuate this motor in the Battle Tracer is simu taneously operated, causing the drivir wheel underneath the Tracer to move slov ly along the table, carrying the Tracer wi it. The distance traverst in this way exactly proportional to the actual distan traverst by the ship itself.

Lines of perforations are made by tl teeth of the driving wheel to trace tl course of our own vessel. The inner di likewise is made to turn by a third motc and the picture of the ship engraved upon will show the direction in which our vess is traveling. In other words, the engrav outline of the ship on the movable dial kept in plane with the rotation of the dri ing wheel carrying the Battle Tracer alo the table.

The pointer (D) heretofore describ going to the outer surface of the movat dial and the inner surface of the fixt di indicates on the outer dial (A) the tr compass bearing of the target, and wh read with reference to the inner dial (I indicates the true bearing of the targ with respect to the ship.

A second pointer (E) controlled by a other electric motor passes to the smalle of the three dials and gives a reading the speed of our own ship transmitted, has been stated, on the revolution co verter.

The enemy arm is continually bei moved in accordance with the range, cor ing from the target bearing transmitte On this arm is located a small carria having two pencil points, and traveling tiny rollers. The distance of this carria to the center of the Tracer is directly pr portional to the range of the target. Th distance is regulated by a fourth motc actuated by the auxiliary range transmitte On the big gun turrets of the battleship a the *range-finding* instruments. These i struments consist of an arm 30 feet lo with mirrors and lenses at each end; one set at a 90 degree angle and is moved un the operator's eye, looking thru a hc near the center of the instrument, spots t enemy. Immediately he attempts to twi the other end mirror so that the enen may be observed at the same time. Tl angle thus formed allows the computati of the range. The range thus determin is transmitted to the Tracer room, whe an operator turns the Auxiliary Ran Transmitter in accordance with the i formation he receives from the *range-fin ing* instrument. In this way communic tion to the Tracer is obtained.

Scales are provided for reading the ran directly. Likewise, pencil points operate on the ends of magnets controlled by clock, produce dots along side of the cours Now, then, let us see what all these resul come to. First, we plot automatically t communications directly from the propell shafts and gyro-compass the course ar speed of our ship on a large sheet of pape

This is one definite factor that is know Secondly, instruments, on the mast-hea of the vessel, keeping a "line" upon th enemy vessel, cause the enemy arm to tra another course upon the table. See di gram herewith.

All of this is figured out to mathematic accuracy and system of ratios so that the enemy is eight miles away, the penc

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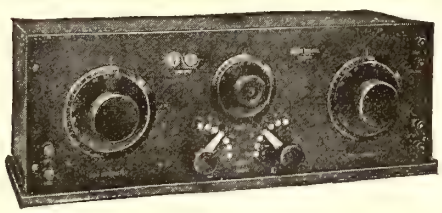
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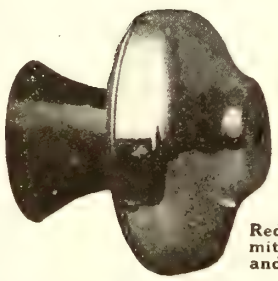
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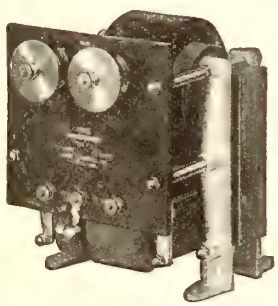
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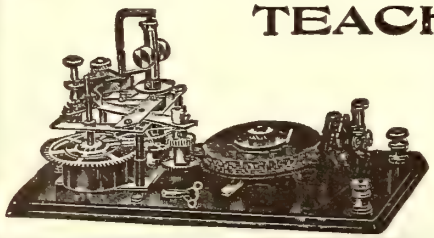
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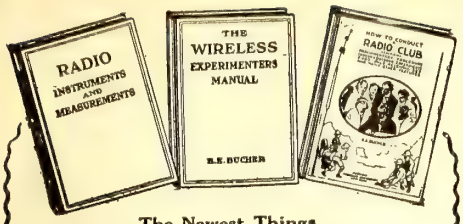
By EVERETT LEO DEETER

(*Continued from page* 1284)

other phenomenal qualities, before the thing is completely constructed. And don't dream about the Audions in diagram No. 2, for they are good ones, and these are used in place of a real old style coherer. The more bulbs the merrier. I used seventeen of them and saved the price of a relay, as you don't have to have one then, the relay action being quite strong indeed.

Open the door to diagram No. 4. The thumbscrew G holds the spring which pulls up the arm E thru the force of gravity, and thumbscrew A keeps it from pulling it on out into eternity. The one directly under the arm keeps the armature K from hitting the magnet cores. The two latter bolts set the arc thru which the arm E moves. It should come down just enough to move sprocket wheel one notch. The thumbscrew L is to adjust the wire connection between the two arms, which should be just tight when both arms are up, and allow the lower one to make contact at C. By sliding the arm B in the notch cut at end the time of raising of the sinker is varied, as it causes the float to go deeper in the water, thus taking it a longer time to raise. The spring arm U is to keep the wheel from moving back and to hold it in place. The coils may be from some discarded telegraph instrument, or may be hand-made and wound on a lathe, to about 15 ohms resistance. Both arms should be made of aluminum, and at least the one at the bottom, so as to lessen the weight on the float. The amount of water in the float will have to be tried by experiment. It then should be soldered water-tight, and onto the heavy wire arm (aluminum). The construction of the arm B is shown in the diagrams, as well as its support at N (diagram No. 1). The upper arm and magnets are mounted as shown in diagram No. 5. Diagram No. 4 gives details of a relay which can be made by the amateur, and coils should be about 1,000 ohms when combined. The rear of the board is shown in diagram No. 3. The switch segments are of copper and are nailed with brads, the connecting wire is wrapt around one brad and soldered. The brush C makes contact with the wheel B, on which the switch arm is connected. The switch should be made on the small board shown so that if at any time one should wish to add more points to his switch he could make a new board. He would also have to cut out another sprocket wheel. The brush C is connected to binding post G. The construction of bearings for the axle are given in diagrams. We can now consider the important features of the job as done, and the rest being a snap we will leave you to finish that yourself—we don't like snaps. My aerial snaps every time the wind blows.

Last on the curriculum is what to operate. The author had the following: An electric street car, battleship with cannon fired by electric spark, aimed at small German submarine which dipt out of sight as if blown apart; house lit by miniature lights; apparatus for raising flag by explosion in can; lights along railroad line and on battleship. These made a very attractive outfit to operate by wireless. There are many other interesting things that can be operated thus, and the enthusiastic amateur can think up plenty of them. But you will want to hunt for the nearest fire exit before you try some of them. And paste a diagram of your switch points on your sending outfit, with respective numbers, so you can tell how many times to push. "Good night."



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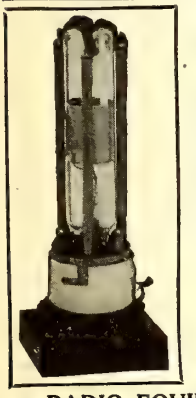
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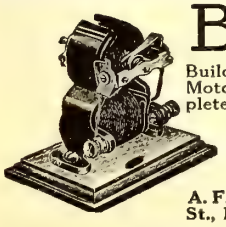
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The Educated Harpoon

By CHARLES S. WOLFE

(*Continued from page* 1256)

he invited, "come along. It's possible that an outsider might see something that we've all missed and you can't do any harm."

Nothing loathe, I accepted the invitation and rode down to the Atwood Building in the tonneau with Fenner. The Chief was busy driving and I managed to whisper to Fenner, "When did you get such a pull with the police?"

He gave an amused laugh. "Oh, I answer technical questions for them occasionally. My chief asset is the fact that few know that I have any interest in these affairs at all. You'll be a clam, I know."

The car stopped in front of the Atwood just then and I had no chance to question him further.

The Atwood was one of our skyscraper office buildings. The Chief entered the corridor, steered us into an elevator and we were whisked aloft. "Sixteenth floor," grunted the Chief to the operator, and we stept out into the corridor on that story.

Following Chief Davidson, we came to a suite of offices, the frosted glass of the door bearing the legend, "Corey & Co., General Offices." "Phew!" gasped Fenner. "Who was it? Not——?"

Davidson paused with his hand on the knob. "Yes, it was. Old John Corey and you can guess the commotion this'll make."

He flung open the door, and we filed in. The policeman on guard touched his cap in salute to his superior. We were in an outer office. Several desks were arranged around the room, and at one of them three girls huddled in a scared little group. One was sobbing softly. I noticed a man with his back toward us, looking out the window into space, apparently.

Paying no attention to the occupants of this room, Davidson strode across to a door marked "John Corey, Private." Opening it, he paused on the threshold. Fenner and I crowded at his back. Over his shoulder I could see into the inner office. A man, clad in a grey suit, was on the floor on his hands and knees. He looked up quickly.

"Come ahead," he said to the Chief, "you can't spoil any marks. There's nothing to spoil."

We entered.

Seated at a desk in the center of the room was a man. His head rested on the flat top of the desk, his arms flung forward before him. Davidson nodded toward him. "Just as he was found," he said, simply. It was my first sight of violent death.

Horror, or some other violent emotion, making my heart throb jerkily, I moved forward with Fenner, and looked down at the corpse.

A glance at the bowed back told the tale. The coat was soaked with blood, which had welled from a gaping wound below the left shoulder blade. I'll never tell you why I didn't faint. I wanted to.

Fenner turned to the man in grey. "What have you learned, Frank?" he asked.

Frank, who was evidently a detective, shook his head gloomily. "Nothing," he replied, "except what you see. He's been stabbed, that's evident, and whoever did it took the weapon away with him. But how he got in here, and how he got out, God alone knows. I've been over this floor on my hands and knees with a microscope. There's not a mark. Not a foot print in the dust, except those made by Corey himself. Not'ng. Not a finger print on the walls,

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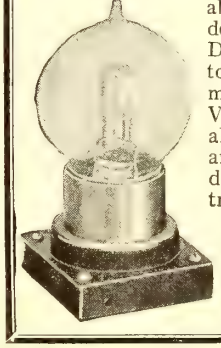
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on the desk, on the body, on the floor, on the door knob—inside or out—not anywhere. It's beyond me."

"Couldn't come in thru the outer office, eh?" Fenner's eyes were roving over the room. Frank shook his head slowly in negation. "Three girls and the head bookkeeper out there all evening, working overtime. All swear not one of them has been in this room this evening. Corey came in thru the outer office—the only way he could come in, for this office has only the one entrance—and closed the door. About half past eight one of the girls opened the door to come in. She saw that something had happened to Corey, and she didn't cross the threshold. All of them had sense enough to stay out. They telephoned for us. I was the first man in."

"No other doors?"

"Nope. Only one way in. Thru that office."

Fenner was gazing at the wall on the street side. "Did you open that window?" he asked.

"No. It was open. But it might as well have been bricked up for all the good it's going to do us. Corey opened it himself, no doubt. It's just sixteen stories to the street, and you can bet no one climbed up to it. It's five stories to the roof. One chance in one thousand that any one climbed down. It would take nerves of steel to drop over the edge on a rope, and if some one did have the nerve, they couldn't have gotten in that window noiselessly enough not to warn Corey. And just assuming that they did, they'd surely leave a mark doing it, wouldn't they?"

Fenner nodded. "They would indeed," he acquiesed. "How about the people in the office out there? Are they all above suspicion?"

"All above it," complained Frank, "and not only that, but the very number of them lets them out without question. It's not reasonable to suppose that three girls and a man, all trusted employees, would conspire to kill their employer without a motive for doing so. One of them might try it, or maybe even two, but it's hardly likely that all four would be against the man."

"Right you are," admitted Fenner, "I thought that way myself, but we have to eliminate the possibility of an inside job first. Well, Chief, I don't see that I can do you any good in this matter. It is unusual enough to be interesting, and if you don't mind I'll drop in and have a look around in the morning.

"Help yourself," gloomed Davidson. "I don't believe you can do anything in this case myself. I just took a chance. You might have, you know."

"I wish that I could have. And I'll look it over in the morning on the off chance. Good night, Frank, and good luck. Good night, Chief. Come on, Bill," And we left.

As we walked homeward, Fenner said: "It seems that the day of miracles is not gone by, after ail. What do you think of that for a puzzle?"

"It's beyond me," I replied, soberly. "The only possible explanation that I can think of is that the man committed suicide."

Joe stood still and rocked with laughter. "Oh, Bill, Bill," he gasped, "there's only one man in a million—yes, I'll make it a billion—that commits suicide by stabbing himself in the back, to say nothing of calmly disposing of the weapon just after he's dead."

"Well, then," I demanded, sullenly, "how do you account for the thing?"

He grew thoughtful at once. "I can't," he admitted, "unless ——"

"Unless what?" I asked, as he paused.

"Unless—unless—well, I wouldn't want to say unless anything just now. Would you like to go down with me again tomorrow morning?"

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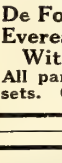
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"I certainly would," I rejoined, instantly. "This thing's got my goat."

"All right, then. I'll stop for you on my way down."

I lay awake for hours trying to figure out how the thing could have been done. There didn't seem to be a plausible explanation. If the facts in the case had been handed to me as a sort of a puzzle, I would have said that it simply couldn't be done. And yet—there was the dead man.

Eventually I gave it up and fell into a restless slumber.

* * * * * * *

Next morning Fenner called for me as arranged. "Well," he asked, cheerfully, "have you solved the mystery over night?"

"No," I said. "It seems more baffling than ever after a night's thought. Have you found the answer?"

"Not yet. Do you happen to have a good pair of field glasses?"

I had, and I produced them. "That's fine," said Fenner after examining them. "Let's go."

We had no trouble getting into Corey's offices. The body had been removed, and practically all traces of the tragedy had disappeared.

Fenner dropped into the chair which so lately had been used by the hapless victim. As he sat at the desk his back was to the window, which had been closed.

"Well," he mused, "how was this man killed? If this chair could only talk. Suppose I was across the street in another building. Ah! Say I'm an old whaler. I have a harpoon and a coil of rope. The window is open in this office. That broad back is a fine target ——. Bill, look out that window and see if I couldn't do it."

I turned to Fenner, and in my most sarcastic tones I said: "You could, Joe, if you had an educated harpoon. After you threw it, it would pause cannily in mid-air, turn at an angle of forty-five degrees, leap agiley up about six stories, make another forty-five degree turn, slide gracefully thru the window, and ——."

But Fenner was on his feet and beside me. His face was grave, but his eyes twinkled. "Sufficient, William," he said, "your sarcasm is excellent, but I'm too busy to listen to the rest of it. Let's have those field glasses."

Ten minutes past. I began to grow fidgety, when he suddenly handed the glasses to me. "Bill," he said, "do you see that building out there—the one that appears to be as high as this one?"

"I do," I replied. "That could only be the Yeakle. It and the Atwood are the two tallest buildings we have."

"Well, look it over carefully, and tell me if you make out a clothes line on the roof."

I gazed. At first I didn't see one, but presently I located it. I told Fenner that there was undoubtedly a clothes line there.

"So I thought," he said, absently. "Well—let's call Davidson over here. It's up to him now."

I stared, amazed. "Up to him," I parroted. "What's up to him?"

"The arrest of the murderer," said Fenner, rather impatiently. "You're on to the thing, aren't you?"

"Do you mean that you know who killed Corey?" I asked, excitedly, as Fenner reached for the telephone.

He paused with his hand on the receiver. "No, I don't. But I know what he was killed with—and Davidson will find out the rest."

"Well," I demanded, "what was he killed with?"

Fenner called a number into the 'phone and gave me a sweet smile over his shoulder as he waited. "That chunk of clothes line, and——" he grew exceedingly sarcastic, "an educated harpoon."

Nor would he say more until Davidson, with Frank at his heels, burst into the room seething with excitement.

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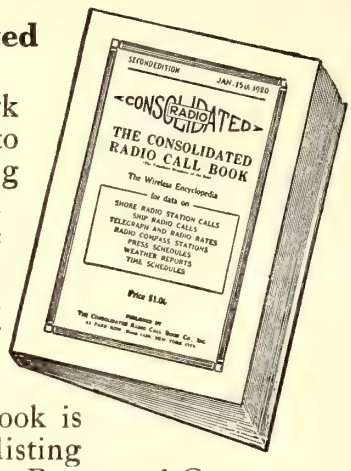
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"What's this, Joe," panted the Chief. "Find something? Got anything?"

Joe leaned back in his chair, and I saw that he was enjoying himself immensely. "Yes, Chief," he said, cheerfully, "I know what Corey was killed with."

The Chief darted a fiery glance at Frank. "Find it in here some place, did you?" he barked.

"No," I could positively feel Frank's relief, "but I know what it was done with."

"Damn," exploded the Chief. "So do I. It was a knife, but where——"

"Oh, no, it wasn't," smiled Fenner. "It was a harpoon."

The Chief's lower jaw sagged and Frank darted to the window. Then he turned back listlessly to Joe. "Come again, Fenner," he said. "It can't be done."

"Not from those buildings below very handy," admitted Joe, "but this harpoon came from the Yeakle."

The Chief laughed shortly. "That's a poor joke, Joe," he snapt. "The Yeakle is a good quarter of a mile away."

Fenner laughed. "Yes, but this was an *educated harpoon,*" he said.

The detective Frank gave a sudden start. "I get you, Fenner," he yelled, and he was in motion while he spoke. "And I'll get him and bring him here."

"Hey," yelled the Chief, "What——"

But a slamming door was the only answer. Frank was gone.

Davidson turned to Fenner. "What kind of a game is this?" he demanded. "You're a pair of crazy asses, you and Frank. Now tell me what you're up to."

"Bright boy, Frank," observed Fenner, "it didn't take him long to tumble, once he got the tip. Now sit down and wait until he gets back."

For a half hour we waited in silence. Fenner smoked nonchalantly and refused to talk. The Chief fumed and paced the room. "A waste of time," he muttered again and again. The minutes dragged by.

And then the door opened and Frank pusht into our presence a swarthy little man with waxt mustaches and a decidedly foreign air. He was handcuffed. Two uniformed policemen came behind, bearing a long wooden box, which they placed on the desk. "Here's the bird, Chief," chortled Frank; "Fenner you're a dandy."

The Chief and I stared. "Sure you got the right man?" he demanded. Then to the prisoner, "What have you got to say? Remember, it may be used against you."

"There is nothing to say," said the prisoner, in perfect English, "except that I killed Corey——"

"You confess?" yelled the Chief.

The man shrugged hopelessly. "Confess!" he echoed, "what else is there to do? I suppose you want to know why. Well, because Corey ruined me financially. He stole my purse; I stole his life. But I'd like to know how you picked up the trail."

Fenner stept over to the unfortunate man. "I found it," he said, simply. "Why didn't you keep that clothes line of yours indoors?"

The man started, paled, then cried in anguish, "My God, I never thought of that. I could have, couldn't I?"

"You could," agreed Fenner, grimly, "and if you had, you never would have been caught. Send him over, Chief, and I'll tell you how the trick was done."

The man departed in charge of the two officers and Fenner tore the lid off the wooden box which the officers had brought. He turned to me. "And here, Bill," he said, mockingly, "is your educated harpoon."

And he placed before my astonished eyes an educated harpoon in very truth. It was a small airplane, wirelessly controlled, and its nose was a long, bayonet-like knife.

"Then the clothes line——"

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